THE COMPLETE WORKS OF ARISTOTLE

THE REVISED OXFORD TRANSLATION

Edited by Jonathan Barnes

VOLUME ONE

PRINCETON / BOLLINGEN SERIES LXXI · 2

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CONTENTS

Volume One

Volume Two

PREFACE

BENJAMIN JOWETT published his translation of Aristotle's *Politics* in 1885, and he nursed the desire to see the whole of Aristotle done into English. In his will he left the perpetual copyright on his writings to Balliol College, desiring that any royalties should be invested and that the income from the investment should be applied "in the first place to the improvement or correction" of his own books, and "secondly to the making of New Translations or Editions of Greek Authors." In a codicil to the will, appended less than a month before his death, he expressed the hope that "the translation of Aristotle may be finished as soon as possible."

The Governing Body of Balliol duly acted on Jowett's wish: J. A. Smith, then a Fellow of Balliol and later Waynflete Professor of Moral and Metaphysical Philosophy, and W. D. Ross, a Fellow of Oriel College, were appointed as general editors to supervise the project of translating all of Aristotle's writings into English; and the College came to an agreement with the Delegates of the Clarendon Press for the publication of the work. The first volume of what came to be known as The Oxford Translation of Aristotle appeared in 1908. The work continued under the joint guidance of Smith and Ross, and later under Ross's sole editorship. By 1930, with the publication of the eleventh volume, the whole of the standard *corpus aristotelicum* had been put into English. In 1954 Ross added a twelfth volume, of selected fragments, and thus completed the task begun almost half a century earlier.

The translators whom Smith and Ross collected together included the most eminent English Aristotelians of the age; and the translations reached a remarkable standard of scholarship and fidelity to the text. But no translation is perfect, and all translations date: in 1976, the Jowett Trustees, in whom the copyright of the Translation lies, determined to commission a revision of the entire text. The Oxford Translation was to remain in substance its original self; but alterations were to be made, where advisable, in the light of recent scholarship and with the requirements of modern readers in mind.

The present volumes thus contain a revised Oxford Translation: in all but three treatises, the original versions have been conserved with only mild emendations. (The three exceptions are the *Categories* and *de Interpretatione*, where the translations of J. L. Ackrill have been substituted for those of E. M. Edgehill, and the *Posterior Analytics*, where G. R. G. Mure's version has been replaced by that of J. Barnes. The new translations have all been previously published in the Clarendon Aristotle series.) In addition, the new Translation contains the tenth book of the *History of Animals*, and the third book of the *Economics*, which were not done for the original Translation; and the present selection from the fragments of Aristotle's lost works includes a large number of passages which Ross did not translate.

In the original Translation, the amount and scope of annotation differed greatly from one volume to the next: some treatises carried virtually no footnotes, others (notably the biological writings) contained almost as much scholarly commentary as text—the work of Ogle on the *Parts of Animals* or of d'Arcy Thompson on the *History of Animals*, Beare's notes to *On Memory* or Joachim's to *On Indivisible Lines*, were major contributions to Aristotelian scholarship. Economy has demanded that in the revised Translation annotation be kept to a minimum; and all the learned notes of the original version have been omitted. While that omission represents a considerable impoverishment, it has reduced the work to a more manageable bulk, and at the same time it has given the constituent translations a greater uniformity of character. It might be added that the revision is thus closer to Jowett's own intentions than was the original Translation.

The revisions have been slight, more abundant in some treatises than in others but amounting, on the average, to some fifty alterations for each Bekker page of Greek. Those alterations can be roughly classified under four heads.

(i) A quantity of work has been done on the Greek text of Aristotle during the past half century: in many cases new and better texts are now available, and the reviser has from time to time emended the original Translation in the light of this research. (But he cannot claim to have made himself intimate with all the textual studies that recent scholarship has thrown up.) A standard text has been taken for each treatise, and the few departures from it, where they affect the sense, have been indicated in footnotes. On the whole, the reviser has been conservative, sometimes against his inclination.

(ii) There are occasional errors or infelicities of translation in the original version: these have been corrected insofar as they have been observed.

(iii) The English of the original Translation now seems in some respects archaic in its vocabulary and in its syntax: no attempt has been made to impose a consistently modern style upon the translations, but where archaic English might mislead the modern reader, it has been replaced by more current idiom.

(iv) The fourth class of alterations accounts for the majority of changes made by the reviser. The original Translation is often paraphrastic: some of the translators used paraphrase freely and deliberately, attempting not so much to English Aristotle's Greek as to explain in their own words what he was intending to convey—thus translation turns by slow degrees into exegesis. Others construed their task more narrowly, but even in their more modest versions expansive paraphrase from time to time intrudes. The revision does not pretend to eliminate paraphrase altogether (sometimes paraphrase is venial; nor is there any precise boundary between translation and paraphrase); but it does endeavor, especially in the logical and philosophical parts of the *corpus*, to replace the more blatantly exegetical passages of the original by something a little closer to Aristotle's text.

The general editors of the original Translation did not require from their translators any uniformity in the rendering of technical and semitechnical terms. Indeed, the translators themselves did not always strive for uniformity within a single treatise or a single book. Such uniformity is surely desirable; but to introduce it would have been a massive task, beyond the scope of this revision. Some effort has, however, been made to remove certain of the more capricious variations of translation (especially in the more philosophical of Aristotle's treatises).

Nor did the original translators try to mirror in their English style the style of Aristotle's Greek. For the most part, Aristotle is terse, compact, abrupt, his arguments condensed, his thought dense. For the most part, the Translation is flowing and expansive, set out in well-rounded periods and expressed in a language which is usually literary and sometimes orotund. To that extent the Translation produces a false impression of what it is like to read Aristotle in the original; and indeed it is very likely to give a misleading idea of the nature of Aristotle's philosophizing, making it seem more polished and finished than it actually is. In the reviser's opinion, Aristotle's sinewy Greek is best translated into correspondingly tough English; but to achieve that would demand a new translation, not a revision. No serious attempt has been made to alter the style of the original—a style which, it should be said, is in itself elegant enough and pleasing to read.

The reviser has been aided by several friends; and he would like to acknowledge in particular the help of Mr. Gavin Lawrence and Mr. Donald Russell. He remains acutely conscious of the numerous imperfections that are left. Yet—as Aristotle himself would have put it—the work was laborious, and the reader must forgive the reviser for his errors and give him thanks for any improvements which he may chance to have effected.

March 1981 J. B.

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THE TRANSLATIONS of the *Categories* and the *de Interpretatione* are reprinted here by permission of Professor J. L. Ackrill and Oxford University Press (© Oxford University Press, 1963); the translation of the *Posterior Analytics* is reprinted by permission of Oxford University Press (© Oxford University Press, 1975); the translation of the third book of the *Economics* is reprinted by permission of The Loeb Classical Library (William Heinemann and Harvard University Press); the translation of the fragments of the *Protrepticus* is based, with the author's generous permission, on the version by Professor Ingemar Düring.

NOTE TO THE READER

THE TRADITIONAL *corpus aristotelicum* contains several works which were certainly or probably not written by Aristotle. A single asterisk against the title of a work indicates that its authenticity has been seriously doubted; a pair of asterisks indicates that its spuriousness has never been seriously contested. These asterisks appear both in the Table of Contents and on the title pages of the individual works concerned.

The title page of each work contains a reference to the edition of the Greek text against which the translation has been checked. References are by editor's name, series or publisher (OCT stands for Oxford Classical Texts), and place and date of publication. In those places where the translation deviates from the chosen text and prefers a different reading in the Greek, a footnote marks the fact and indicates which reading is preferred; such places are rare.

The numerals printed in the outer margins key the translation to Immanuel Bekker's standard edition of the Greek text of Aristotle of 1831. References consist of a page number, a column letter, and a line number. Thus "1343^{a}" marks column one of page 1343 of Bekker's edition; and the following "5," "10," "15," etc. stand against lines 5, 10, 15, etc. of that column of text. Bekker references of this type are found in most editions of Aristotle's works, and they are used by all scholars who write about Aristotle.

NOTE (1994): This is an unrevised reprint of the first edition; but a small number of typographical errors have been corrected. Many of these errors were generously communicated to the editor by Mr. M. W. Dunn, who recorded the translation for the blind.

THE COMPLETE WORKS OF ARISTOTLE

CATEGORIES

J. L. Ackrill

1 · When things have only a name in common and the definition of being which corresponds to the name is different, they are called *homonymous*. Thus, for example, both a man and a picture are animals. These have only a name in common and the definition of being which corresponds to the name is different; for if one is to say what being an animal is for each of them, one will give two distinct definitions.

When things have the name in common and the definition of being which corresponds to the name is the same, they are called *synonymous*. Thus, for example, both a man and an ox are animals. Each of these is called, by a common name, an animal, and the definition of being is also the same; for if one is to give the definition of each—what being an animal is for each of them—one will give the same definition.

When things get their name from something, with a difference of ending, they are called *paronymous*. Thus, for example, the grammarian gets his name from grammar, the brave get theirs from bravery.

2 · Of things that are said, some involve combination while others are said without combination. Examples of those involving combination are: man runs, man wins; and of those without combination: man, ox, runs, wins.

Of things there are: (*a*) some are *said of* a subject but are not *in* any subject. For example, man is said of a subject, the individual man, but is not in any subject. (*b*) Some are in a subject but are not said of any subject. (By 'in a subject' I mean what is in something, not as a part, and cannot exist separately from what it is in.) For example, the individual knowledge-of-grammar is in a subject, the soul, but is not said of any subject; and the individual white is in a subject, the body (for all colour is in a body), but is not said of any subject. (*c*) Some are both said of a subject and in a subject. For example, knowledge is in a subject, the soul, and is also said of a subject, knowledge-of-grammar. (*d*) Some are neither in a subject nor said of a subject, for example, the individual man or the individual horse—for nothing of this sort is either in a subject or said of a subject. Things that are individual and numerically one are, without exception, not said of any subject, but there is nothing to prevent some of them from being in a subject—the individual knowledge-of-grammar is one of the things in a subject.

TEXT: L. Minio-Paluello, OCT, Oxford, 1956, 2nd ed.

3 · Whenever one thing is predicated of another as of a subject, all things said of what is predicated will be said of the subject also. For example, man is predicated of the individual man, and animal of man; so animal will be predicated of the individual man also—for the individual man is both a man and an animal.

The differentiae of genera which are different[1] and not subordinate one to the other are themselves different in kind. For example, animal and knowledge: footed, winged, aquatic, two-footed, are differentiae of animal, but none of these is a differentia of knowledge; one sort of knowledge does not differ from another by being two-footed. However, there is nothing to prevent genera subordinate one to the other from having the same differentiae. For the higher are predicated of the genera below them, so that all differentiae of the predicated genus will be differentiae of the subject also.

4 · Of things said without any combination, each signifies either substance or quantity or qualification or a relative or where or when or being-in-a-position or having or doing or being-affected. To give a rough idea, examples of substance are man, horse; of quantity: four-foot, five-foot; of qualification: white, grammatical; of a relative: double, half, larger; of where: in the Lyceum, in the market-place; of when: yesterday, last-year; of being-in-a-position: is-lying, is-sitting; of having: has-shoes-on, has-armour-on; of doing: cutting, burning; of being-affected: being-cut, being-burned.

None of the above is said just by itself in any affirmation, but by the combination of these with one another an affirmation is produced. For every affirmation, it seems, is either true or false; but of things said without any combination none is either true or false (e.g. man, white, runs, wins).

5 · A *substance*—that which is called a substance most strictly, primarily, and most of all—is that which is neither said of a subject nor in a subject, e.g. the individual man or the individual horse. The species in which the things primarily called substances are, are called *secondary substances,* as also are the genera of these species. For example, the individual man belongs in a species, man, and animal is a genus of the species; so these—both man and animal—are called secondary substances.

It is clear from what has been said that if something is said of a subject both its name and its definition are necessarily predicated of the subject. For example, man is said of a subject, the individual man, and the name is of course predicated (since you will be predicating man of the individual man), and also the definition of man will be predicated of the individual man (since the individual man is also a man). Thus both the name and the definition will be predicated of the subject. But as for things which are in a subject, in most cases neither the name nor the definition is predicated of the subject. In some cases there is nothing to prevent the name from being predicated of the subject, but it is impossible for the definition to be

[1] Read τῶν ἑτέρων γενῶν.

predicated. For example, white, which is in a subject (the body), is predicated of the subject; for a body is called white. But the definition of white will never be predicated of the body.

All the other things are either said of the primary substances as subjects or in them as subjects. This is clear from an examination of cases. For example, animal is predicated of man and therefore also of the individual man; for were it predicated of none of the individual men it would not be predicated of man at all. Again, colour is in body and therefore also in an individual body; for were it not in some individual body it would not be in body at all. Thus all the other things are either said of the primary substances as subjects or in them as subjects. So if the primary substances did not exist it would be impossible for any of the other things to exist.[2]

Of the secondary substances the species is more a substance than the genus, since it is nearer to the primary substance. For if one is to say of the primary substance what it is, it will be more informative and apt to give the species than the genus. For example, it would be more informative to say of the individual man that he is a man than that he is an animal (since the one is more distinctive of the individual man while the other is more general); and more informative to say of the individual tree that it is a tree than that it is a plant. Further, it is because the primary substances are subjects for all the other things and all the other things are predicated of them or are in them, that they are called substances most of all. But as the primary substances stand to the other things, so the species stands to the genus: the species is a subject for the genus (for the genera are predicated of the species but the species are not predicated reciprocally of the genera). Hence for this reason too the species is more a substance than the genus.

But of the species themselves—those which are not genera—one is no more a substance than another: it is no more apt to say of the individual man that he is a man than to say of the individual horse that it is a horse. And similarly of the primary substances one is no more a substance than another: the individual man is no more a substance than the individual ox.

It is reasonable that, after the primary substances, their species and genera should be the only other things called secondary substances. For only they, of things predicated, reveal the primary substance. For if one is to say of the individual man what he is, it will be in place to give the species or the genus (though more informative to give man than animal); but to give any of the other things would be out of place—for example, to say white or runs or anything like that. So it is reasonable that these should be the only other things called substances. Further, it is because the primary substances are subjects for everything else that they are called substances most strictly. But as the primary substances stand to everything else, so the species and genera of the primary substances stand to all the rest: all the rest are predicated of these. For if you will call the individual man grammatical, then you will call both a man and an animal grammatical; and similarly in other cases.

[2]The Oxford text continues: 'For all the other things are either said of these as subjects or in them as subjects; so that if the primary substances did not exist, it would be impossible for any of the other things to exist.' Most scholars excise those sentences.

It is a characteristic common to every substance not to be in a subject. For a primary substance is neither said of a subject nor in a subject. And as for secondary substances, it is obvious at once that they are not in a subject. For man is said of the individual man as subject but is not in a subject: man is not *in* the individual man. Similarly, animal also is said of the individual man as subject, but animal is not *in* the individual man. Further, while there is nothing to prevent the name of what is in a subject from being sometimes predicated of the subject, it is impossible for the definition to be predicated. But the definition of the secondary substances, as well as the name, is predicated of the subject: you will predicate the definition of man of the individual man, and also that of animal. No substance, therefore, is in a subject.

This is not, however, peculiar to substance, since the differentia also is not in a subject. For footed and two-footed are said of man as subject but are not in a subject; neither two-footed nor footed is *in* man. Moreover, the definition of the differentia is predicated of that of which the differentia is said. For example, if footed is said of man the definition of footed will also be predicated of man; for man is footed.

We need not be disturbed by any fear that we may be forced to say that the parts of a substance, being in a subject (the whole substance), are not substances. For when we spoke of things *in a subject* we did not mean things belonging in something as *parts.*

It is a characteristic of substances and differentiae that all things called from them are so called synonymously. For all the predicates from them are predicated either of the individuals or of the species. (For from a primary substance there is no predicate, since it is said of no subject; and as for secondary substances, the species is predicated of the individual, the genus both of the species and of the individual. Similarly, differentiae too are predicated both of the species and of the individuals.) And the primary substances admit the definition of the species and of the genera, and the species admits that of the genus; for everything said of what is predicated will be said of the subject also. Similarly, both the species and the individuals admit the definition of the differentiae. But synonymous things were precisely those with both the name in common and the same definition. Hence all the things called from substances and differentiae are so called synonymously.

Every substance seems to signify a certain 'this'. As regards the primary substances, it is indisputably true that each of them signifies a certain 'this'; for the thing revealed is individual and numerically one. But as regards the secondary substances, though it appears from the form of the name—when one speaks of man or animal—that a secondary substance likewise signifies a certain 'this', this is not really true; rather, it signifies a certain qualification—for the subject is not, as the primary substance is, one, but man and animal are said of many things. However, it does not signify simply a certain qualification, as white does. White signifies nothing but a qualification, whereas the species and the genus mark off the qualification of substance—they signify substance of a certain qualification. (One draws a wider boundary with the genus than with the species, for in speaking of animal one takes in more than in speaking of man.)

Another characteristic of substances is that there is nothing contrary to them. For what would be contrary to a primary substance? For example, there is nothing contrary to an individual man, nor yet is there anything contrary to man or to animal. This, however, is not peculiar to substance but holds of many other things also, for example, of quantity. For there is nothing contrary to four-foot or to ten or to anything of this kind—unless someone were to say that many is contrary to few or large to small; but still there is nothing contrary to any *definite* quantity.

Substance, it seems, does not admit of a more and a less. I do not mean that one substance is not more a substance than another (we have said that it is), but that any given substance is not called more, or less, that which it is. For example, if this substance is a man, it will not be more a man or less a man either than itself or than another man. For one man is not more a man than another, as one pale thing is more pale than another and one beautiful thing more beautiful than another. Again, a thing is called more, or less, such-and-such than itself; for example, the body that is pale is called more pale now than before, and the one that is hot is called more, or less, hot. Substance, however, is not spoken of thus. For a man is not called more a man now than before, nor is anything else that is a substance. Thus substance does not admit of a more and a less.

It seems most distinctive of substance that what is numerically one and the same is able to receive contraries. In no other case could one bring forward anything, numerically one, which is able to receive contraries. For example, a colour which is numerically one and the same will not be black and white, nor will numerically one and the same action be bad and good; and similarly with everything else that is not substance. A substance, however, numerically one and the same, is able to receive contraries. For example, an individual man—one and the same—becomes pale at one time and dark at another, and hot and cold, and bad and good.

Nothing like this is to be seen in any other case, unless perhaps someone might object and say that statements and beliefs are like this. For the same statement seems to be both true and false. Suppose, for example, that the statement that somebody is sitting is true; after he has got up this same statement will be false. Similarly with beliefs. Suppose you believe truly that somebody is sitting; after he has got up you will believe falsely if you hold the same belief about him. However, even if we were to grant this, there is still a difference in the *way* contraries are received. For in the case of substances it is by themselves changing that they are able to receive contraries. For what has become cold instead of hot, or dark instead of pale, or good instead of bad, has changed (has altered); similarly in other cases too it is by itself undergoing change that each thing is able to receive contraries. Statements and beliefs, on the other hand, themselves remain completely unchangeable in every way; it is because the *actual thing* changes that the contrary comes to belong to them. For the statement that somebody is sitting remains the same; it is because of a change in the actual thing that it comes to be true at one time and false at another. Similarly with beliefs. Hence at least the *way* in which it is able to receive contraries—through a change in itself—would be distinctive of substance, even if we were to grant that beliefs and statements are able to receive contraries. However, this is not true. For it is not because they themselves receive anything that statements and beliefs are said to be able to receive contraries, but because of what has happened to something else. For it is because the actual thing exists or does not exist that the statement is said to be true or false, not because it is able itself to receive contraries. No statement, in fact, or belief is changed at all by anything. So, since nothing happens in them, they are not able to receive contraries. A substance, on the other hand, is said to be able to receive contraries because it itself receives contraries. For it receives sickness and health, and paleness and darkness; and because it itself receives the various things of this kind it is said to be able to receive contraries. It is, therefore, distinctive of substance that what is numerically one and the same is able to receive contraries. This brings to an end our discussion of substance.

6 · Of quantities some are discrete, others continuous; and some are composed of parts which have position in relation to one another, others are not composed of parts which have position.

Discrete are number and language; continuous are lines, surfaces, bodies, and also, besides these, time and place. For the parts of a number have no common boundary at which they join together. For example, if five is a part of ten the two fives do not join together at any common boundary but are separate; nor do the three and the seven join together at any common boundary. Nor could you ever in the case of a number find a common boundary of its parts, but they are always separate. Hence number is one of the discrete quantities. Similarly, language also is one of the discrete quantities (that language is a quantity is evident, since it is measured by long and short syllables; I mean here language that is *spoken*). For its parts do not join together at any common boundary. For there is no common boundary at which the syllables join together, but each is separate in itself. A line, on the other hand, is a continuous quantity. For it is possible to find a common boundary at which its parts join together, a point. And for a surface, a line; for the parts of a plane join together at some common boundary. Similarly in the case of a body one could find a common boundary—a line or a surface—at which the parts of the body join together. Time also and place are of this kind. For present time joins on to both past time and future time. Place, again, is one of the continuous quantities. For the parts of a body occupy some place, and they join together at a common boundary. So the parts of the place occupied by the various parts of the body, themselves join together at the same boundary at which the parts of the body do. Thus place also is a continuous quantity, since its parts join together at one common boundary.

Further, some quantities are composed of parts which have position in relation to one another, others are not composed of parts which have position. For example, the parts of a line have position in relation to one another: each of them is situated somewhere, and you could distinguish them and say where each is situated in the plane and which one of the other parts it joins on to. Similarly, the parts of a plane have some position here again: one could say where each is situated and which join on to one another. So, too, with the parts of a solid and the parts of a place. With a number, on the other hand, one could not observe that the parts have some position in relation to one another or are situated somewhere, nor see which of the parts join on to one another. Nor with the parts of a time either; for none of the parts of a time endures, and how could what is not enduring have any position? Rather might you say that they have a certain *order* in that one part of a time is before and another after. Similarly with a number also, in that one is counted before two and two before three; in this way they may have a certain order, but you would certainly not find position. And language similarly. For none of its parts endures, once it has been uttered it can no longer be recaptured; and so its parts cannot have position, seeing that none of them endures. Some quantities then are composed of parts which have position, others are not composed of parts which have position.

Only these we have mentioned are called quantities strictly, all the others derivatively; for it is to these we look when we call the others quantities. For example, we speak of a large amount of white because the *surface* is large, and an action or a change is called long because the *time* is long. For it is not in its own right that each of these others is called a quantity. For example, if one is to say how long an action is, one will determine this by the time, saying that it is a-year-long or something of that sort; and in saying how much white one will determine it by the surface—whatever the size of the surface one will say that the white too is that size. Thus only those we mentioned are called quantities strictly and in their own right, while nothing else is so in its own right but, if at all, derivatively.

Next, a quantity has no contrary. In the case of definite quantities it is obvious that there is no contrary; there is, for example, no contrary to four-foot or five-foot or to a surface or anything like that. But might someone say that many is contrary to few or large to small? None of these, however, is a quantity; they are relatives. For nothing is called large or small just in itself, but by reference to something else. For example, a mountain is called small yet a grain of millet large—because one is larger than other things of its kind while the other is smaller than other things of its kind. Thus the reference is to something else, since if a thing were called small or large in itself the mountain would never be called small yet the grain of millet large. Again, we say that there are many people in the village but few in Athens—though there are many times more here than there; and that there are many in the house but few in the theatre—though there are many more here than there. Further, 'four-foot', 'five-foot', and the like all signify a quantity, but 'large' or 'small' does not signify a quantity but rather a relative, since the large and the small are looked at in relation to something else. So it is clear that these are relatives.

Moreover, whether one counts them as quantities or does not, they have no contrary. For how could there be any contrary to what cannot be grasped just in itself but only by reference to something else? Further, if large and small are to be contraries it will turn out that the same thing admits contraries at the same time, and that things are their own contraries. For the same thing turns out to be at the same time both large and small—since in relation to this thing it is small but in relation to another this same thing is large; so the same thing turns out to be both large and small at the same time and thus to admit contraries at the same time. But 6a1 nothing seems to admit contraries at the same time. In the case of a substance, for example, while it seems to be able to receive contraries, yet it is certainly not at the same time ill and well nor is it at the same time pale and dark; nor does anything else admit contraries at the same time. It turns out also that things are their own contraries. For if large is contrary to small, and the same thing is at the same time large and small, a thing would be its own contrary. But it is impossible for a thing to be its own contrary. Large, therefore, is not contrary to small, nor many to few. So that even if someone says that these belong not to relatives but to quantity, it will still have no contrary.

But it is most of all with regard to place that there seems to be contrariety of a quantity. For people regard up as contrary to down—meaning by 'down' the region towards the centre—because the centre is at the greatest distance from the limits of the world. And they probably derive from these their definition of the other contraries also; for they define as contraries those things in the same genus which are most distant from one another.

A quantity does not seem to admit of a more and a less. Four-foot for example: one thing is not more four-foot than another. Or take number: we do not speak of a three as more three than a five, nor of one three as more three than another three. Nor yet is one time called more a time than another. Nor is there a single one, among those we listed, as to which a more and a less is spoken of. Hence a quantity does not admit of a more and a less.

Most distinctive of a quantity is its being called both equal and unequal. For each of the quantities we spoke of is called both equal and unequal. For example, a body is called both equal and unequal, and a number is called both equal and unequal, and so is a time; so also with the others we spoke of, each is called both equal and unequal. But anything else—whatever is not a quantity—is certainly not, it would seem, called equal and unequal. For example, a condition is certainly not called equal and unequal, but, rather, similar; and white is certainly not equal and unequal, but similar. Thus most distinctive of a quantity would be its being called both equal and unequal.

7 · We call *relatives* all such things as are said to be just what they are, *of* or *than* other things, or in some other way *in relation to* something else. For example, what is larger is called what it is *than* something else (it is called larger than something); and what is double is called what it is *of* something else (it is called 6b1 double of something); similarly with all other such cases. The following, too, and their like, are among relatives: state, condition, perception, knowledge, position. For each of these is called what it is (and not something different) *of* something else. A state is called a state of something, knowledge knowledge of something, position position of something, and the rest similarly. All things then are relative which are called just what they are, *of* or *than* something else—or in some other way *in relation to* something else. Thus a mountain is called large in relation to something else (the mountain is called large in relation to something); and what is similar is

called similar *to* something; and the others of this kind are in the same way spoken of in relation to something.

Lying, standing, and sitting are particular positions; position is a relative. To-be-lying, to-be-standing, or to-be-sitting are themselves not positions, but they get their names paronymously from the aforesaid positions.

There is contrariety in relatives, e.g. virtue is contrary to vice (and each of them is relative), and knowledge to ignorance. But there is not a contrary to every relative; there is no contrary to what is double or treble or anything like that.

Relatives seem also to admit of a more and a less. For a thing is called more similar and less similar, and more unequal and less unequal; and each of these is relative, since what is similar is called similar *to* something and what is unequal unequal *to* something. But not all admit of a more and less; for what is double, or anything like that, is not called more double or less double.

All relatives are spoken of in relation to correlatives that reciprocate. For example, the slave is called slave of a master and the master is called master of a slave; the double double of a half, and the half half of a double; the larger larger than a smaller, and the smaller smaller than a larger; and so for the rest too. Sometimes, however, there will be a verbal difference, of ending. Thus knowledge is called knowledge *of* what is knowable, and what is knowable knowable *by* knowledge; perception perception *of* the perceptible, and the perceptible perceptible *by* perception.[3]

Sometimes, indeed, they will not seem to reciprocate—if a mistake is made and that in relation to which something is spoken of is not given properly. For example, if a wing is given as *of a bird, bird of a wing* does not reciprocate; for it has not been given properly in the first place as wing of a bird. For it is not as being a bird that a wing is said to be of it, but as being a winged, since many things that are not birds have wings. Thus if it is given properly there is reciprocation; for example, a wing is wing of a winged and a winged is winged with a wing.

It may sometimes be necessary even to invent names, if no name exists in relation to which a thing would be given properly. For example, if a rudder is given as *of a boat,* that is not to give it properly (for it is not as being a boat that a rudder is said to be of it, since there are boats which have not got rudders); and so there is not reciprocation—a boat is not called boat of a rudder. But perhaps it would be given more properly if given thus, that a rudder is rudder of (or somehow else related to) a 'ruddered' (since there is no established name); and now there *is* reciprocation, if it is given properly—a ruddered is ruddered by a rudder. Similarly in other cases. For example, a head would be more properly given as of a headed than as of an animal, because it is not as being an animal that a thing has a head, since many animals have not got a head. This is perhaps the easiest way to lay hold of things for which there are no established names—if names derived from the original relatives are assigned to their reciprocating correlatives, as in the above case 'winged' was derived from 'wing' and 'ruddered' from 'rudder'.

All relatives, then, are spoken of in relation to correlatives that reciprocate,

[3] The function performed in English by "of" and "by" is performed in Greek by the genitive and dative cases, which have different endings.

provided they are properly given. For, of course, if a relative is given as related to some chance thing and not to just that thing in relation to which it is spoken of, there is not reciprocation. I mean that even with relatives that are admittedly spoken of in relation to correlatives that reciprocate and for which names exist, none reciprocates if a relative is given as related to something accidental and not to just that thing in relation to which it is spoken of. For example, if a slave is given as of—not a master, but—a man or a biped or anything else like that, there is not reciprocation; for it has not been given properly.

Again, if that in relation to which a thing is spoken of is properly given, then, when all the other things that are accidental are stripped off and that alone is left to which it was properly given as related, it will always be spoken of in relation to that. For example, if a slave is spoken of in relation to a master, then, when everything accidental to a master is stripped off—like being a biped, capable of knowledge, a man—and there is left only being a master, a slave will always be spoken of in relation to that. For a slave is called slave of a master. On the other hand, if that in relation to which a thing is spoken of is not properly given, then, when the other things are stripped off and that alone is left to which it was given as related, it will not be spoken of in relation to that. Suppose a slave is given as *of a man* and a wing as *of a bird,* and strip off from man his being a master; a slave will no longer be spoken of in relation to a man, for if there is no master there is no slave either. Similarly, strip off from bird its being winged; a wing will no longer be a relative, for if there is nothing winged neither will there be a wing of anything.

One must therefore give as correlative whatever it is properly spoken of in relation to; and if a name already exists it is easy to give this, but if it does not it may be necessary to invent a name. When correlatives are given thus it is clear that all relatives will be spoken of in relation to correlatives that reciprocate.

Relatives seem to be simultaneous by nature; and in most cases this is true. For there is at the same time a double and a half, and when there is a half there is a double, and when there is a slave there is a master; and similarly with the others. Also, each carries the other to destruction; for if there is not a double there is not a half, and if there is not a half there is not a double. So too with other such cases.

Yet it does not seem to be true of all relatives that they are simultaneous by nature. For the knowable would seem to be prior to knowledge. For as a rule it is of actual things already existing that we acquire knowledge; in few cases, if any, could one find knowledge coming into existence at the same time as what is knowable. Moreover, destruction of the knowable carries knowledge to destruction, but knowledge does not carry the knowable to destruction. For if there is not a knowable there is not knowledge—there will no longer be anything for knowledge to be of—but if there is not knowledge there is nothing to prevent there being a knowable. Take, for example, the squaring of the circle, supposing it to be knowable; knowledge of it does not yet exist but the knowable itself exists. Again, if animal is destroyed there is no knowledge, but there may be many knowables.

The case of perception is similar to this; for the perceptible seems to be prior to perception. For the destruction of the perceptible carries perception to destruction, but perception does not carry the perceptible to destruction. For perceptions are to do with body and in body, and if the perceptible is destroyed, body too is destroyed (since body is itself a perceptible), and if there is not body, perception too is destroyed; hence the perceptible carries perception to destruction. But perception does not carry the perceptible. For if animal is destroyed perception is destroyed, but there will be something perceptible, such as body, hot, sweet, bitter, and all the other perceptibles. Moreover, perception comes into existence at the same time as what is capable of perceiving—an animal and perception come into existence at the same time—but the perceptible exists even before perception exists; fire and water and so on, of which an animal is itself made up, exist even before there exists an animal at all, or perception. Hence the perceptible would seem to be prior to perception.

It is a problem whether (as one would think) *no* substance is spoken of as a relative, or whether this is possible with regard to some secondary substances. In the case of primary substances it is true; neither wholes nor parts are spoken of in relation to anything. An individual man is not called someone's individual man, nor an individual ox someone's individual ox. Similarly with parts; an individual hand is not called someone's individual hand (but someone's hand), and an individual head is not called someone's individual head (but someone's head). Similarly with secondary substances, at any rate most of them. For example, a man is not called someone's man nor an ox someone's ox nor a log someone's log (but it is called someone's property). With such cases, then, it is obvious that they are not relatives, but with some secondary substances there is room for dispute. For example, a head is called someone's head and a hand is called someone's hand, and so on; so that these would seem to be relatives.

Now if the definition of relatives given above was adequate, it is either exceedingly difficult or impossible to reach the solution that no substance is spoken of as a relative. But if it was not adequate, and if those things are relatives for which *being is the same as being somehow related to something,* then perhaps some answer may be found. The previous definition does, indeed, apply to all relatives, yet this—their being called what they are, of other things—is not what their being relatives is.

It is clear from this that if someone knows any relative definitely he will also know definitely that in relation to which it is spoken of. This is obvious on the face of it. For if someone knows of a certain 'this' that it is a relative, and being for relatives is the same as being somehow related to something, he knows that also to which this is somehow related. For if he does not in the least know that to which this is somehow related, neither will he know whether it is somehow related to something. The same point is clear also in particular cases. For example, if someone knows definitely of a certain 'this' that it is double he also, by the same token, knows definitely what it is double of; for if he does not know it to be double anything definite neither does he know whether it is double at all. Similarly, if he knows of a certain 'this' that it is more beautiful, he must also, because of this, know definitely what it is more beautiful than. (He is not to know *indefinitely* that this is more beautiful than an inferior thing. For that sort of thing is supposition, not knowledge. For he will no longer strictly *know* that it is more beautiful than an inferior thing, since it may so happen that there is nothing inferior to it.) It is plain, therefore, that anyone who knows any relative definitely must know definitely that also in relation to which it is spoken of.

But as for a head or a hand or any such substance, it is possible to know it—what it itself is—definitely, without necessarily knowing definitely that in relation to which it is spoken of. For whose this head is, or whose the hand, it is not necessary[4] to know definitely. So these would not be relatives. And if they are not relatives it would be true to say that no substance is a relative.

It is perhaps hard to make firm statements on such questions without having examined them many times. Still, to have gone through the various difficulties is not unprofitable.

8 · By a *quality* I mean that in virtue of which things are said to be qualified somehow. But quality is one of the things spoken of in a number of ways.

One kind of quality let us call *states* and *conditions*. A state differs from a condition in being more stable and lasting longer. Such are the branches of knowledge and the virtues. For knowledge seems to be something permanent and hard to change if one has even a moderate grasp of a branch of knowledge, unless a great change is brought about by illness or some other such thing. So also virtue; justice, temperance, and the rest seem to be not easily changed. It is what are easily changed and quickly changing that we call conditions, e.g. hotness and chill and sickness and health and the like. For a man is in a certain condition in virtue of these but he changes quickly from hot to cold and from being healthy to being sick. Similarly with the rest, unless indeed even one of these were eventually to become through length of time part of a man's nature and irremediable or exceedingly hard to change—and *then* one would perhaps call this a state. It is obvious that by a state people do mean what is more lasting and harder to change. For those who lack full mastery of a branch of knowledge and are easily changed are not said to be in a state of knowledge, though they are of course in some condition, a better or a worse, in regard to that knowledge. Thus a state differs from a condition in that the one is easily changed while the other lasts longer and is harder to change.

States are also conditions but conditions are not necessarily states. For people in a state are, in virtue of this, also in some condition, but people in a condition are not in every case also in a state.

Another kind of quality is that in virtue of which we call people boxers or runners or healthy or sickly—anything, in short, which they are called in virtue of a natural capacity or incapacity. For it is not because one is in some condition that one is called anything of this sort, but because one has a natural capacity for doing something easily or for being unaffected. For example, people are called boxers or runners not because they are in some condition but because they have a natural

[4] Read *οὐκ ⟨ἀναγκαῖόν⟩ ἐστιν εἰδέναι*. The received text says: '. . . it is not *possible* to know definitely.'

capacity to do something easily; they are called healthy because they have a natural capacity not to be affected easily by what befalls them, and sickly because they have an incapacity to be unaffected. Similarly with the hard and the soft: the hard is so called because it has a capacity not to be divided easily, the soft because it has an incapacity for this same thing.

A third kind of quality consists of *affective qualities* and *affections*. Examples of such are sweetness, bitterness, sourness, and all their kin, and also hotness and coldness and paleness and darkness. That these are qualities is obvious, for things that possess them are said to be qualified in virtue of them. Thus honey because it possesses sweetness is called sweet, and a body pale because it possesses paleness, and similarly with the others. They are called *affective* qualities not because the things that possess them have themselves been affected somehow—for honey is not called sweet because it has been affected somehow nor is any other such thing. Similarly, hotness and coldness are not called affective qualities because the things that possess them have themselves been affected somehow, but it is because each of the qualities mentioned is productive of an affection of the senses that they are called affective qualities. For sweetness produces a certain affection of taste, hotness one of touch, and the rest likewise.

Paleness and darkness, however, and other colourings are not called affective qualities in the same way as those just mentioned, but because they themselves have been brought about by an affection. That many changes of colour do come about through an affection is clear; when ashamed one goes red, when frightened one turns pale, and so on. And so if somebody suffers by nature from some such affection it is reasonable that he should have the corresponding colouring. For the very same bodily condition which occurs now when one is ashamed might occur also in virtue of a man's natural make-up, so that the corresponding colouring too would come about by nature.

When such circumstances have their origin in affections that are hard to change and permanent they are called qualities. For if pallor or darkness have come about in the natural make-up they are called qualities (for in virtue of them we are said to be qualified); and if pallor or darkness have resulted from long illness or from sunburn, and do not easily give way—or even last for a lifetime—these too are called qualities (since, as before, in virtue of them we are said to be qualified). But those that result from something that easily disperses and quickly gives way are called affections; for people are not, in virtue of them, said to be qualified somehow. Thus a man who reddens through shame is not called ruddy, nor one who pales in fright pallid; rather he is said to have been affected somehow. Hence such things are called affections but not qualities.

Similarly with regard to the soul also we speak of affective qualities and affections. Those which are present right from birth as a result of certain affections are called qualities, for example, madness and irascibility and the like; for in virtue of these people are said to be qualified, being called irascible and mad. Similarly with any aberrations that are not natural but result from some other circumstances, and are hard to get rid of or even completely unchangeable; such things, too, are qualities, for in virtue of them people are said to be qualified. But those which result from things that quickly subside are called affections, e.g. if a man in distress is rather bad-tempered; for the man who in such an affection is rather bad-tempered is not said to be bad-tempered, but rather he is said to have been affected somehow. Hence such things are called affections but not qualities.

A fourth kind of quality is shape and the external form of each thing, and in addition straightness and curvedness and anything like these. For in virtue of each of these a thing is said to be qualified somehow; because it is a triangle or square it is said to be qualified somehow, and because it is straight or curved. And in virtue of its form each thing is said to be qualified somehow.

'Rare' and 'dense' and 'rough' and 'smooth' might be thought to signify a qualification; they seem, however, to be foreign to the classification of qualifications. It seems rather to be a certain position of the parts that each of them reveals. For a thing is dense because its parts are close together, rare because they are separated from one another; smooth because its parts lie somehow on a straight line, rough because some stick up above others.

Perhaps some other manner of quality might come to light, but we have made a pretty complete list of those most spoken of.

These, then, that we have mentioned are *qualities,* while things called paronymously because of these or called in some other way from them are *qualified.* Now in most cases, indeed in practically all, things are called paronymously, as the pale man from paleness, the grammatical from grammar, the just from justice, and so on. But in some cases, because there are no names for the qualities, it is impossible for things to be called paronymously from them. For example, the runner or the boxer, so called in virtue of a natural capacity, is not called paronymously from any quality; for there are no names for the capacities in virtue of which these men are said to be qualified—as there *are* for the branches of knowledge in virtue of which men are called boxers or wrestlers with reference to their condition (for we speak of boxing and of wrestling as branches of knowledge, and it is paronymously from them that those in the condition are said to be qualified). Sometimes, however, even when there is a name for a quality, that which is said to be qualified in virtue of it is not so called paronymously. For example, the good man is so called from virtue, since it is because he has virtue that he is called good; but he is not called paronymously from virtue. This sort of case is, however, rare. Things then that are called paronymously from the qualities we mentioned, or called from them in some other way, are said to be qualified.

There is contrariety in regard to qualification. For example, justice is contrary to injustice and whiteness to blackness, and so on; also things said to be qualified in virtue of them—the unjust to the just and the white to the black. But this is not so in all cases; for there is no contrary to red or yellow or such colours though they are qualifications.

Further, if one of a pair of contraries is a qualification, the other too will be a qualification. This is clear if one examines the other predicates. For example, if justice is contrary to injustice and justice is a qualification, then injustice too is a qualification. For none of the other predicates fits injustice, neither quantity nor relative nor where nor in fact any other such predicate except qualification. Similarly with the other contraries that involve qualification.

Qualifications admit of a more and a less; for one thing is called more pale or less pale than another, and more just than another. Moreover, it itself sustains increase (for what is pale can still become paler)—not in all cases though, but in most. It might be questioned whether one justice is called more a justice than another, and similarly for the other conditions. For some people dispute about such cases. They utterly deny that one justice is called more or less a justice than another, or one health more or less a health, though they say that one person has health less than another, justice less than another, and similarly with grammar and the other conditions. At any rate things spoken of in virtue of these unquestionably admit of a more and a less: one man is called more grammatical than another, juster, healthier, and so on.

Triangle and square do not seem to admit of a more, nor does any other shape. For things which admit the definition of triangle or circle are all equally triangles or circles, while of things which do not admit it none will be called *more that* than another—a square is not more a circle than an oblong is, for neither admits the definition of circle. In short, unless both admit the definition of what is under discussion neither will be called more that than the other. Thus not all qualifications admit of a more and a less.

Nothing so far mentioned is distinctive of quality, but it is in virtue of qualities only that things are called *similar* and *dissimilar;* a thing is not similar to another in virtue of anything but that in virtue of which it is qualified. So it would be distinctive of quality that a thing is called similar or dissimilar in virtue of it.

We should not be disturbed lest someone may say that though we proposed to discuss quality we are counting in many relatives (since states and conditions are relatives). For in pretty well all such cases the genera are spoken of in relation to something, but none of the particular cases is. For knowledge, a genus, is called just what it is, of something else (it is called knowledge of something); but none of the particular cases is called just what it is, of something else. For example, grammar is not called grammar of something nor music music of something. If at all it is in virtue of the genus that these too are spoken of in relation to something: grammar is called knowledge of something (not grammar of something) and music knowledge of something (not music of something). Thus the particular cases are not relatives. But it is with the particular cases that we are said to be qualified, for it is these which we possess (it is because we have some particular knowledge that we are called knowledgeable). Hence these—the particular cases, in virtue of which we are on occasion said to be qualified—would indeed be qualities; and these are not relatives.

Moreover, if the same thing really is a qualification and a relative there is nothing absurd in its being counted in both the genera.

11b1 **9** · Doing and being-affected admit of contrariety and of a more and a less. For heating is contrary to cooling, and being heated to being cooled, and being pleased to being pained; so they admit of contrariety. And of a more and a less also. For it is possible to heat more and less, and to be heated more and less, and to be pained more and less; hence doing and being-affected admit of a more and a less.[5]

. . . .

[So much, then, is said about these; and about being-in-a-position too it has been remarked, in the discussion of relatives, that it is spoken of paronymously from the positions. About the rest, when and where and having, owing to their obviousness nothing further is said about them than what was said at the beginning, that having is signified by 'having-shoes-on', 'having-armour-on', where by, for example, 'in the Lyceum'—and all the other things that were said about them.]

10 · [About the proposed genera, then, enough has been said; but something must be said about opposites and the various ways in which things are customarily opposed.]

Things are said to be opposed to one another in four ways: as relatives or as contraries or as privation and possession or as affirmation and negation. Examples of things thus opposed (to give a rough idea) are: as relatives, the double and the half; as contraries, the good and the bad; as privation and possession, blindness and sight; as affirmation and negation, he is sitting—he is not sitting.

Things opposed as *relatives* are called just what they are, *of* their opposites or in some other way *in relation to* them. For example, the double is called just what it is (double) *of* the half. Again, knowledge and the knowable are opposed as relatives, and knowledge is called just what it is, *of* the knowable, and the knowable too is called just what it is, in relation to its opposite, knowledge; for the knowable is called knowable *by* something—by knowledge. Thus things opposed as relatives are called just what they are, *of* their opposites or in some other way *in relation to* one another.

Things opposed as *contraries*, however, are never called just what they are, in relation to one another, though they are called *contraries of* one another. For the good is not called *good of* the bad, but the contrary of it; and the white not *white of* the black, but its contrary. Thus these oppositions differ from one another.

12a1 If contraries are such that it is necessary for one or the other of them to belong to the things they naturally occur in or are predicated of, there is nothing intermediate between them. For example, sickness and health naturally occur in animals' bodies and it is indeed necessary for one or the other to belong to an animal's body, either sickness or health; again, odd and even are predicated of numbers, and it is indeed necessary for one or the other to belong to a number, either odd or even. And between these there is certainly nothing intermediate—

[5]Aristotle's discussion of the categories ends here, in an unfinished state: the following passage in square brackets was added by an ancient editor in order to link Chapters 1–9 to Chapters 10–14.

between sickness and health or odd and even. But if it is not necessary for one or the other to belong, there is something intermediate between them. For example, black and white naturally occur in bodies, but it is not *necessary* for one or the other of them to belong to a body (for not every body is either white or black); again, bad and good are predicated both of men and of many other things, but it is not necessary for one or the other of them to belong to those things they are predicated of (for not all are either bad or good). And between these there is certainly something intermediate—between white and black are grey, yellow and all other colours, and between the bad and the good the neither bad nor good. In some cases there exist names for the intermediates, as with grey and yellow between white and black; in some, however, it is not easy to find a name for the intermediate, but it is by the negation of each of the extremes that the intermediate is marked off, as with the neither good nor bad and neither just nor unjust.

Privation and *possession* are spoken of in connexion with the same thing, for example sight and blindness in connexion with the eye. To generalize, each of them is spoken of in connexion with whatever the possession naturally occurs in. We say that anything capable of receiving a possession is deprived of it when it is entirely absent from that which naturally has it, at the time when it is natural for it to have it. For it is not what has not teeth that we call toothless, or what has not sight blind, but what has not got them at the time when it is natural for it to have them. For some things from birth have neither sight nor teeth yet are not called toothless or blind.

Being deprived and possessing are not privation and possession. For sight is a possession and blindness a privation, but having sight is not sight nor is being blind blindness. For blindness is a particular privation but being blind is being deprived, not a privation. Moreover, if blindness were the same as being blind both would be predicated of the same thing. But though a man is called blind a man is certainly not called blindness. These do, however, seem to be opposed—being deprived and having a possession—as privation and possession are. For the manner of opposition is the same. For as blindness is opposed to sight so also is being blind opposed to having sight. (Nor is what underlies an affirmation or negation itself an affirmation or negation. For an affirmation is an affirmative statement and a negation a negative statement, whereas none of the things underlying an affirmation or negation is a statement. These are, however, said to be opposed to one another as affirmation and negation are; for in these cases, too, the manner of opposition is the same. For in the way an affirmation is opposed to a negation, for example 'he is sitting'—'he is not sitting', so are opposed also the actual things underlying each, his sitting—his not sitting.)

That privation and possession are not opposed as relatives is plain. For neither is called just what it is, of its opposite. Sight is not sight of blindness nor is it spoken of in any other way in relation to it; nor would one call blindness blindness of sight—blindness is called privation of sight but is not called blindness of sight. Moreover, all relatives are spoken of in relation to correlatives that reciprocate, so that with blindness, too, if it were a relative, that in relation to which it is spoken of would reciprocate; but it does not reciprocate, since sight is not called sight of blindness.

Nor are cases of privation and possession opposed as contraries, as is clear from the following. With contraries between which there is nothing intermediate it is necessary for one or the other of them always to belong to the things they naturally occur in or are predicated of. For there was nothing intermediate in just those cases where it was necessary for one or the other to belong to a thing capable of receiving them, as with sickness and health and odd and even. But where there is something intermediate it is never necessary for one or the other to belong to everything: it is not necessary for everything to be white or black that is capable of receiving them, or hot or cold, since something intermediate between these may perfectly well be present. Moreover, there was something intermediate in just those cases where it was not necessary for one or the other to belong to a thing capable of receiving them—except for things to which the one belongs by nature, as being hot belongs to fire and being white to snow; and in these cases it is necessary for definitely one or the other to belong, and not as chance has it. For it is not possible for fire to be cold or snow black. Thus it is not necessary for one or the other of them
13a1 to belong to everything capable of receiving them, but only to things to which the one belongs by nature, and in these cases it must be definitely the one and not as chance has it.

But neither of these accounts is true of privation and possession. For it is not necessary for one or the other of them always to belong to a thing capable of receiving them, since if it is not yet natural for something to have sight it is not said either to be blind or to have sight; so that these would not be contraries of the sort that have nothing intermediate between them. Nor, however, of the sort that do have something intermediate between them. For it is necessary at some time for one or the other of them to belong to everything capable of receiving them. For when once it is natural for something to have sight then it will be said either to be blind or to have sight—not definitely one or the other of these but as chance has it, since it is not necessary either for it to be blind or for it to have sight, but as chance has it. But with contraries which have something intermediate between them we said it was never necessary for one or the other to belong to everything, but to certain things, and to them definitely the one. Hence it is clear that things opposed as privation and possession are not opposed in either of the ways contraries are.

Further, with contraries it is possible (while the thing capable of receiving them is there) for change into one another to occur, unless the one belongs to something by nature as being hot does to fire. For it is possible for the healthy to fall sick and for the white to become black and the hot cold; and it is possible to become bad instead of good or good instead of bad. (For the bad man, if led into better ways of living and talking, would progress, if only a little, towards being better. And if he once made even a little progress it is clear that he might either change completely or make really great progress. For however slight the progress he made to begin with, he becomes ever more easily changed towards virtue, so that he is likely to make still more progress; and when this keeps happening it brings him over completely into the contrary state, provided time permits.) With privation and possession, on the other hand, it is impossible for change into one another to occur. For change occurs from possession to privation but from privation to possession it is impossible; one who has gone blind does not recover sight nor does a bald man regain his hair nor does a toothless man grow teeth.

It is plain that things opposed as affirmation and negation are not opposed in any of the above ways; for only with them is it necessary always for one to be true and the other one false. For with contraries it is not necessary always for one to be true and the other false, nor with relatives nor with possession and privation. For example, health and sickness are contraries, and neither is either true or false; similarly, the double and the half are opposed as relatives, and neither of them is either true or false; nor are cases of possession and privation, such as sight and blindness. Nothing, in fact, that is said without combination is either true or false; and all the above *are* said without combination.

It might, indeed, very well seem that the same sort of thing does occur in the case of contraries said *with* combination, 'Socrates is well' being contrary to 'Socrates is sick'. Yet not even with these is it necessary always for one to be true and the other false. For if Socrates exists one will be true and one false, but if he does not both will be false; neither 'Socrates is sick' nor 'Socrates is well' will be true if Socrates himself does not exist at all. As for possession and privation, if he does not exist at all neither is true, while not always one or the other is true if he does. For 'Socrates has sight' is opposed to 'Socrates is blind' as possession to privation; and if he exists it is not necessary for one or the other to be true or false (since until the time when it is natural for him to have it both are false), while if Socrates does not exist at all then again both are false, both 'he has sight' and 'he is blind'. But with an affirmation and negation one will always be false and the other true whether he exists or not. For take 'Socrates is sick' and 'Socrates is not sick': if he exists it is clear that one or the other of them will be true or false, and equally if he does not; for if he does not exist 'he is sick' is false but 'he is not sick' true. Thus it would be distinctive of these alone—opposed affirmations and negations—that always one or the other of them is true or false.

11 · What is contrary to a good thing is necessarily bad; this is clear by induction from cases—health and sickness, justice and injustice, courage and cowardice, and so on with the rest. But what is contrary to a bad thing is sometimes good but sometimes bad. For excess is contrary to deficiency, which is bad, and is itself bad; yet moderation as well is contrary to both, and it is good. However, though this sort of thing may be seen in a few cases, in most cases what is contrary to a bad thing is always a good.

With contraries it is not necessary if one exists for the other to exist too. For if everyone were well health would exist but not sickness, and if everything were white whiteness would exist but not blackness. Further, if Socrates's being well is contrary to Socrates's being sick, and it is not possible for both to hold at the same time of the same person, it would not be possible if one of the contraries existed for the other to exist too; if Socrates's being well existed Socrates's being sick would not.

It is clearly the nature of contraries to belong to the same thing (the same either in species or in genus)—sickness and health in an animal's body, but whiteness and blackness in a body simply, and justice and injustice in a soul.

All contraries must either be in the same genus or in contrary genera, or be themselves genera. For white and black are in the same genus (since colour is their genus), but justice and injustice are in contrary genera (since the genus of one is virtue, of the other vice), while good and bad are not in a genus but are themselves actually genera of certain things.

12 · One thing is called prior to another in four ways. First and most strictly, in respect of time, as when one thing is called older or more ancient than another; for it is because the time is longer that it is called either older or more ancient. Secondly, what does not reciprocate as to implication of existence. For example, one is prior to two because if there are two it follows at once that there is one whereas if there is one there are not necessarily two, so that the implication of the other's existence does not hold reciprocally from one; and that from which the implication of existence does not hold reciprocally is thought to be prior. Thirdly, a thing is called prior in respect of some order, as with sciences and speeches. For in the demonstrative sciences there is a prior and posterior in order, for the elements are prior in order to the constructions (and in grammar the elements are prior to the syllables); likewise with speeches, for the introduction is prior in order to the exposition. Further, besides the ways mentioned, what is better and more valued is thought to be prior by nature: ordinary people commonly say of those they specially value and love that they 'have priority'. This fourth way is perhaps the least proper.

There are, then, this many ways of speaking of the prior. There would seem, however, to be another manner of priority besides those mentioned. For of things which reciprocate as to implication of existence, that which is in some way the cause of the other's existence might reasonably be called prior by nature. And that there are some such cases is clear. For there being a man reciprocates as to implication of existence with the true statement about it: if there is a man, the statement whereby we say that there is a man is true, and reciprocally—since if the statement whereby we say that there is a man is true, there is a man. And whereas the true statement is in no way the cause of the actual thing's existence, the actual thing does seem in some way the cause of the statement's being true: it is because the actual thing exists or does not that the statement is called true or false. Thus there are five ways in which one thing might be called prior to another.

13 · Those things are called *simultaneous* without qualification and most strictly which come into being at the same time; for neither is prior or posterior. These are called simultaneous in respect of time. But those things are called *simultaneous by nature* which reciprocate as to implication of existence, provided that neither is in any way the cause of the other's existence, e.g. the double and the half. These reciprocate, since if there is a double there is a half and if there is a half there is a double, but neither is the cause of the other's existence. Also, co-ordinate

species of the same genus are called simultaneous by nature. It is those resulting from the same division that are called co-ordinate, e.g. bird and beast and fish. For these are of the same genus and co-ordinate, since animal is divided into these—into bird and beast and fish. And none of them is prior or posterior, but things of this kind are thought to be simultaneous by nature. (Each of these might itself be 15a1 further divided into species—I mean beast and bird and fish). So those things resulting from the same division of the same genus will also be simultaneous by nature. Genera, however, are always prior to species since they do not reciprocate as to implication of existence; e.g. if there is a fish there is an animal, but if there is an animal there is not necessarily a fish. Thus we call simultaneous by nature those things which reciprocate as to implication of existence provided that neither is in any way the cause of the other's existence; and also co-ordinate species of the same genus. And we call simultaneous without qualification things which come into being at the same time.

14 · There are six kinds of change: generation, destruction, increase, diminution, alteration, change of place. That the rest are distinct from one another is obvious (for generation is not destruction, nor yet is increase or diminution,[6] nor is change of place; and similarly with the others too), but there is a question about alteration—whether it is not perhaps necessary for what is altering to be altering in virtue of one of the other changes. However, this is not true. For in pretty well all the affections, or most of them, we undergo alteration without partaking of any of the other changes. For what changes as to an affection does not necessarily increase or diminish—and likewise with the others. Thus alteration would be distinct from the other changes. For if it were the same, a thing altering would, as such, have to be increasing too or diminishing, or one of the other changes would have to follow; but this is not necessary. Equally, a thing increasing—or undergoing some other change—would have to be altering. But there are things that increase without altering, as a square is increased by the addition of a gnomon but is not thereby altered; similarly, too, with other such cases. Hence the changes are distinct from one another.

Change in general is contrary to staying the same. As for the particular kinds, 15b1 destruction is contrary to generation and diminution to increase, while change of place seems most opposed to staying in the same place—and perhaps to change towards the contrary place (upward change of place, for example, being opposed to downward and downward to upward). As for the other change in our list, it is not easy to state what is contrary to it. There seems to be nothing contrary, unless here too one were to oppose staying the same in qualification or change towards the contrary qualification (just as with change of place we had staying in the same place or change towards the contrary place). For alteration is change in qualification. Thus to change in qualification is opposed staying the same in qualification or change towards the contrary qualification (becoming white, for example, being

[6] Read ἡ αὔξησις ⟨ἢ⟩ μείωσις.

opposed to becoming black). For a thing alters through the occurrence of change towards contrary qualifications.

15 · *Having* is spoken of in a number of ways: having as a state and condition or some other quality (we are said to have knowledge and virtue); or as a quantity, like the height someone may have (he is said to have a height of five feet or six feet); or as things on the body, like a cloak or tunic; or as on a part, like a ring on a hand; or as a part, like a hand or foot; or as in a container, as with the measure of wheat or the jar of wine (for the jar is said to have wine, and the measure wheat, so these are said to have as in a container); or as a possession (for we are said to have a house and a field). One is also said to have a wife, and a wife a husband, but this seems to be a very strange way of 'having', since by 'having a wife' we signify nothing other than that he is married to her. Some further ways of having might perhaps come to light, but we have made a pretty complete enumeration of those commonly spoken of.

DE INTERPRETATIONE

J. L. Ackrill

1 · First we must settle what a name is and what a verb is, and then what a 16a1
negation, an affirmation, a statement and a sentence[1] are.

Now spoken sounds are symbols of affections in the soul, and written marks symbols of spoken sounds. And just as written marks are not the same for all men, neither are spoken sounds. But what these are in the first place signs of—affections of the soul—are the same for all; and what these affections are likenesses of—actual things—are also the same. These matters have been discussed in the work on the soul[2] and do not belong to the present subject.

Just as some thoughts in the soul are neither true nor false while some are necessarily one or the other, so also with spoken sounds. For falsity and truth have to do with combination and separation. Thus names and verbs by themselves—for instance 'man' or 'white' when nothing further is added—are like the thoughts that are without combination and separation; for so far they are neither true nor false. A sign of this is that even 'goat-stag' signifies something but not, as yet, anything true or false—unless 'is' or 'is not' is added (either simply or with reference to time).

2 · A *name* is a spoken sound significant by convention, without time, none of whose parts is significant in separation. For in 'Whitfield' the 'field' does not signify anything in its own right, as it does in the phrase 'white field'. Not that it is the same with complex names as with simple ones: in the latter the part is in no way significant, in the former it has some force but is not significant of anything in separation, for example the 'boat' in 'pirate-boat'.

I say 'by convention' because no name is a name naturally but only when it has become a symbol. Even inarticulate noises (of beasts, for instance) do indeed reveal something, yet none of them is a name.

'Not man' is not a name, nor is there any correct name for it. It is neither a phrase nor a negation. Let us call it an indefinite name.

'Philo's', 'to-Philo', and the like are not names but inflexions of names. The 16b1
same account holds for them as for names except that an inflexion when combined with 'is', 'was', or 'will be' is not true or false whereas a name always is. Take, for example, 'Philo's is' or 'Philo's is not'; so far there is nothing either true or false.

TEXT: L. Minio-Paluello, OCT, Oxford, 1956, 2nd ed.

[1] 'Sentence' here and hereafter translates λόγος.

[2] See *de Anima* III 3–8.

3 · A *verb* is what additionally signifies time, no part of it being significant separately; and it is a sign of things said of something else.

It additionally signifies time: 'recovery' is a name, but 'recovers' is a verb, because it additionally signifies something's holding *now*. And it is always a sign of what holds, that is, holds of a subject.

'Does not recover' and 'does not ail' I do not call verbs. For though they additionally signify time and always hold of something, yet there is a difference—for which there is no name. Let us call them indefinite verbs, because they hold indifferently of anything whether existent or non-existent. Similarly, 'recovered' and 'will-recover' are not verbs but inflexions of verbs. They differ from the verb in that it additionally signifies the present time, they the time outside the present.

When uttered just by itself a verb is a name and signifies something—the speaker arrests his thought and the hearer pauses—but it does not yet signify whether it is or not. For not even[3] 'to be' or 'not to be' is a sign of the actual thing (nor if you say simply 'that which is'); for by itself it is nothing, but it additionally signifies some combination, which cannot be thought of without the components.

4 · A *sentence* is a significant spoken sound some part of which is significant in separation—as an expression, not as an affirmation.

I mean that animal, for instance, signifies something, but not that it is or is not (though it will be an affirmation or negation if something is added); the single syllables of 'animal', on the other hand, signify nothing. Nor is the 'ice' in 'mice' significant; here it is simply a spoken sound. In double words, as we said, a part does signify, but not in its own right.

Every sentence is significant (not as a tool but, as we said, by convention), but not every sentence is a statement-making sentence, but only those in which there is truth or falsity. There is not truth or falsity in all sentences: a prayer is a sentence but is neither true or false. The present investigation deals with the statement-making sentence; the others we can dismiss, since consideration of them belongs rather to the study of rhetoric or poetry.

5 · The first single statement-making sentence is the affirmation, next is the negation. The others are single in virtue of a connective.

Every statement-making sentence must contain a verb or an inflexion of a verb. For even the definition of man is not yet a statement-making sentence—unless 'is' or 'will be' or 'was' or something of this sort is added. (To explain why 'two-footed land animal' is one thing and not many belongs to a different inquiry; certainly it will not be one simply through being said all together.)

A single statement-making sentence is either one that reveals a single thing or one that is single in virtue of a connective. There are more than one if more things than one are revealed or if connectives are lacking.

[3]Read οὐδὲ γάρ.

(Let us call a name or a verb simply an expression, since by saying it one cannot reveal anything by one's utterance in such a way as to be making a statement, whether one is answering a question or speaking spontaneously.)

Of these the one is a simple statement, affirming or denying something of something, the other is compounded of simple statements and is a kind of composite sentence. The simple statement is a significant spoken sound about whether something does or does not hold (in one of the divisions of time).

6 · An *affirmation* is a statement affirming something of something, a *negation* is a statement denying something of something.

Now it is possible to state of what does hold that it does not hold, of what does not hold that it does hold, of what does hold that it does hold, and of what does not hold that it does not hold. Similarly for times outside the present. So it must be possible to deny whatever anyone has affirmed, and to affirm whatever anyone has denied. Thus it is clear that for every affirmation there is an opposite negation, and for every negation an opposite affirmation. Let us call an affirmation and a negation which are opposite a *contradiction*. I speak of statements as opposite when they affirm and deny the same thing of the same thing—not homonymously, together with all other such conditions that we add to counter the troublesome objections of sophists.

7 · Now of actual things some are universal, others particular (I call universal that which is by its nature predicated of a number of things, and particular that which is not; man, for instance, is a universal, Callias a particular). So it must sometimes be of a universal that one states that something holds or does not, sometimes of a particular. Now if one states universally of a universal that something holds or does not, there will be contrary statements (examples of what I mean by 'stating universally of a universal' are: every man is white—no man is white). But when one states something of a universal but not universally, the statements are not contrary (though what is being revealed may be contrary). Examples of what I mean by 'stating of a universal not universally' are: a man is white—a man is not white; man is a universal but it is not used universally in the statement (for 'every' does not signify the universal but that it is taken universally). It is not true to predicate a universal universally of a subject, for there cannot be an affirmation in which a universal is predicated universally of a subject, for instance: every man is every animal.

I call an affirmation and a negation *contradictory* opposites when what one signifies universally the other signifies not universally, e.g. every man is white—not every man is white, no man is white—some man is white. But I call the universal affirmation and the universal negation contrary opposites, e.g. every man is just—no man is just. So these cannot be true together, but their opposites may both be true with respect to the same thing, e.g. not every man is white—some man is white.

Of contradictory statements about a universal taken universally it is necessary for one or the other to be true or false; similarly if they are about particulars, e.g. Socrates is white—Socrates is not white. But if they are about a universal not taken universally it is not always the case that one is true and the other false. For it is true to say at the same time that a man is white and that a man is not white, or that a man is noble and a man is not noble (for if base, then not noble; and if something is becoming something, then it *is* not that thing). This might seem absurd at first sight, because 'a man is not white' looks as if it signifies also at the same time that no man is white; this, however, does not signify the same, nor does it necessarily hold at the same time.

It is evident that a single affirmation has a single negation. For the negation must deny the same thing as the affirmation affirmed, and of the same thing, whether a particular or a universal (taken either universally or not universally). I mean, for example, Socrates is white—Socrates is not white. But if something else is denied, or the same thing is denied of something else, that will not be the opposite statement, but a different one. The opposite of 'every man is white' is 'not every man is white'; of 'some man is white', 'no man is white'; of 'a man is white', 'a man is not white'.

We have explained, then: that a single affirmation has a single negation as its contradictory opposite, and which these are; that contrary statements are different, and which these are; and that not all contradictory pairs are true or false, why this is, and when they are true or false.

8 · A single affirmation or negation is one which signifies one thing about one thing (whether about a universal taken universally or not), e.g. every man is white—not every man is white, a man is white—a man is not white, no man is white—some man is white—assuming that 'white' signifies one thing.

But if one name is given to two things which do not make up one thing, there is not a single affirmation. Suppose, for example, that one gave the name cloak to horse and man; 'a cloak is white' would not be a single affirmation. For to say this is no different from saying a horse and a man is white, and this is no different from saying a horse is white and a man is white. So if this last signifies more than one thing and is more than one affirmation, clearly the first also signifies either more than one thing or nothing (because no man is a horse). Consequently it is not necessary, with these statements either, for one contradictory to be true and the other false.

9 · With regard to what is and what has been it is necessary for the affirmation or the negation to be true or false. And with universals taken universally it is always necessary for one to be true and the other false, and with particulars too, as we have said; but with universals not spoken of universally it is not necessary. But with particulars that are going to be it is different.

For if every affirmation or negation is true or false it is necessary for everything either to be the case or not to be the case. For if one person says that something will be and another denies this same thing, it is clearly necessary for one of them to be saying what is true—if every affirmation is true or false; for both will not be the case together under such circumstances. For if it is true to say that it is white or is not white, it is necessary for it to be white or not white; and if it is white or is not white, then it was true to say or deny this. If it is not the case it is false, if it is false it is not the case. So it is necessary for the affirmation or the negation to be true. It follows that nothing either is or is happening, or will be or will not be, by chance or as chance has it, but everything of necessity and not as chance has it (since either he who says or he who denies is saying what is true). For otherwise it might equally well happen or not happen, since what is as chance has it is no more thus than not thus, nor will it be.

Again, it if is white now it was true to say earlier that it would be white; so that it was always true to say of anything that has happened that it would be so. But if it was always true to say that it was so, or would be so, it could not not be so, or not be going to be so. But if something cannot not happen it is impossible for it not to happen; and if it is impossible for something not to happen it is necessary for it to happen. Everything that will be, therefore, happens necessarily. So nothing will come about as chance has it or by chance; for if by chance, not of necessity.

Nor, however, can we say that *neither* is true—that it neither will be nor will not be so. For, firstly, though the affirmation is false the negation is not true, and though the negation is false the affirmation, on this view, is not true. Moreover, if it is true to say that something is white and large,[4] both have to hold of it, and if true that they will hold tomorrow, they will have to hold tomorrow;[5] and if it neither will be nor will not be the case tomorrow, then there is no 'as chance has it'. Take a sea-battle: it would *have* neither to happen nor not to happen.

These and others like them are the absurdities that follow if it is necessary for every affirmation and negation either about universals spoken of universally or about particulars, that one of the opposites be true and the other false, and that nothing of what happens is as chance has it, but everything is and happens of necessity. So there would be no need to deliberate or to take trouble (thinking that if we do this, this will happen, but if we do not, it will not). For there is nothing to prevent someone's having said ten thousand years beforehand that this would be the case, and another's having denied it; so that whichever of the two was true to say then, will be the case of necessity. Nor, of course, does it make any difference whether any people made the contradictory statements or not. For clearly this is how the actual things are even if someone did not affirm it and another deny it. For it is not because of the affirming or denying that it will be or will not be the case, nor is it a question of ten thousand years beforehand rather than any other time. Hence, if in the whole of time the state of things was such that one or the other was true, it was necessary for this to happen, and for the state of things always to be such that everything that happens happens of necessity. For what anyone has truly said would

[4]Read λευκὸν καὶ μέγα.
[5]Read εἰ δὲ ὑπάρξει . . . , ὑπάρξειν . . .

be the case cannot not happen; and of what happens it was always true to say that it would be the case.

But what if this is impossible? For we see that what will be has an origin both in deliberation and in action, and that, in general, in things that are not always actual there is the possibility of being and of not being; here both possibilities are open, both being and not being, and consequently, both coming to be and not coming to be. Many things are obviously like this. For example, it is possible for this cloak to be cut up, and yet it will not be cut up but will wear out first. But equally, its not being cut up is also possible, for it would not be the case that it wore out first unless its not being cut up were possible. So it is the same with all other events that are spoken of in terms of this kind of possibility. Clearly, therefore, not everything is or happens of necessity: some things happen as chance has it, and of the affirmation and the negation neither is true rather than the other; with other things it is one rather than the other and as a rule, but still it is possible for the other to happen instead.

What is, necessarily is, when it is; and what is not, necessarily is not, when it is not. But not everything that is, necessarily is; and not everything that is not, necessarily is not. For to say that everything that is, is of necessity, when it is, is not the same as saying unconditionally that it is of necessity. Similarly with what is not. And the same account holds for contradictories: everything necessarily is or is not, and will be or will not be; but one cannot divide and say that one or the other is necessary. I mean, for example: it is necessary for there to be or not to be a sea-battle tomorrow; but it is not necessary for a sea-battle to take place tomorrow, nor for one not to take place—though it is necessary for one to take place or not to take place. So, since statements are true according to how the actual things are, it is clear that wherever these are such as to allow of contraries as chance has it, the same necessarily holds for the contradictories also. This happens with things that are not always so or are not always not so. With these it is necessary for one or the other of the contradictories to be true or false—not, however, this one or that one, but as chance has it; or for one to be true *rather* than the other, yet not *already* true or false.

19b1 Clearly, then, it is not necessary that of every affirmation and opposite negation one should be true and the other false. For what holds for things that are does not hold for things that are not but may possibly be or not be; with these it is as we have said.

10 · Now an affirmation signifies something about something, this last being either a name or a 'non-name'; and what is affirmed must be one thing about one thing. (Names and 'non-names' have already been discussed. For I do not call 'not-man' a name but an indefinite name—for what it signifies is in a way one thing, but indefinite—just as I do not call 'does not recover' a verb). So every affirmation will contain either a name and a verb or an indefinite name and a verb. Without a verb there will be no affirmation or negation. 'Is', 'will be', 'was', 'becomes', and the like are verbs according to what we laid down, since they additionally signify time.

So a first affirmation and negation are: 'a man is', 'a man is not'; then, 'a not-man is', 'a not-man is not'; and again, 'every man is', 'every man is not', 'every not-man is', 'every not-man is not'. For times other than the present the same account holds.

But when 'is' is predicated additionally as a third thing, there are two ways of expressing opposition. (I mean, for example, a man is just; here I say that the 'is' is a third component—whether name or verb—in the affirmation.) Because of this there will here be *four* cases (two of which will be related, as to order of sequence, to the affirmation and negation in the way the privations are, while two will not). I mean that 'is' will be added either to 'just' or to 'not-just', and so, too, will the negation. Thus there will be four cases. What is meant should be clear from the following diagram:

(*a*) 'a man is just'	(*b*) 'a man is not just' This is the negation of (*a*).
(*d*) 'a man is not not-just' This is the negation of (*c*).	(*c*) 'a man is not-just'

'Is' and 'is not' are here added to 'just' and to 'not-just'.

This then is how these are arranged (as is said in the *Analytics*).[6] Similarly, too, if the affirmation is about the name taken universally, e.g.:

(*a*) 'every man is just'	(*b*) 'not every man is just'
(*d*) 'not every man is not-just'	(*c*) 'every man is not-just'

Here, however, it is not in the same way possible for diagonal statements to be true together, though it is possible sometimes.

These, then, are two pairs of opposites. There are others if something is added to 'not-man' as a sort of subject, thus:

(*a*) 'a not-man is just'	(*b*) 'a not-man is not just'
(*d*) 'a not-man is not not-just'	(*c*) 'a not-man is not-just'

There will not be any more oppositions than these. These last are a group on their own separate from the others, in that they use 'not-man' as a name.

In cases where 'is' does not fit (e.g. with 'recovers' or 'walks') the verbs have the same effect when so placed as if 'is' were joined on, e.g.:

(*a*) 'every man recovers'	(*b*) 'every man does not recover'
(*d*) 'every not-man does not recover'	(*c*) 'every not-man recovers'

Here one must not say 'not every man' but must add the 'not', the negation, to 'man'. For 'every' does not signify a universal, but that it is taken universally. This is clear from the following.

[6]See *Prior Analytics* I 46.

(*a*) 'a man recovers'	(*b*) 'a man does not recover'
(*d*) 'a not-man does not recover'	(*c*) 'a not-man recovers'

For these differ from the previous ones in not being universal. So 'every' or 'no' additionally signify nothing other than that the affirmation or negation is about the name taken universally. Everything else, therefore, must be added unchanged.

Since the contrary negation of 'every animal is just' is that which signifies that no animal is just, obviously these will never be true together or of the same thing, but their opposites sometimes will (e.g. not every animal is just, and some animal is just). 'No man is just' follows from 'every man is not-just', while the opposite of this, 'not every man is not-just', follows from 'some man is just' (for there must be one). It is clear too that, with regard to particulars, if it is true, when asked something, to deny it, it is true also to affirm something. For instance: Is Socrates wise? No. Then Socrates is not-wise. With universals, on the other hand, the corresponding affirmation is not true, but the negation is true. For instance: Is every man wise? No. Then every man is not-wise. This is false, but 'then not every man is wise' is true; this is the opposite statement, the other is the contrary.

Names and verbs that are indefinite (and thereby opposite), such as 'not-man' and 'not-just', might be thought to be negations without a name and a verb. But they are not. For a negation must always be true or false; but one who says not-man—without adding anything else—has no more said something true or false (indeed rather less so) than one who says man.

'Every not-man is just' does not signify the same as any of the above, nor does its opposite, 'not every not-man is just'. But 'every not-man is not-just' signifies the same as 'no not-man is just'.

If names and verbs are transposed they still signify the same thing, e.g. a man is white—white is a man. For otherwise the same statement will have more than one negation, whereas we have shown that one has only one. For 'a man is white' has for negation 'a man is not white', while 'white is a man'—if it is not the same as 'a man is white'—will have for negation either 'white is not a not-man' or 'white is not a man'. But one of these is a negation of 'white is a not-man', the other of 'a man is white'. Thus there will be two negations of one statement. Clearly, then, if the name and the verb are transposed the same affirmation and negation are produced.

11 · To affirm or deny one thing of many, or many of one, is not *one* affirmation or negation unless the many things together make up some one thing. I do not call them one if there exists one name but there is not some one thing they make up. For example, man is perhaps an animal and two-footed and tame, yet these do make up some one thing; whereas white and man and walking do not make up one thing. So if someone affirms some one thing of these it is not one affirmation; it is one spoken sound, but more than one affirmation. Similarly, if these are affirmed of one thing, that is more than one affirmation. So if a dialectical question demands as answer either the statement proposed or one side of a contradiction (the statement in fact being a side of one contradiction), there could not be *one* answer in

these cases. For the question itself would not be one question, even if true. These matters have been discussed in the *Topics*.[7] (It is also clear that 'What is it?' is not a dialectical question either; for the question must give one the choice of stating whichever side of the contradiction one wishes. The questioner must specify further and ask whether man is this or not this.)

Of things predicated separately some can be predicated in combination, the whole predicate as one, others cannot. What then is the difference? For of a man it is true to say two-footed separately and animal separately, and also to say them as one; similarly, white and man separately, and also as one. But if someone is good and a cobbler it does not follow that he is a good cobbler. For if because each of two holds both together also hold, there will be many absurdities. For since of a man both 'white' and 'a man' are true, so also is the whole compound; again, if 'white' then the whole compound—so that he will be a white white man, and so on indefinitely. Or, again, we shall have 'walking white musician', and then these compounded many times over. Further, if Socrates is a man and is Socrates he will be a man Socrates; and if two-footed and a man then a two-footed man. Clearly, then, one is led into many absurdities if one lays down without restriction that the compounds come about. How the matter should be put we will now explain.

Of things predicated, and things they get predicated of, those which are said accidentally, either of the same thing or of one another, will not be one. For example, a man is white and musical, but 'white' and 'musical' are not one, because they are both accidental to the same thing. And even if it is true to say that the white is musical, 'musical white' will still not be one thing; for it is accidentally that the musical is white, and so 'white musical' will not be one.[8] Nor, consequently, will the cobbler who is (without qualification) good, though an animal which is two-footed will (since this is not accidental). Further, where one of the things is contained in the other, they will not be one. This is why 'white' is not repeated and why a man is not an animal man or a two-footed man; for two-footed and animal are contained in man.

It is true to speak of the particular case even without qualification; e.g. to say that some particular man is a man or some particular white man white. Not always, though. When in what is added some opposite is contained from which a contradiction follows, it is not true but false (e.g. to call a dead man a man); but when no such opposite is contained, it is true. Or rather, when it is contained it is always not true, but when it is not, it is not always true. For example, Homer is something (say, a poet). Does it follow that he is? No, for the 'is' is predicated accidentally of Homer; for it is because he is a poet, not in its own right, that the 'is' is predicated of Homer. Thus, where predicates *both* contain no contrariety if definitions are put instead of names *and* are predicated in their own right and not accidentally, in these cases it will be true to speak of the particular thing even without qualification. It is not true to say that what is not, since it is thought about, is something that is; for what is thought about it is not that it is, but that it is not.

[7]See esp. *Topics* VIII.
[8]Read μουσικὸν ἕν.

12 · Having cleared up these points, we must consider how negations and affirmations of the possible to be and the not possible are related to one another, and of the admissible and not admissible, and about the impossible and the necessary. For there are some puzzles here.

Suppose we say that of combined expressions those are the contradictory opposites of one another which are ordered by reference to 'to be' and 'not to be'. For example, the negation of 'to be a man' is 'not to be a man', not 'to be a not-man', and the negation of 'to be a white man' is 'not to be a white man', not 'to be a not-white man' (otherwise, since of everything the affirmation or the negation holds, the log will be truly said *to be a not-white man*). And if this is so, in cases where 'to be' is not added what is said instead of 'to be' will have the same effect. For example, the negation of 'a man walks' is not 'a not-man walks' but 'a man does not walk'; for there is no difference between saying that a man walks and saying that a man is walking.

So then, if this holds good everywhere, the negation of 'possible to be' is 'possible not to be', and not 'not possible to be'. Yet it seems that for the same thing it is possible both to be and not to be. For everything capable of being cut or of walking is capable also of not walking or of not being cut. The reason is that whatever is capable in this way is not always actual, so that the negation too will hold of it: what can walk is capable also of not walking, and what can be seen of not being seen. But it is impossible for opposite expressions to be true of the same thing. This then is not the negation. For it follows from the above that either the same thing is said and denied of the same thing at the same time, or it is not by 'to be' and 'not to be' being added that affirmations and negations are produced. So if the former is impossible we must choose the latter. The negation of 'possible to be', therefore, is 'not possible to be'.

The same account holds for 'admissible to be': its negation is 'not admissible to be'. Similarly with the others, 'necessary' and 'impossible'. For as in the previous examples 'to be' and 'not to be' are additions, while the actual things that are subjects are white and man, so here 'to be' serves as subject, while 'to be possible' and 'to be admissible' are additions—these determining the possible and not possible in the case of 'to be', just as in the previous cases 'to be' and 'not to be' determine the true.

The negation of 'possible not to be' is 'not possible not to be'. This is why 'possible to be' and 'possible not to be' may be thought actually to follow from one another. For it is possible for the same thing to be and not to be: such statements are not contradictories of one another. But 'possible to be' and 'not possible to be' never hold together, because they are opposites. Nor do 'possible not to be' and 'not possible not to be' ever hold together.

Similarly, the negation of 'necessary to be' is not 'necessary not to be' but 'not necessary to be'; and of 'necessary not to be', 'not necessary not to be'. And of 'impossible to be' it is not 'impossible not to be' but 'not impossible to be'; and of 'impossible not to be', 'not impossible not to be'. Universally, indeed, as has been said, one must treat 'to be' and 'not to be' as the subjects, and these others must be joined on to 'to be' and 'not to be' to make affirmations and negations. We must take the opposite expressions to be these: possible—not possible; admissible—not admissible; impossible—not impossible; necessary—not necessary; true—not true.

13 · With this treatment the implications work out in a reasonable way. From 'possible to be' follow 'admissible to be' (and, reciprocally, the former from the latter) and 'not impossible to be' and 'not necessary to be'. From 'possible not to be' and 'admissible not to be' follow both 'not necessary not to be' and 'not impossible not to be'. From 'not possible to be' and 'not admissible to be' follow 'necessary not to be' and 'impossible to be'. From 'not possible not to be' and 'not admissible not to be' follow 'necessary to be' and 'impossible not to be'. What we are saying can be seen from the following table.

I	II
possible to be	not possible to be
admissible to be	not admissible to be
not impossible to be	impossible to be
not necessary to be	necessary not to be
III	**IV**
possible not to be	not possible not to be
admissible not to be	not admissible not to be
not impossible not to be	impossible not to be
not necessary not to be	necessary to be

'Impossible' and 'not impossible' follow from 'admissible' and 'possible' and 'not possible' and 'not admissible' contradictorily but conversely; for the negation of 'impossible' follows from 'possible to be', and the affirmation from the negation, 'impossible to be' from 'not possible to be' (for 'impossible to be' is an affirmation, 'not impossible' a negation).

But what about the necessary? Evidently things are different here: it is contraries which follow, and the contradictories are separated. For the negation of 'necessary not to be' is not 'not necessary to be'. For both may be true of the same thing, since the necessary not to be is not necessary to be. The reason why these do not follow in the same way as the others is that it is when applied in a contrary way that 'impossible' and 'necessary' have the same force. For if it is impossible *to be* it is necessary for this (not, *to be,* but) *not to be;* and if it is impossible not to be it is necessary for this to be. Thus if those follow from 'possible' and 'not possible' in the same way, these follow in a contrary way, since 'necessary' and 'impossible' do signify the same but (as we said) when applied conversely.

But perhaps it is impossible for the contradictories in the case of the necessary to be placed thus? For the necessary to be is possible to be. (Otherwise the negation will follow, since it is necessary either to affirm or to deny it; and then, if it is not possible to be, it is impossible to be; so the necessary to be is impossible to be—which is absurd.) However, from 'possible to be' follows 'not impossible to be', and from this follows 'not necessary to be'; with the result that the necessary to be is not necessary to be—which is absurd.

However, it is not 'necessary to be' nor yet 'necessary not to be' that follows from 'possible to be'. For with this both may happen, but whichever of the others is true these will no longer be true; for it is at the same time possible to be and not to be, but if it is necessary to be or not to be it will not be possible for both. It remains, therefore, for 'not necessary not to be' to follow from 'possible to be'; for this is true of 'necessary to be' also. Moreover, this proves to be contradictory to what follows from 'not possible to be', since from that follow 'impossible to be' and 'necessary not to be', whose negation is 'not necessary not to be'. So these contradictories, too, follow in the way stated, and nothing impossible results when they are so placed.

One might raise the question whether 'possible to be' follows from 'necessary to be'. For if it does not follow the contradictory will follow, 'not possible to be'—or if one were to deny that this is the contradictory one must say that 'possible not to be' is; both of which are false of 'necessary to be'. On the other hand, the same thing seems to be capable of being cut and of not being cut, of being and of not being, so that the necessary to be will be admissible not to be; but this is false.

Well now, it is evident that not everything capable either of being or of walking is capable of the opposites also. There are cases of which this is not true. Firstly, with things capable non-rationally; fire, for example, can heat and has an irrational capability. While the same rational capabilities are capabilities for more than one thing, for contraries, not all irrational capabilities are like this. Fire, as has been said, is not capable of heating and of not heating, and similarly with everything else that is actualized all the time. Some, indeed, even of the things with irrational capabilities are at the same time capable of opposites. But the point of our remarks is that not every capability is for opposites—not even all those which are capabilities of the same kind.

Again, some capabilities are homonymous. For the capable is spoken of in more than one way: either because it is true as being actualized (e.g. it is capable of walking because it walks, and in general capable of being because what is called capable already is in actuality), or because it might be actualized (e.g. it is capable of walking because it might walk). This latter capability applies to changeable things only, the former to unchangeable things also. (Of both it is true to say that it is not impossible for them to walk, or to be—both what is already walking and actualized and what can walk.) Thus it is not true to assert the second kind of capability of that which is without qualification necessary, but it is true to assert the other. So, since the universal follows from the particular, from being of necessity there follows capability of being—though not every sort.

Perhaps, indeed, the necessary and not necessary are first principles of everything's either being or not being, and one should look at the others as following from these. It is evident from what has been said that what is of necessity is in actuality; so that, if the things which are eternal are prior, then also actuality is prior to capability. Some things are actualities without capability (like the primary substances), others with capability (and these are prior by nature but posterior in time to the capability); and others are never actualities but only capabilities.

14 · Is the affirmation contrary to the negation, or the affirmation to the affirmation—the statement that every man is just contrary to the statement 'no man is just', or 'every man is just' contrary to 'every man is unjust'? Take, for example, Callias is just, Callias is not just, Callias is unjust; which of these are contraries?

Now if spoken sounds follow things in the mind, and there it is the belief of the contrary which is contrary (e.g. the belief that every man is just is contrary to the belief 'every man is unjust'), the same must hold also of spoken affirmations. But if it is not the case there that the belief of the contrary is contrary, neither will the affirmation be contrary to the affirmation, but rather the above-mentioned negation. So we must inquire what sort of true belief is contrary to a false belief, the belief of the negation or the belief that the contrary holds. What I mean is this: there is a true belief about the good, that it is good, another (false) one, that it is not good, and yet another, that it is bad; now which of these is contrary to the true one? And if they are one belief, by reason of which is it contrary? (It is false to suppose that contrary beliefs are distinguished by being of contraries. For the belief about the good, that it is good, and the one about the bad, that it is bad, are perhaps the same—and true, whether one belief or more than one. Yet these are contrary things. It is not, then, through being of contraries that beliefs are contrary, but rather through being to the contrary effect.)

Now about the good there is the belief that it is good, the belief that it is not good, and the belief that it is something else, something which does not and cannot hold of it. (We must not take any of the other beliefs, either to the effect that what does not hold holds or to the effect that what holds does not hold—for there is an indefinite number of both kinds, both of those to the effect that what does not hold holds and of those to the effect that what holds does not hold—but only those in which there is deception. And these are from things from which comings-into-being arise. But comings-into-being are from opposites. So also, then, are cases of deceit.) Now the good is both good and not bad, the one in itself, the other accidentally (for it is accidental to it to be not bad); but the more true belief about anything is the one about what it is in itself; and if this holds for the true it holds also for the false. Therefore the belief that the good is not good is a false belief about what holds in itself, while the belief that it is bad is a false belief about what holds accidentally, so that the more false belief about the good would be that of the negation rather than that of the contrary. But it is he who holds the contrary belief who is most deceived with regard to anything, since contraries are among things which differ most with regard to the same thing. If, therefore, one of these is contrary, and the belief of the contradiction is more contrary, clearly this must be the contrary. The belief that the good is bad is complex; for the same person must perhaps suppose also that it is not good.

Further, if in other cases also the same must hold, it would seem that we have given the correct account of this one as well. For either everywhere that of the contradiction is the contrary, or nowhere. But in cases where there are no contraries there is still a false belief, the one opposite to the true one; e.g. he who thinks that the man is not a man is deceived. If, therefore, these are contraries, so too elsewhere are the beliefs of the contradiction.

Further, the belief about the good that it is good and that about the not good that it is not good are alike; and so, too, are the belief about the good that it is not good and that about the not good that it is good. What belief then is contrary to the true belief about the not good that it is not good? Certainly not the one which says that it is bad, for this might sometimes be true at the same time, while a true belief is never contrary to a true one. (There is something not good which is bad, so that it is possible for both to be true at the same time.) Nor again is it the belief that it is not bad, for these also might hold at the same time. There remains, then, as contrary to the belief about the not good that it is not good, the belief about the not good that it is good. Hence, too, the belief about the good that it is not good is contrary to that about the good that it is good.

Evidently it will make no difference even if we make the affirmation universally. For the universal negation will be contrary; e.g. the belief that none of the goods is good will be contrary to the belief to the effect that every good is good. For if in the belief about the good that it is good 'the good' is taken universally, it is the same as the belief that whatever is good is good. And this is no different from the belief that everything which is good is good. And similarly also in the case of the not good.

If then this is how it is with beliefs, and spoken affirmations and negations are symbols of things in the soul, clearly it is the universal negation about the same thing that is contrary to an affirmation; e.g. the contrary of 'every good is good' or 'every man is good' is 'no good is good' or 'no man is good', while 'not every good is good' or 'not every man is good' are opposed contradictorily. Evidently also it is not possible for either a true belief or a true contradictory statement to be contrary to a true one. For contraries are those which enclose their opposites; and while these latter may possibly be said truly by the same person, it is not possible for contraries to hold of the same thing at the same time.

PRIOR ANALYTICS

A. J. Jenkinson

BOOK I

1 · First we must state the subject of the enquiry and what it is about: the subject is demonstration, and it is about demonstrative understanding.[1] Next we must determine what a proposition[2] is, what a term is, and what a deduction[3] is (and what sort of deduction is perfect and what imperfect); and after that, what it is for one thing to be or not be in another as a whole, and what we mean by being predicated of every or of no.

A proposition, then, is a statement affirming or denying something of something; and this is either universal or particular or indefinite. By universal I mean a statement that something belongs to all or none of something; by particular that it belongs to some or not to some or not to all; by indefinite that it does or does not belong, without any mark of being universal or particular, e.g. 'contraries are subjects of the same science', or 'pleasure is not good'. A demonstrative proposition differs from a dialectical one, because a demonstrative proposition is the assumption of one of two contradictory statements (the demonstrator does not ask for his premiss, but lays it down), whereas a dialectical proposition choice between two contradictories. But this will make no difference to the production of a deduction in either case; for both the demonstrator and the dialectician argue deductively after assuming that something does or does not belong to something. Therefore a deductive proposition without qualification will be an affirmation or denial of something concerning something in the way we have described; it will be demonstrative, if it is true and assumed on the basis of the first principles of its science; it will be dialectical if it asks for a choice between two contradictories (if one is enquiring) or if it assumes what is apparent and reputable, as we said in the *Topics*[4] (if one is deducing). Thus as to what a proposition is and how deductive, demonstrative and dialectical propositions differ, we have now said enough for our present purposes—we shall discuss the matter with precision later on.[5]

TEXT: W. D. Ross, OCT, Oxford, 1964

[1]'Understanding' here, and throughout the *Analytics*, translates ἐπιστήμη.

[2]'Proposition' here and hereafter translates πρότασις.

[3]'Deduction' here and hereafter translates συλλογισμός.

[4]See *Topics* 102a27–30.

[5]See *Posterior Analytics* I 4–12.

I call a term that into which the proposition is resolved, i.e. both the predicate and that of which it is predicated, 'is' or 'is not' being added.

A deduction is a discourse in which, certain things being stated, something other than what is stated follows of necessity from their being so. I mean by the last phrase that it follows because of them, and by this, that no further term is required from without in order to make the consequence necessary.

I call perfect a deduction which needs nothing other than what has been stated to make the necessity evident; a deduction is imperfect if it needs either one or more things, which are indeed the necessary consequences of the terms set down, but have not been assumed in the propositions.

That one term should be in another as in a whole is the same as for the other to be predicated of all of the first. And we say that one term is predicated of all of another, whenever nothing can be found of which the other term cannot be asserted; 'to be predicated of none' must be understood in the same way.

25a1 2 · Every proposition states that something either belongs or must belong or may belong; of these some are affirmative, others negative, in respect of each of the three modes; again some affirmative and negative propositions are universal, others particular, others indefinite. It is necessary then that in universal attribution the terms of the negative proposition should be convertible, e.g. if no pleasure is good, then no good will be pleasure; the terms of the affirmative must be convertible, not however universally, but in part, e.g. if every pleasure is good, some good must be pleasure; the particular affirmative must convert in part (for if some pleasure is good, then some good will be pleasure); but the particular negative need not convert, for if some animal is not man, it does not follow that some man is not animal.

First then take a universal negative with the terms A and B. Now if A belongs to no B, B will not belong to any A; for if it does belong to some B (say to C), it will not be true that A belongs to no B—for C is one of the Bs. And if A belongs to every B, then B will belong to some A; for if it belongs to none, then A will belong to no B—but it was laid down that it belongs to every B. Similarly if the proposition is particular: if A belongs to some B, it is necessary for B to belong to some A; for if it belongs to none, A will belong to no B. But if A does not belong to some B, it is not necessary that B should not belong to some A: e.g., if B is animal and A man; for man does not belong to every animal, but animal belongs to every man.

3 · The same manner of conversion will hold good also in respect of necessary propositions. The universal negative converts universally; each of the affirmatives converts into a particular. If it is necessary that A belongs to no B, it is necessary also that B belongs to no A. For if it is possible that it belongs to some A, it would be possible also that A belongs to some B. If A belongs to all or some B of necessity, it is necessary also that B belongs to some A; for if there were no necessity, neither would A belong to some B of necessity. But the particular negative does not convert, for the same reason which we have already stated.

In respect of possible propositions, since possibility is used in several ways (for we say that what is necessary and what is not necessary and what is potential is possible), affirmative statements will all convert in a similar manner. For if it is possible that *A* belongs to all or some *B*, it will be possible that *B* belongs to some *A*. For if it could belong to none, then *A* could belong to no *B*. This has been already proved. But in negative statements the case is different. Whatever is said to be possible, either because it necessarily belongs or because it does not necessarily not belong, admits of conversion like other negative statements, e.g. if one should say, it is possible that the man is not a horse, or that no garment is white. For in the former case the one necessarily does not belong to the other; in the latter there is no necessity that it should: and the proposition converts like other negative statements. For if it is possible for no man to be a horse, it is also admissible for no horse to be a man; and if it is admissible for no garment to be white, it is also admissible for nothing white to be a garment. For if some white thing must be a garment, then some garment will necessarily be white. This has been already proved. The particular negative is similar. But if anything is said to be possible because it is the general rule and natural (and it is in this way we define the possible), the negative propositions can no longer be converted in the same way: the universal negative does not convert, and the particular does. This will be plain when we speak about the possible.[6] At present we may take this much as clear in addition to what has been said: the statements that it is possible that *A* belongs to no *B* or does not belong to some *B* are affirmative in form; for the expression 'is possible' ranks along with 'is', and 'is' makes an affirmative always and in every case, whatever the terms to which it is added in predication, e.g. 'it is not-good' or 'it is not-white' or in a word 'it is not-this'. But this also will be proved in the sequel.[7] In conversion these will behave like the other affirmative propositions.

4 · After these distinctions we now state by what means, when, and how every deduction is produced; subsequently we must speak of demonstration. Deduction should be discussed before demonstration, because deduction is the more general: a demonstration is a sort of deduction, but not every deduction is a demonstration.

Whenever three terms are so related to one another that the last is in the middle as in a whole, and the middle is either in, or not in, the first as in a whole, the extremes must be related by a perfect deduction. I call that term middle which both is itself in another and contains another in itself: in position also this comes in the middle. By extremes I mean both that term which is itself in another and that in which another is contained. If *A* is predicated of every *B*, and *B* of every *C*, *A* must be predicated of every *C*: we have already explained what we mean by 'predicated of every'. Similarly also, if *A* is predicated of no *B*, and *B* of every *C*, it is necessary that *A* will belong to no *C*.

[6]See Chapters 13–17.
[7]See Chapter 46.

But if the first term belongs to all the middle, but the middle to none of the last term, there will be no deduction in respect of the extremes; for nothing necessary follows from the terms being so related; for it is possible that the first should belong either to all or to none of the last, so that neither a particular nor a universal conclusion is necessary. But if there is no necessary consequence, there cannot be a deduction by means of these propositions. As an example of a universal affirmative relation between the extremes we may take the terms animal, man, horse; of a universal negative relation, the terms animal, man, stone. Nor again can a deduction be formed when neither the first term belongs to any of the middle, nor the middle to any of the last. As an example of a positive relation between the extremes take the terms science, line, medicine: of a negative relation science, line, unit.

If then the terms are universally related, it is clear in this figure when a deduction will be possible and when not, and that if a deduction is possible the terms must be related as described, and if they are so related there will be a deduction.

But if one term is related universally, the other in part only, to its subject, there must be a perfect deduction whenever universality is posited with reference to the major term either affirmatively or negatively, and particularity with reference to the minor term affirmatively; but whenever the universality is posited in relation to the minor term, or the terms are related in any other way, a deduction is impossible. I call that term the major in which the middle is contained and that term the minor which comes under the middle. Let *A* belong to every *B* and *B* to some *C*. Then if 'predicated of every' means what was said above, it is necessary that *A* belongs to some *C*. And if *A* belongs to no *B* and *B* to some *C*, it is necessary that *A* does not belong to some *C*. (The meaning of 'predicated of none' has also been defined.) So there will be a perfect deduction. This holds good also if deduction *BC* should be indefinite, provided that it is affirmative; for we shall have the same deduction whether it is indefinite or particular.

But if the universality is posited with respect to the minor term either affirmatively or negatively, a deduction will not be possible, whether the other is affirmative or negative, indefinite or particular: e.g. if *A* belongs or does not belong to some *B*, and *B* belongs to every *C*. As an example of a positive relation between the extremes take the terms good, state, wisdom; of a negative relation, good, state, ignorance. Again if *B* belongs to no *C*, and *A* belongs or does not belong to some *B* (or does not belong to every *B*), there cannot be a deduction. Take the terms white, horse, swan; white, horse, raven. The same terms may be taken also if *BA* is indefinite.

26b1 Nor when the proposition relating to the major extreme is universal, whether affirmative or negative, and that to the minor is negative and particular, can there be a deduction: e.g. if *A* belongs to every *B*, and *B* does not belong to some *C* or not to every *C*. For the first term may be predicable both of all and of none of the term to some of which the middle does not belong. Suppose the terms are animal, man, white: next take some of the white things of which man is not predicated—swan and snow: animal is predicated of all of the one, but of none of the other. Consequently there cannot be a deduction. Again let A belong to no B, but let B not belong to some C. Take the terms inanimate, man, white: then take some white things of which man is not predicated—swan and snow: inanimate is predicated of all of the one, of none of the other.

Further since it is indefinite to say that B does not belong to some C, and it is true that it does not belong to some C both if it belongs to none and if it does not belong to every, and since if terms are assumed such that it belongs to none, no deduction follows (this has already been stated), it is clear that this arrangement of terms will not afford a deduction: otherwise one would have been possible in the other case too. A similar proof may also be given if the universal proposition is negative.

Nor can there in any way be a deduction if both the relations are particular, either positively or negatively, or the one positively and the other negatively, or one indefinite and the other definite, or both indefinite. Terms common to all the above are animal, white, horse; animal, white, stone.

It is clear then from what has been said that if there is a deduction in this figure with a particular conclusion, the terms must be related as we have stated: if they are related otherwise, no deduction is possible at all. It is evident also that all the deductions in this figure are perfect (for they are all completed by means of what was originally assumed) and that all conclusions are proved by this figure, viz. universal and particular, affirmative and negative. Such a figure I call the first.

5 · Whenever the same thing belongs to all of one subject, and to none of another, or to all of each subject or to none of either, I call such a figure the second; by middle term in it I mean that which is predicated by both subjects, by extremes the terms of which this is said, by major extreme that which lies near the middle, by minor that which is further away from the middle. The middle term stands outside the extremes, and is first in position. A deduction cannot ever be perfect in this figure, but it may be potential whether the terms are related universally or not.

If then the terms are related universally a deduction will be possible, whenever the middle belongs to all of one subject and to none of another (it does not matter which has the negative relation), but in no other way. Let M be predicated of no N, but of every O. Since, then, the negative is convertible, N will belong to no M; but M was assumed to belong to every O: consequently N will belong to no O. This has already been proved. Again if M belongs to every N, but to no O, then O will belong to no N. For if M belongs to no O, O belongs to no M; but M (as was said) belongs to every N: O then will belong to no N; for the first figure has again been formed. But since the negative is convertible, N will belong to no O. Thus it will be the same deduction.

It is possible to prove these results also by *reductio ad impossibile.*

It is clear then that a deduction is formed when the terms are so related, but not a perfect one; for the necessity is not perfectly established merely from the original assumptions; others also are needed.

But if M is predicated of every N and O, there will not be a deduction. Terms to illustrate a positive relation between the extremes are substance, animal, man; a negative relation, substance, animal, number—substance being the middle term.

Nor is a deduction possible when *M* is predicated neither of any *N* nor of any *O*. Terms to illustrate a positive relation are line, animal, man; a negative relation, line, animal, stone.

It is clear then that if a deduction is formed when the terms are universally related, the terms must be related as we stated at the outset; for if they are otherwise related no necessary consequence follows.

If the middle term is related universally to one of the extremes, a particular negative deduction must result whenever the middle term is related universally to the major whether positively or negatively, and particularly to the minor and in a manner opposite to that of the universal statement (by 'an opposite manner' I mean, if the universal statement is negative, the particular is affirmative: if the universal is affirmative, the particular is negative). For if *M* belongs to no *N*, but to some *O*, it is necessary that *N* does not belong to some *O*. For since the negative is convertible, *N* will belong to no *M*; but *M* was admitted to belong to some *O*: therefore *N* will not belong to some *O*; for a deduction is found by means of the first figure. Again if *M* belongs to every *N*, but not to some *O*, it is necessary that *N* does not belong to some *O*; for if *N* belongs to every *O*, and *M* is predicated also of every *N*, *M* must belong to every *O*; but we assumed that *M* does not belong to some *O*. And if *M* belongs to every *N* but not to every *O*, we shall conclude that *N* does not belong to every *O*: the proof is the same as the above. But if *M* is predicated of every *O*, but not of every *N*, there will be no deduction. Take the terms animal, substance, raven; animal, white raven. Nor will there be a deduction when *M* is predicated of no *O*, but of some *N*. Terms to illustrate a positive relation between the extremes are animal, substance, unit; a negative relation, animal, substance, science.

If then the universal statement is opposed to the particular, we have stated when a deduction will be possible and when not; but if the premisses are similar in form, I mean both negative or both affirmative, a deduction will not be possible at all. First let them be negative, and let the universality apply to the major term, i.e. let *M* belong to no *N*, and not to some *O*. It is possible then for *N* to belong either to every *O* or to no *O*. Terms to illustrate the negative relation are black, snow, animal. But it is not possible to find terms of which the extremes are related positively and universally, if *M* belongs to some *O*, and does not belong to some *O*. For if *N* belonged to every *O*, but *M* to no *N*, then *M* would belong to no *O*; but we assumed that it belongs to some *O*. In this way then it is not admissible to take terms: our point must be proved from the indefinite nature of the particular statement. For since it is true that *M* does not belong to some *O*, even if it belongs to no *O*, and since if it belongs to no *O* a deduction is (as we have seen) not possible, clearly it will not be possible now either.

Again let the propositions be affirmative, and let the universality apply as before, i.e. let *M* belong to every *N* and to some *O*. It is possible then for *N* to belong to every *O* or to no *O*. Terms to illustrate the negative relation are white, swan, stone. But it is not possible to take terms to illustrate the universal affirmative relation, for the reason already stated: the point must be proved from the indefinite nature of the particular statement. And if the universality applies to the minor extreme, and *M* belongs to no *O*, and not to some *N*, it is possible for *N* to belong either to every *O* or to no *O*. Terms for the positive relation are white, animal, raven; for the negative relation, white, stone, raven. If the propositions are positive, terms for the negative relation are white, animal, snow; for the positive relation, white, animal, swan. Evidently then, whenever the propositions are similar in form, and one is universal, the other particular, a deduction cannot be formed at all. Nor is one possible if the middle term belongs to some of each of the extremes, or does not belong to some of either, or belongs to some of the one, not to some of the other, or belongs to neither universally, or is related to them indefinitely. Common terms for all the above are white, animal, man; white, animal, inanimate.

It is clear then from what has been said that if the terms are related to one another in the way stated, a deduction results of necessity; and if there is a deduction, the terms must be so related. But it is evident also that all the deductions in this figure are imperfect; for all are made perfect by certain supplementary assumptions, which either are contained in the terms of necessity or are assumed as hypotheses, i.e. when we prove *per impossibile*. And it is evident that an affirmative deduction is not attained by means of this figure, but all are negative, whether universal or particular.

6 · But if one term belongs to all, and another to none, of a third, or if both belong to all, or to none, of it, I call such a figure the third; by middle term in it I mean that of which both are predicated, by extremes I mean the predicates, by the major extreme that which is further from the middle, by the minor that which is nearer to it. The middle term stands outside the extremes, and is last in position. A deduction cannot be perfect in this figure either, but it may be potential whether the terms are related universally or not to the middle term.

If they are universal, whenever both *P* and *R* belong to every *S*, it follows that *P* will necessarily belong to some *R*. For, since the affirmative is convertible, *S* will belong to some *R*: consequently since *P* belongs to every *S*, and *S* to some *R*, *P* must belong to some *R*; for a deduction in the first figure is produced. It is possible to demonstrate this both *per impossibile* and by exposition. For if both *P* and *R* belong to every *S*, should one of the *S*s, e.g. *N*, be taken, both *P* and *R* will belong to this, and thus *P* will belong to some *R*.

If *R* belongs to every *S*, and *P* to no *S*, there will be a deduction that *P* will necessarily not belong to some *R*. This may be demonstrated in the same way as before by converting the proposition *RS*. It might be proved also *per impossibile*, as in the former cases. But if *R* belongs to no *S*, *P* to every *S*, there will be no deduction. Terms for the positive relation are animal, horse, man; for the negative relation animal, inanimate, man.

Nor can there be a deduction when both terms are asserted of no *S*. Terms for the positive relation are animal, horse, inanimate; for the negative relation man, horse, inanimate—inanimate being the middle term.

It is clear then in this figure also when a deduction will be possible and when not, if the terms are related universally. For whenever both the terms are affirmative, there will be a deduction that one extreme belongs to some of the other; but when they are negative, no deduction will be possible. But when one is negative, the other affirmative, if the major is negative, the minor affirmative, there will be a deduction that the one extreme does not belong to some of the other; but if the relation is reversed, no deduction will be possible.

If one term is related universally to the middle, the other in part only, when both are affirmative there must be a deduction, no matter which is universal. For if *R* belongs to every *S*, *P* to some *S*, *P* must belong to some *R*. For since the affirmative is convertible, *S* will belong to some *P*; consequently since *R* belongs to every *S*, and *S* to some *P*, *R* must also belong to some *P*; therefore *P* must belong to some *R*. Again if *R* belongs to some *S*, and *P* to every *S*, *P* must belong to some *R*. This may be demonstrated in the same way as the preceding. And it is possible to demonstrate it also *per impossibile* and by exposition, as in the former cases.

But if one term is affirmative, the other negative, and if the affirmative is universal, a deduction will be possible whenever the minor term is affirmative. For if *R* belongs to every *S*, but *P* does not belong to some *S*, it is necessary that *P* does not belong to some *R*. For if *P* belongs to every *R*, and *R* belongs to every *S*, then *P* will belong to every *S*; but we assumed that it did not. Proof is possible also without reduction, if one of the *S*s be taken to which *P* does not belong.

But whenever the major is affirmative, no deduction will be possible, e.g. if *P* belongs to every *S*, and *R* does not belong to some *S*. Terms for the universal affirmative relation are animate, man, animal. For the universal negative relation it is not possible to get terms, if *R* belongs to some *S*, and does not belong to some *S*. For if *P* belongs to every *S*, and *R* to some *S*, then *P* will belong to some *R*; but we assumed that it belongs to no *R*. We must put the matter as before. Since its not belonging to some is indefinite, it is true to say of that which belongs to none that it does not belong to some. But if *R* belongs to no *S*, no deduction is possible, as has been shown. Clearly then no deduction will be possible here.

But if the negative term is universal, whenever the major is negative and the minor affirmative there will be a deduction. For if *P* belongs to no *S*, and *R* belongs to some *S*, *P* will not belong to some *R*; for we shall have the first figure again, if the proposition *RS* is converted.

But when the minor is negative, there will be no deduction. Terms for the positive relation are animal, man, wild; for the negative relation, animal, science, wild—the middle in both being the term wild.

Nor is a deduction possible when both are stated in the negative, but one is universal, the other particular. When the minor is related universally to the middle, take the terms animal, science, wild; animal, man, wild. When the major is related universally to the middle, take as terms for a negative relation raven, snow, white. For a positive relation terms cannot be found, if *R* belongs to some *S*, and does not belong to some *S*. For if *P* belongs to every *R*, and *R* to some *S*, then *P* belongs to some *S*; but we assumed that it belongs to no *S*. Our point, then, must be proved from the indefinite nature of the particular statement.

Nor is a deduction possible at all, if each of the extremes belongs to some of the middle, or does not belong, or one belongs and the other does not, or one belongs to some, the other not to all, or if they are indefinite. Common terms for all are animal, man, white; animal, inanimate, white.

It is clear then in this figure also when a deduction will be possible, and when not; and that if the terms are as stated, a deduction results of necessity, and if there is a deduction, the terms must be so related. It is clear also that all the deductions in this figure are imperfect (for all are made perfect by certain supplementary assumptions), and that it will not be possible to deduce a universal conclusion by means of this figure, whether negative or affirmative.

7 · It is evident also that in all the figures, whenever a deduction does not result, if both the terms are affirmative or negative nothing necessary follows at all, but if one is affirmative, the other negative, and if the negative is assumed universally, a deduction always results relating the minor to the major term, e.g. if *A* belongs to every or some *B*, and *B* belongs to no *C*; for if the propositions are converted it is necessary that *C* does not belong to some *A*. Similarly also in the other figures; a deduction always results by means of conversion. It is evident also that the substitution of an indefinite for a particular affirmative will effect the same deduction in all the figures.

It is clear too that all the imperfect deductions are made perfect by means of the first figure. For all are brought to a conclusion either probatively or *per impossibile*, in both ways the first figure is formed: if they are made perfect probatively, because (as we saw) all are brought to a conclusion by means of conversion, and conversion produces the first figure; if they are proved *per impossibile*, because on the assumption of the false statement the deduction comes about by means of the first figure, e.g. in the last figure, if *A* and *B* belong to every *C*, it follows that *A* belongs to some *B*; for if *A* belonged to no *B*, and *B* belongs to every *C*, *A* would belong to no *C*; but (as we stated) it belongs to every *C*. Similarly also with the rest.

It is possible also to reduce all deductions to the universal deductions in the 29b1
first figure. Those in the second figure are clearly made perfect by these, though not all in the same way; the universal ones are made perfect by converting the negative premiss, each of the particular by *reductio ad impossibile*. In the first figure particular deductions are indeed made perfect by themselves, but it is possible also to prove them by means of the second figure, reducing them *ad impossibile*, e.g. if *A* belongs to every *B*, and *B* to some *C*, it follows that *A* belongs to some *C*. For if it belonged to no *C*, and belongs to every *B*, then *B* will belong to *C*: this we know by means of the second figure. Similarly also demonstration will be possible in the case of the negative. For if *A* belongs to no *B*, and *B* belongs to some *C*, *A* will not belong to some *C*; for if it belonged to every *C*, and belongs to *B*, then *B* will belong to no *C*; and this (as we saw) is the middle figure. Consequently, since all deductions in the middle figure can be reduced to universal deductions in the first figure, and since particular deductions in the first figure can be reduced to deductions in the middle figure, it is clear that particular deductions can be reduced to universal deductions in the first figure. Deductions in the third figure, if the terms are universal, are directly made perfect by means of those deductions; but, when one of the

propositions is particular, by means of the particular deductions in the first figure and these (we have seen) may be reduced to the universal deductions in the first figure; consequently also the particular deductions in the third figure may be so reduced. It is clear then that all may be reduced to the universal deductions in the first figure.

We have stated then how deductions which prove that something belongs or does not belong to something else are constituted, both how those of the same figure are constituted in themselves, and how those of different figures are related to one another.

8 · Since there is a difference according as something belongs, necessarily belongs, or may belong (for many things belong, but not necessarily, others neither necessarily nor indeed at all, but it is possible for them to belong), it is clear that there will be different deductions for each of these, and deductions with differently related terms, one concluding from what is necessary, another from what is, a third from what is possible.

In the case of what is necessary, things are pretty much the same as in the case of what belongs; for when the terms are put in the same way, then, whether something belongs or necessarily belongs (or does not belong), a deduction will or will not result alike in both cases, the only difference being the addition of the expression 'necessarily' to the terms. For the negative is convertible alike in both cases, and we should give the same account of the expressions 'to be in something as in a whole' and 'to be predicated of every'. Thus in the other cases, the conclusion will be proved to be necessary by means of conversion, in the same manner as in the case of simple predication. But in the middle figure when the universal is affirmative, and the particular negative, and again in the third figure when the universal is affirmative and the particular negative, the demonstration will not take the same form, but it is necessary by the exposition of a part of the subject, to which in each case the predicate does not belong, to make the deduction in reference to this: with terms so chosen the conclusion will be necessary. But if the relation is necessary in respect of the part exposed, it must hold of some of that term in which this part is included; for the part exposed is just some of that. And each of the resulting deductions is in the appropriate figure.

9 · It happens sometimes also that when *one* proposition is necessary the deduction is necessary, not however when either is necessary, but only when the one related to the major is, e.g. if A is taken as necessarily belonging or not belonging to B, but B is taken as simply belonging to C; for if the propositions are taken in this way, A will necessarily belong or not belong to C. For since A necessarily belongs, or does not belong, to every B, and since C is one of the Bs, it is clear that for C also the positive or the negative relation to A will hold necessarily. But if AB is not necessary, but BC is necessary, the conclusion will not be necessary. For if it were, it would result both through the first figure and through the third that A belongs necessarily to some B. But this is false; for B may be such that it is possible that A

should belong to none of it. Further, an example also makes it clear that the conclusion will not be necessary, e.g. if *A* were movement, *B* animal, *C* man; man is an animal necessarily, but an animal does not move necessarily, nor does man. Similarly also if *AB* is negative; for the proof is the same.

In particular deductions, if the universal is necessary, then the conclusion will be necessary; but if the particular, the conclusion will not be necessary, whether the universal proposition is negative or affirmative. First let the universal be necessary, and let *A* belong to every *B* necessarily, but let *B* simply belong to some *C*: it is necessary then that *A* belongs to some *C* necessarily; for *C* falls under *B*, and *A* was assumed to belong necessarily to every *B*. Similarly also if the deduction should be negative; for the proof will be the same. But if the particular is necessary, the conclusion will not be necessary; for from the denial of such a conclusion nothing impossible results, just as it does not in the universal deductions. The same is true of negatives too. Try the terms movement, animal, white.

10 · In the second figure, if the negative proposition is necessary, then the conclusion will be necessary, but if the affirmative, not necessary. First let the negative be necessary; let *A* be possible of no *B*, and simply belong to *C*. Since then the negative is convertible, *B* is possible of no *A*. But *A* belongs to every *C*; consequently *B* is possible of no *C*. For *C* falls under *A*. The same result would be obtained if the negative refers to *C*; for if *A* is possible of no *C*, *C* is possible of no *A*; but *A* belongs to every *B*, consequently *C* is possible of no *B*; for again we have obtained the first figure. Neither then is *B* possible of *C*; for conversion is possible as before.

But if the affirmative proposition is necessary, the conclusion will not be necessary. Let *A* belong to every *B* necessarily, but to no *C* simply. If then the negative is converted, the first figure results. But it has been proved in the case of the first figure that if the negative related to the major is not necessary the conclusion will not be necessary either. Therefore the same result will obtain here. Further, if the conclusion is necessary, it follows that *C* necessarily does not belong to some *A*. For if *B* necessarily belongs to no *C*, *C* will necessarily belong to no *B*. But *B* at any rate must belong to some *A*, if it is true (as was assumed) that *A* necessarily belongs to every *B*. Consequently it is necessary that *C* does not belong to some *A*. But nothing prevents such an *A* being taken that it is possible for *C* to belong to all of it. Further one might show by an exposition of terms that the conclusion is not necessary without qualification, though it is necessary given the premisses. For example let *A* be animal, *B* man, *C* white, and let the propositions be assumed in the same way as before: it is possible that animal should belong to nothing white. Man then will not belong to anything white, but not necessarily; for it is possible for a man to become white, not however so long as animal belongs to nothing white. Consequently given these premisses the conclusion will be necessary, but it is not necessary without qualification.

Similar results will obtain also in particular deductions. For whenever the negative proposition is both universal and necessary, then the conclusion will be necessary; but whenever the affirmative is universal and the negative particular, the conclusion will not be necessary. First then let the negative be both universal and necessary: let it be possible for no *B* that *A* should belong to it, and let *A* belong to some *C*. Since the negative is convertible, it will be possible for no *A* that *B* should belong to it; but *A* belongs to some *C*; consequently *B* necessarily does not belong to some *C*. Again let the affirmative be both universal and necessary, and let the affirmative refer to *B*. If then *A* necessarily belongs to every *B*, but does not belong to some *C*, it is clear that *B* will not belong to some *C*, but not necessarily. For the same terms can be used to demonstrate the point, which were used in the universal deductions. Nor again, if the negative is necessary but particular, will the conclusion be necessary. The point can be demonstrated by means of the same terms.

11 · In the last figure when the terms are related universally to the middle, and both propositions are affirmative, if one of the two is necessary, then the conclusion will be necessary. But if one is negative, the other affirmative, whenever the negative is necessary the conclusion also will be necessary, but whenever the affirmative is necessary the conclusion will not be necessary. First let both the propositions be affirmative, and let *A* and *B* belong to every *C*, and let *AC* be necessary. Since then *B* belongs to every *C*, *C* also will belong to some *B*, because the universal is convertible into the particular; consequently if *A* belongs necessarily to every *C*, and *C* belongs to some *B*, it is necessary that *A* should belong to some *B* also. For *B* is under *C*. The first figure then is formed. A similar proof will be given also if *BC* is necessary. For *C* is convertible with some *A*; consequently if *B* belongs necessarily to every *C*, it will belong necessarily also to some *A*.

Again let *AC* be negative, *BC* affirmative, and let the negative be necessary. Since then *C* is convertible with some *B*, but *A* necessarily belongs to no *C*, *A* will necessarily not belong to some *B* either; for *B* is under *C*. But if the affirmative is necessary, the conclusion will not be necessary. For suppose *BC* is affirmative and necessary, while *AC* is negative and not necessary. Since then the affirmative is convertible, *C* also will belong to some *B* necessarily; consequently if *A* belongs to no *C* while *C* belongs to some *B*, *A* will not belong to some *B*—but not of necessity; for it has been proved, in the case of the first figure, that if the negative proposition is not necessary, neither will the conclusion be necessary. Further, the point may be made clear by considering the terms. Let *A* be good, *B* animal, *C* horse. It is possible then that good should belong to no horse, and it is necessary that animal should belong to every horse; but it is not necessary that some animal should not be good, since it is possible for every animal to be good. Or if that is not possible, take as the term awake or asleep; for every animal can accept these.

If, then, the terms are universal in relation to the middle, we have stated when the conclusion will be necessary. But if one is universal, the other particular, and if both are affirmative, whenever the universal is necessary the conclusion also must be necessary. The demonstration is the same as before; for the particular affirmative also is convertible. If then it is necessary that *B* should belong to every *C*, and *A* falls under C, it is necessary that B should belong to some A. But if B must belong to some A, then A must belong to some B; for conversion is possible. Similarly also if AC should be necessary and universal; for B falls under C. But if the particular is necessary, the conclusion will not be necessary. Let BC be both particular and necessary, and let A belong to every C, not however necessarily. If BC is converted the first figure is formed, and the universal proposition is not necessary, but the particular is necessary. But when the propositions were thus, the conclusion (as we proved) was not necessary; consequently it is not here either. Further, the point is clear if we look at the terms. Let A be waking, B biped, and C animal. It is necessary that B should belong to some C, but it is possible for A to belong to C, and that A should belong to B is not necessary. For there is no necessity that some biped should be asleep or awake. Similarly and by means of the same terms proof can be made, should AC be both particular and necessary.

But if one of the terms is affirmative, the other negative, whenever the universal is both negative and necessary the conclusion also will be necessary. For if it is not possible that A should belong to any C, but B belongs to some C, it is necessary that A should not belong to some B. But whenever the affirmative is necessary, whether universal or particular, or the negative is particular, the conclusion will not be necessary. The rest of the proof of this will be the same as before; but if terms are wanted, when the affirmative is universal and necessary, take the terms waking, animal, man, man being middle, and when the affirmative is particular and necessary, take the terms waking, animal, white; for it is necessary that animal should belong to some white thing, but it is possible that waking should belong to none, and it is not necessary that waking should not belong to some animal. But when the negative is particular and necessary, take the terms biped, moving, animal, animal being middle.

12 · It is clear then that a deduction that something belongs is not reached unless both propositions state that something belongs, but a necessary conclusion is possible even if one only of the propositions is necessary. But in both cases, whether the deductions are affirmative or negative, it is necessary that one proposition should be similar to the conclusion. I mean by 'similar', if the conclusion states that something belongs, the proposition must too; if the conclusion is necessary, the proposition must be necessary. Consequently this also is clear, that the conclusion will be neither necessary nor simple unless a necessary or simple proposition is assumed.

13 · Perhaps enough has been said about necessity, how it comes about and how it differs from belonging. We proceed to discuss that which is possible, when and how and by what means it can be proved. I use the terms 'to be possible' and 'the possible' of that which is not necessary but, being assumed, results in nothing impossible. We say indeed, homonymously, of the necessary that it is possible. [But that my definition of the possible is correct is clear from the contradictory negations and affirmations. For the expressions 'it is not possible to belong', 'it is impossible to

belong', and 'it is necessary not to belong' are either identical or follow from one another; consequently their opposites also, 'it is possible to belong', 'it is not impossible to belong', and 'it is not necessary not to belong', will either be identical or follow from one another. For of everything the affirmation or the denial holds good. That which is possible then will be not necessary and that which is not necessary will be possible.][8] It results that all propositions in the mode of possibility are convertible into one another. I mean not that the affirmative are convertible into the negative, but that those which are affirmative in form admit of conversion by opposition, e.g. 'it is possible to belong' may be converted into 'it is possible not to belong', and 'it is possible to belong to every' into 'it is possible to belong to no' or 'not to every', and 'it is possible to belong to some' into 'it is possible not to belong to some'. And similarly for the others. For since that which is possible is not necessary, and that which is not necessary may possibly not belong, it is clear that if it is possible that *A* should belong to *B*, it is possible also that it should not belong to *B*; and if it is possible that it should belong to every, it is also possible that it should not belong to every. The same holds good in the case of particular affirmations; for the proof is identical. And such propositions are affirmative and not negative; for 'to be possible' is in the same rank as 'to be', as was said above.

Having made these distinctions we next point out that 'to be possible' is used in two ways. In one it means to happen for the most part and fall short of necessity, e.g. a man's turning grey or growing or decaying, or generally what naturally belongs to a thing (for this has not its necessity unbroken, since a man does not exist forever, although if a man does exist, it comes about either necessarily or for the most part). In another way it means the indefinite, which can be both thus and not thus, e.g. an animal's walking or an earthquake's taking place while it is walking, or generally what happens by chance; for none of these inclines by nature in the one way more than in the opposite.

That which is possible in each of its two ways is convertible into its opposite, not however in the same way: what is natural is convertible because it does not necessarily belong (for in this sense it is possible that a man should not grow grey) and what is indefinite is convertible because it inclines this way no more than that. Science and demonstrative deductions are not concerned with things which are indefinite, because the middle term is uncertain; but they are concerned with things that are natural, and as a rule arguments and inquiries are made about things which are possible in this sense. Deductions indeed can be made about the former, but it is unusual at any rate to inquire about them.

These matters will be treated more definitely in the sequel;[9] our business at present is to state when and how and what deductions can be made from possible propositions. The expression 'it is possible for this to belong to that' may be taken in two ways: either 'to which that belongs' or 'to which it may belong'; for '*A* may be said of that of which *B*' means one or other of these—either 'of which *B* is said' or 'of which it may be said'; and there is no difference between '*A* may be said of that of

[8]Ross excises the passage in brackets.
[9]Aristotle's promise is not kept in any text we possess.

which B' and 'A may belong to every B'. It is clear then that the expression 'A may possibly belong to every B' might be used in two ways. First then we must state the nature and characteristics of the deduction which arises if B is possible of the subject of C, and A is possible of the subject of B. For thus both propositions are assumed in the mode of possibility; but whenever A is possible of the subject of B, one proposition is simple, the other possible. Consequently we must start from propositions which are similar in form, as in the other cases.

14 · Whenever A may belong to every B, and B to every C, there will be a perfect deduction that A may belong to every C. This is clear from the definition; for it was in this way that we explained 'to be possible to belong to every'. Similarly if it 33a1 is possible for A to belong to no B, and for B to belong to every C, then it is possible for A to belong to no C. For the statement that it is possible for A not to belong to that of which B may be true means (as we saw) that none of those things which can fall under B is left out of account. But whenever A may belong to every B, and B may belong to no C, then indeed no deduction results from the propositions assumed; but if BC is converted after the manner of possibility, the same deduction results as before. For since it is possible that B should belong to no C, it is possible also that it should belong to every C. This has been stated above. Consequently if B is possible for every C, and A is possible for every B, the same deduction again results. Similarly if in both propositions the negative is joined with 'it is possible': e.g. if A may belong to no B, and B to no C. No deduction results from the assumed propositions, but if they are converted we shall have the same deduction as before. It is clear then that if the negation relates either to the minor extreme or to both the propositions, either no deduction results, or if one does it is not perfect. For the necessity results from the conversion.

But if one of the propositions is universal, the other particular, when one relating to the major extreme is universal there will be a deduction. For if A is possible for every B, and B for some C, then A is possible for some C. This is clear from the definition of being possible. Again if A may belong to no B, and B may belong to some C, it is necessary that A may not belong to some of the Cs. The proof is the same as above. But if the particular proposition is negative, and the universal is affirmative, and they are in the same position as before, e.g. A is possible for every B, B may not belong to some C, then an evident deduction does not result from the assumed propositions; but if the particular is converted and it is laid down that B may belong to some C, we shall have the same conclusion as before, as in the cases given at the beginning.

But if the proposition relating to the major extreme is particular, the minor universal, whether both are affirmative, or negative, or different in quality, or if both are indefinite or particular, in no way will a deduction be possible. For nothing prevents B from reaching beyond A, so that as predicates they cover unequal areas. Let C be that by which B extends beyond A. To C it is not possible that A should belong—either to all or to none or to some or not to some, since propositions in the 33b1 mode of possibility are convertible and it is possible for B to belong to more things than A. Further, this is obvious if we take terms; for if the propositions are as assumed, the first term is both possible for none of the last and must belong to all of it. Take as terms common to all the cases under consideration animal, white, man, where the first belongs necessarily to the last; animal, white, garment, where it is not possible that the first should belong to the last. It is clear then that if the terms are related in this manner, no deduction results. For every deduction proves that something belongs either simply or necessarily or possibly. It is clear that there is no proof of the first or of the second. For the affirmative is destroyed by the negative, and the negative by the affirmative. There remains the proof of possibility. But this is impossible. For it has been proved that if the terms are related in this manner it is both necessary that the first should belong to all the last and not possible that it should belong to any. Consequently there cannot be a deduction to prove the possibility; for the necessary (as we stated) is not possible.

It is clear that if the terms are universal in possible propositions a deduction always results in the first figure, whether they are affirmative or negative, but that a perfect deduction results in the first case, an imperfect in the second. But possibility must be understood according to the definition laid down, not as covering necessity. This is sometimes forgotten.

15 · If one proposition is simple, the other possible, whenever the one related to the major extreme indicates possibility all the deductions will be perfect and establish possibility in the sense defined; but whenever the one related to the minor indicates possibility all the deductions will be imperfect, and those which are negative will establish not possibility according to the definition, but that something does not necessarily belong to any, or to every. For if something does not necessarily belong to any or to every, we say it is possible that it should belong to none or not to every. Let A be possible for every B, and let B belong to every C. Since C falls under B, and A is possible for every B, clearly it is possible for every C also. So a perfect deduction results. Likewise if the proposition AB is negative, and BC is affirmative, the former stating possible, the latter simple attribution, a perfect deduction results proving that A possibly belongs to no C.

It is clear that perfect deductions result if the proposition related to the minor term states simple belonging; but that deductions will result in the opposite case, must be proved *per impossibile*. At the same time it will be evident that they are imperfect; for the proof proceeds not from the propositions assumed. First we must state that if B's being follows necessarily from A's being, B's possibility will follow necessarily from A's possibility. For suppose, the terms being so related, that A is possible, and B is impossible. If then that which is possible, when it is possible for it to be, might happen, and if that which is impossible, when it is impossible, could not happen, and if at the same time A is possible and B impossible, it would be possible for A to happen without B, and if to happen, then to be. For that which has happened, when it has happened, is. But we must take the impossible and the possible not only in the sphere of becoming, but also in the spheres of truth and belonging, and the various other spheres in which we speak of the possible; for it will be alike in all. Further we must understand the statement that *B*'s being follows from *A*'s being, not as meaning that if some single thing *A* is, *B* will be; for nothing follows of necessity from the being of some one thing, but from two at least, i.e. when the propositions are related in the manner stated to be that of a deduction. For if *C* is predicated of *D*, and *D* of *F*, then *C* is necessarily predicated of *F*. And if each is possible, the conclusion also is possible. If then, for example, one should indicate the propositions by *A*, and the conclusion by *B*, it would not only result that if *A* is necessary, *B* is necessary, but also that if *A* is possible, *B* is possible.

Since this is proved it is evident that if a false and not impossible assumption is made, the consequence of the assumption will also be false and not impossible: e.g. if *A* is false, but not impossible, and if *B* follows from *A*, *B* also will be false but not impossible. For since it has been proved that if *B*'s being follows from *A*'s being, then *B*'s possibility will follow from *A*'s possibility, and *A* is assumed to be possible, consequently *B* will be possible; for if it were impossible, the same thing would at the same time be possible and impossible.

Since we have clarified these points, let *A* belong to every *B*, and *B* be possible for every *C*: it is necessary then that *A* should possibly belong to every *C*. Suppose that it is not possible, but assume that *B* belongs to every *C*: this is false but not impossible. If then *A* is not possible for every *C* but *B* belongs to every *C*, then *A* is not possible for every *B*; for a deduction is formed in the third figure. But it was assumed that *A* possibly belonged to every *B*. It is necessary then that *A* is possible for every *C*. For though the assumption we made is false and not impossible, the conclusion is impossible. [It is possible also in the first figure to bring about the impossibility, by assuming that *B* belongs to *C*. For if *B* belongs to every *C*, and *A* is possible for every *B*, then *A* would be possible for every *C*. But the assumption was made that *A* is not possible for every *C*.][10]

We must understand 'that which belongs to every' with no limitation in respect of time, e.g. to the present or to a particular period, but without qualification. For it is by the help of such propositions that we make deductions, since if the proposition is understood with reference to the present moment, there cannot be a deduction. For nothing perhaps prevents man belonging at a particular time to everything that is moving, i.e. if nothing else were moving; but moving is possible for every horse; yet man is possible for no horse. Further let the first term be animal, the middle moving, the last man. The propositions then will be as before, but the conclusion necessary, not possible. For man is necessarily animal. It is clear then that the universal must be understood without qualification, and not limited in respect of time.

Again let the proposition *AB* be universal and negative, and assume that *A* belongs to no *B*, but *B* possibly belongs to every *C*. These being laid down, it is necessary that *A* possibly belongs to no *C*. Suppose that it cannot belong, and that *B* belongs to *C*, as above. It is necessary then that *A* belongs to some *B*; for we have a deduction in the third figure; but this is impossible. Thus it will be possible for *A* to

[10] Ross excises the passage in brackets.

belong to no C; for if that is supposed false, the consequence is impossible. This deduction then does not establish possibility according to the definition, but that it belongs necessarily to none (for this is the contradictory of the assumption which was made; for it was supposed that A necessarily belongs to some C, but a deduction *per impossibile* establishes the contradictory assertion). Further, it is clear also from an example that the conclusion will not establish possibility. Let A be raven, B intelligent, and C man. A then belongs to no B; for no intelligent thing is a raven. But B is possible for every C; for every man may be intelligent. But A necessarily belongs to no C; so the conclusion does not establish possibility. But neither is it always necessary. Let A be moving, B science, C man. A then will belong to no B; but B is possible for every C. And the conclusion will not be necessary. For it is not necessary that no man should move; indeed it is not necessary that some man should move. Clearly then the conclusion establishes that it belongs necessarily to none. But we must take our terms better.

If the negative relates to the minor extreme and indicates possibility, from the actual propositions taken there can be no deduction, but if the possible proposition is converted, a deduction will be possible, as before. Let A belong to every B, and let B possibly belong to no C. If the terms are arranged thus, nothing necessarily follows; but if BC is converted and it is assumed that B is possible for every C, a deduction results as before; for the terms are in the same relative positions. Likewise if both the relations are negative, if AB indicates that it does not belong, and BC that it possibly belongs to none. Through the propositions actually taken nothing necessary results in any way; but if the possible proposition is converted, we shall have a deduction. Suppose that A belongs to no B, and B may belong to no C. Through these comes nothing necessary. But if B is assumed to be possible for every C (and this is true) and if the proposition AB remains as before, we shall again have the same deduction. But if it be assumed that B does not belong to every C, instead of possibly not belonging, there cannot be a deduction at all, whether the proposition AB is negative or affirmative. As common instances of a necessary and positive relation we may take the terms white, animal, snow; of an impossible relation, white, animal, pitch.

Clearly then if the terms are universal, and one of the propositions is simple, the other possible, whenever the proposition relating to the minor extreme is possible, a deduction always results, only sometimes it results from the propositions that are taken, sometimes it requires the conversion of one proposition. We have stated when each of these happens and the reason why. But if one of the relations is universal, the other particular, then whenever the one relating to the major extreme is universal and possible, whether affirmative or negative, and the particular is affirmative and simple, there will be a perfect deduction, just as when the terms are universal. The demonstration is the same as before. But whenever the one relating to the major extreme is universal, but simple rather than possible, and the other is particular and possible, whether both are negative or affirmative, or one is negative, the other affirmative, in all cases there will be an imperfect deduction. Only some of them will be proved *per impossibile,* others by the conversion of the possible proposition, as has been shown above. And a deduction will be possible by means of conversion when the proposition relating to the major extreme is universal and simple, and the other particular, negative, and possible, e.g. if *A* belongs to every *B* or to no *B*, and *B* may not belong to some *C*. For if *BC* is converted in respect of possibility, a deduction results. But whenever the particular is simple and negative, there cannot be a deduction. As instances of the positive relation we may take the terms white, animal, snow; of the negative, white, animal, pitch. For the demonstration must be made through the indefinite nature of the particular proposition. But if the universal relates to the minor extreme, and the particular to the major, whether either is negative or affirmative, possible or simple, in no way is a deduction possible. Nor is a deduction possible when the propositions are particular or indefinite, whether possible or simple, or the one possible, the other simple. The demonstration is the same as above. As instances of the necessary and positive relation we may take the terms animal, white, man; of the impossible relation, animal, white, garment. It is evident then that if the proposition relating to the major extreme is universal, a deduction always results, but if the one relating to the minor is universal nothing at all can ever be proved.

16 · Whenever one proposition indicates necessity, the other possibility, there will be a deduction when the terms are related as before; and a perfect deduction when the necessity relates to the minor extreme. If the terms are affirmative the conclusion will be possible, not simple, whether they are universal or not; but if one is affirmative, the other negative, when the affirmative is necessary the conclusion will be possible, not negative and simple; but when the negative is necessary the conclusion will be both possible negative, and simple negative, whether the terms are universal or not. Possibility in the conclusion must be understood in the same manner as before. There cannot be a deduction to a necessary negative; for 'not necessarily to belong' is different from 'necessarily not to belong'.

If the terms are affirmative, clearly the conclusion which follows is not necessary. Suppose *A* necessarily belongs to every *B*, and let *B* be possible for every *C*. We shall have an imperfect deduction that *A* may belong to every *C*. That it is imperfect is clear from the proof; for it will be proved in the same manner as above. Again, let *A* be possible for every *B*, and let *B* necessarily belong to every *C*. We shall then have a deduction that *A* may belong to every *C*, not that *A* does belong to every *C*; and it is perfect, not imperfect; for it is perfected directly through the original propositions.

But if the propositions are not similar in quality, suppose first that the negative is necessary, and let *A* be possible for no *B*, but let *B* be possible for every *C*. It is necessary then that *A* belongs to no *C*. For suppose *A* to belong to every *C* or to some *C*. Now we assumed that *A* is not possible for any *B*. Since then the negative is convertible, *B* is not possible for any *A*. But *A* is supposed to belong to every *C* or to some *C*. Consequently *B* will not be possible for any *C* or for every *C*. But it was originally laid down that *B* is possible for every *C*. And it is clear that the possibility of not belonging can be deduced, since the fact of not belonging can be. Again, let the affirmative proposition be necessary, and let *A* possibly not belong to any *B*, and let *B* necessarily belong to every *C*. The deduction will be perfect, but it will establish a possible negative, not a simple negative. For the proposition relating to the major was assumed in this way; and further it is not possible to prove *per impossibile*. For if it were supposed that *A* belongs to some *C*, and it is laid down that *A* possibly does not belong to any *B*, no impossible relation between *B* and *C* follows from this. But if the negative relates to the minor extreme, when it indicates possibility a deduction is possible by conversion, as above; but when impossibility, not. Nor again when both are negative, and the one relating to the minor is not possible. The same terms as before serve both for the positive relation, white, animal, snow, and for the negative relation, white, animal, pitch.

The same relation will obtain in particular deductions. Whenever the negative is necessary, the conclusion will be negative and simple: e.g. if it is not possible that *A* should belong to any *B*, but *B* may belong to some *C*, it is necessary that *A* should not belong to some *C*. For if *A* belongs to every *C*, but cannot belong to any *B*, neither can *B* belong to any *A*. So if *A* belongs to every *C*, *B* can belong to no *C*. But it was laid down that *B* may belong to some *C*. But when the particular affirmative in the negative deduction, i.e. *BC*, or the universal in the affirmative i.e. *AB*, is necessary, there will not be a simple conclusion. The demonstration is the same as before. But if the term relating to the minor extreme is universal, and possible, whether affirmative or negative, and the particular is necessary, there cannot be a deduction. Terms where the relation is positive and necessary: animal, white, man; where it is necessary and negative: animal, white, garment. But when the universal is necessary, the particular possible, if the universal is negative we may take the terms animal, white, raven to illustrate the positive relation, or animal, white, pitch to illustrate the negative; and if the universal is affirmative we may take the terms animal, white, swan to illustrate the positive relation, and animal, white, snow to illustrate the impossible relation. Nor again is a deduction possible when the propositions are indefinite, or both particular. Terms applicable in either case to illustrate the positive relation are animal, white, man; to illustrate the negative, animal, white, inanimate. For the relation of animal to some white, and of white to some inanimate, is both necessary and positive and necessary and negative. Similarly if the relation is possible; so the terms may be used for all cases.

Clearly then from what has been said a deduction results or not from similar relations of the terms whether we are dealing with simple or with necessary propositions, with this exception, that if the negative proposition is simple the conclusion is possible, but if the negative is necessary the conclusion is both possible and negative simple. [It is clear also that all deductions are imperfect and are perfected by means of the figures above mentioned.][11]

[11]Ross excises the bracketed sentence (see 39^{a}1).

17 · In the second figure whenever both propositions are possible, no deduction is possible, whether they are affirmative or negative, universal or particular. But when one indicates belonging, the other possibility, if the affirmative indicates belonging no deduction is possible, but if the universal negative does a conclusion can always be drawn. Similarly when one proposition is necessary, the other possible. Here also we must understand the term 'possible' in the conclusions in the same sense as before.

First we must prove that the negative possible proposition is not convertible, e.g. if *A* may belong to no *B*, it does not follow that *B* may belong to no *A*. For suppose it to follow and assume that *B* may belong to no *A*. Since then possible affirmations are convertible with negations, whether they are contraries or contradictories, and since *B* may belong to no *A*, it is clear that *B* may belong to every *A*. But this is false; for if all this can be that, it does not follow that all that can be this: consequently the negative proposition is not convertible. Further, there is no reason why *A* may not belong to no *B*, while *B* necessarily does not belong to some *A*; e.g. it is possible that no man should be white (for it is also possible that every man should be white), but it is not true to say that it is possible that no white thing should be a man; for many white things are necessarily not men, and the necessary (as we saw) is other than the possible.

Moreover it is not possible to prove the convertibility of these propositions by a *reductio ad absurdum*, i.e. by claiming that since it is false that *B* may belong to no *A*, it is true that it cannot belong to no *A* (for the one statement is the contradictory of the other); but if this is so, it is true that *B* necessarily belongs to some *A*; and consequently *A* necessarily belongs to some *B*—but this is impossible. The argument cannot be admitted; for it does not follow that some *A* is necessarily *B*, if it is not possible that no *A* should be *B*. For the latter expression is used in two ways, one if some *A* is necessarily *B*, another if some *A* is necessarily not *B*. For it is not true to say that that which necessarily does not belong to some of the *A*s may not belong to every *A*, just as it is not true to say that what necessarily belongs to some *A* may belong to every *A*. If any one then should claim that because it is not possible for *C* to belong to every *D*, it necessarily does not belong to some *D*, he would make a false assumption; for it does belong to every *D*, but because in some cases it belongs necessarily, therefore we say that it is not possible for it to belong to every. Hence both 'necessarily belongs to some' and 'necessarily does not belong to some' are opposed to 'may belong to every'. Similarly also they are opposed to 'may belong to no'. It is clear then that in relation to what is possible and not possible, in the sense originally defined, we must assume, not that *A* necessarily belongs to some *B*, but that *A* necessarily does not belong to some *B*. But if this is assumed, no impossibility results; consequently there is no deduction. It is clear from what has been said that the negative is not convertible.

This being proved, suppose it possible that *A* may belong to no *B* and every *C*. By means of conversion no deduction will result; for such a proposition, as has been said, is not convertible. Nor can a proof be obtained by a *reductio;* for if it is assumed that *B* cannot not belong to every *C*, no false consequence results; for *A* may belong both to every C and to no C. In general, if there is a deduction, it is clear that its conclusion will be possible because neither of the propositions is simple; and this must be either affirmative or negative. But neither is possible. Suppose the 37b1 conclusion is affirmative: it will be proved by an example that the predicate cannot belong to the subject. Suppose the conclusion is negative: it will be proved that it is not possible but necessary. Let A be white, B man, C horse. It is possible then for A to belong to all of the one and to none of the other. But it is not possible for B to belong or not to belong to C. That it is not possible for it to belong, is clear. For no horse is a man. Neither is it possible for it not to belong. For it is necessary that no horse should be a man, but the necessary we found to be different from the possible. No deduction then results. A similar proof can be given if the negative is the other way about, or if both are affirmative or negative. The demonstration can be made by means of the same terms. And whenever one is universal, the other particular, or both are particular or indefinite, or in whatever other way the propositions can be altered, the proof will always proceed through the same terms. Clearly then, if both the propositions are possible, no deduction results.

18 · But if one indicates belonging, the other possibility, if the affirmative indicates belonging and the negative possibility no deduction will be possible, whether the terms are universal or particular. The proof is the same as above, and by means of the same terms. But when the affirmative indicates possibility, and the negative belonging, we shall have a deduction. Suppose A belongs to no B, but can belong to every C. If the negative is converted, B will belong to no A. But A *ex hypothesi* can belong to every C: so a deduction is made, proving by means of the first figure that B may belong to no C. Similarly also if the negative relates to C. But if both are negative, one indicating non-belonging, the other possibility, nothing follows necessarily from these premisses as they stand, but if the possible proposition is converted a deduction is formed to prove that B may belong to no C, as before; for we shall again have the first figure. But if both are affirmative, no deduction will be possible. Terms for when the relation is positive: health, animal, man; for when it is negative: health, horse, man.

The same will hold good if the deductions are particular. Whenever the 38a1 affirmative is simple, whether universal or particular, no deduction is possible (this is proved similarly and by the same examples as above), but when the negative is, a conclusion can be drawn by means of conversion, as before. Again if both the relations are negative, and the simple is universal, although no conclusion follows from the actual propositions, a deduction can be obtained by converting the possible as before. But if the negative is simple, but particular, no deduction is possible, whether the other proposition is affirmative or negative. Nor can a conclusion be drawn when both are indefinite, whether affirmative or negative, or particular. The proof is the same and by the same terms.

19 · If one of the propositions indicates necessity, the other possibility, then if the negative is necessary there is a deduction not merely that it can not belong but also that it does not belong; but if the affirmative is necessary, no conclusion is possible. Suppose that A necessarily belongs to no B, but may belong to every C. If the negative is converted B will belong to no A; but A *ex hypothesi* may belong to every C: so once more a conclusion is drawn by the first figure that B may belong to no C. But at the same time it is clear that B will not belong to any C. For assume that it does; then if A cannot belong to any B, and B belongs to some C, A cannot belong to some C; but *ex hypothesi* it may belong to all. A similar proof can be given if the negative relates to C.

Again let the affirmative be necessary, and the other possible; i.e. suppose that A may belong to no B, but necessarily belongs to every C. When the terms are arranged in this way no deduction is possible. For it turns out that B necessarily does not belong to C. Let A be white, B man, C swan. White then necessarily belongs to swan, but may belong to no man; and man necessarily belongs to no swan. Clearly then we cannot draw a possible conclusion; for that which is necessary is admittedly distinct from that which is possible. Nor again can we draw a necessary conclusion: for that presupposes that both propositions are necessary, or at any rate the negative one. Further it is possible also, when the terms are so arranged, that B should belong to C; for nothing prevents C falling under B, A being possible for every B, and necessarily belonging to C; e.g. if C is awake, B animal, A motion. For motion necessarily belongs to what is awake, and is possible for every animal; and 38b1
everything that is awake is animal. Clearly then the conclusion cannot be negative and simple, if the relation must be positive when the terms are related as above. Nor can the opposite affirmations be established: consequently no deduction is possible. A similar proof is possible if the affirmative is the other way about.

But if the propositions are similar in quality, when they are negative a deduction can always be formed by converting the possible as before. Suppose A necessarily does not belong to B, and possibly may not belong to C: if the propositions are converted B belongs to no A, and A may possibly belong to every C; thus we have the first figure. Similarly if the negative relates to C. But if they are affirmative there cannot be a deduction. Clearly the conclusion cannot be a negative simple or a negative necessary proposition because no negative has been laid down either in the simple or in the necessary mode. Nor can the conclusion be a possible negative proposition. For if the terms are so related, B necessarily will not belong to C; e.g. suppose that A is white, B swan, C man. Nor can the opposite affirmations be established, since we have shown that B necessarily does not belong to C. A deduction then is not possible at all.

Similar relations will obtain in particular deductions. For whenever the negative is universal and necessary, a deduction will always be possible to prove both that it may and that it does not (the proof proceeds by conversion); but when the affirmative is universal and necessary, no conclusion can be drawn. This can be proved in the same way as for universal deductions, and by the same terms. Nor is a conclusion possible when both are affirmative: this also may be proved as above. But when both are negative, and the one which signifies non-belonging is universal and necessary, though nothing follows necessarily from the premisses as they are stated, a conclusion can be drawn as above if the possible proposition is converted. But if both are indefinite or particular, no deduction can be formed. The same proof will serve, and the same terms.

It is clear then from what has been said that if the universal and negative proposition is necessary, a deduction is always possible, proving not merely that it can not belong but also that it does not; but if the affirmative is necessary no conclusion can be drawn. It is clear too that a deduction is possible or not under the
39ª1 same conditions whether simple or necessary. And it is clear that all the deductions are imperfect, and are completed by means of the figures mentioned.

20 · In the last figure a deduction is possible whether both or only one of the propositions is possible. When the propositions indicate possibility the conclusion will be possible; and also when one indicates possibility, the other belonging. But when the other is necessary, if it is affirmative the conclusion will be neither necessary nor simple; but if it is negative there will be a deduction that it does not belong, as above. In these also we must understand the expression 'possible' in the conclusion in the same way as before.

First let them be possible and suppose that both *A* and *B* may belong to every *C*. Since then the affirmative is convertible into a particular, and *B* may belong to every *C*, it follows that *C* may belong to some *B*. So, if *A* is possible for every *C*, and *C* is possible for some *B*, then *A* must be possible for some *B*. For we have got the first figure. And if *A* may belong to no *C*, but *B* may belong to every *C*, it follows that *A* may not belong to some *B*; for we shall have the first figure again by conversion. But if both should be negative no necessary consequence will follow from them as they are stated, but if the propositions are converted there will be a deduction as before. For if *A* and *B* may not belong to *C*, if 'may belong' is substituted we shall again have the first figure by means of conversion. But if one of the terms is universal, the other particular, a deduction will be possible, or not, under the same arrangement of the terms as in the case of simple propositions. Suppose that *A* may belong to every *C*, and *B* to some *C*. We shall have the first figure again if the particular proposition is converted. For if *A* is possible for every *C*, and *C* for some *B*, then *A* is possible for some *B*. Similarly if *BC* is universal. Likewise also if *AC* is negative, and *BC* affirmative; for we shall again have the first figure by conversion. But if both should be negative—the one universal and the
39ᵇ1 other particular—although no conclusion will follow from them as they are put, it will follow if they are converted, as above. But when both are indefinite or particular, no deduction can be formed; for *A* must belong both to every *B* and to no *B*. To illustrate the affirmative relation take the terms animal, man, white; to illustrate the negative, take the terms horse, man, white, white being the middle term.

21 · If one of the propositions indicates belonging, the other possibility, the conclusion will be that it is possible, not that it belongs; and a deduction will be possible under the same arrangement of the terms as before. First let them be

affirmative: suppose that *A* belongs to every *C*, and *B* may belong to every *C*. If *BC* is converted, we shall have the first figure, and the conclusion that *A* may belong to some *B*. For when one of the propositions in the first figure indicates possibility, the conclusion also (as we saw) is possible. Similarly if *BC* indicates belonging, *AC* possibility; or if *AC* is negative, *BC* affirmative, no matter which of the two is simple; in both cases the conclusion will be possible; for the first figure is obtained once more, and it has been proved that if one proposition indicates possibility in that figure the conclusion also will be possible. But if the negative relates to the minor extreme, or if both are negative, no conclusion can be drawn from them as they stand, but if they are converted a deduction is obtained as before.

If one of the propositions is universal, the other particular, then when both are affirmative, or when the universal is negative, the particular affirmative, we shall have the same sort of deductions; for all are completed by means of the first figure. So it is clear that the deduction will be not that it belongs but that it is possible. But if the affirmative is universal, the negative particular, the proof will proceed by a *reductio ad impossibile*. Suppose that *B* belongs to every *C*, and *A* may not belong to some *C*: it follows that *A* may not belong to some *B*. For if *A* necessarily belongs to every *B*, and *B* (as has been assumed) belongs to every *C*, *A* will necessarily belong to every *C*; for this has been proved before. But it was assumed that *A* may not belong to some *C*.

Whenever both are indefinite or particular, no deduction will be possible. The demonstration is the same as before, and proceeds by means of the same terms.

22 · If one of the propositions is necessary, the other possible, when the terms are affirmative a possible conclusion can always be drawn; when one is affirmative, the other negative, if the affirmative is necessary a possible negative can be inferred; but if the negative is necessary both a possible and a simple negative conclusion are possible. But a necessary negative conclusion will not be possible, any more than in the other figures.

Suppose first that the terms are affirmative, i.e. that *A* necessarily belongs to every *C*, and *B* may belong to every *C*. Since then *A* must belong to every *C*, and *C* may belong to some *B*, it follows that *A* may (not does) belong to some *B*; for so it resulted in the first figure. A similar proof may be given if *BC* is necessary, and *AC* is possible. Again suppose one is affirmative, the other negative, the affirmative being necessary, i.e. suppose *A* may belong to no *C*, but *B* necessarily belongs to every *C*. We shall have the first figure once more; and—since the negative proposition indicates possibility—it is clear that the conclusion will be possible; for when the propositions stand thus in the first figure, the conclusion (as we found) is possible. But if the negative proposition is necessary, the conclusion will be not only that *A* may not belong to some *B* but also that it does not belong to some *B*. For suppose that *A* necessarily does not belong to *C*, but *B* may belong to every *C*. If the affirmative *BC* is converted, we shall have the first figure, and the negative proposition is necessary. But when the propositions stood thus, it resulted that *A* might not belong to some *C*, and that it did not belong to some *C*; consequently here it follows that A does not belong to some B. But when the negative relates to the minor extreme, if it is possible we shall have a deduction by altering the proposition, as before; but if it is necessary no deduction can be formed. For A both necessarily belongs to every B, and cannot belong to any B. To illustrate the former take the terms sleep, sleeping horse, man; to illustrate the latter take the terms sleep, waking horse, man.

Similar results will obtain if one of the terms is related universally to the middle, the other in part. If both are affirmative, the conclusion will be possible, not simple; and also when one is negative, the other affirmative, the latter being necessary. But when the negative is necessary, the conclusion also will be a simple negative; for the same kind of proof can be given whether the terms are universal or not. For the deductions must be made perfect by means of the first figure, so that a result which follows in the first figure follows also in the third. But when the negative is universal and relates to the minor extreme, if it is possible a deduction can be formed by means of conversion; but if it is necessary a deduction is not possible. The proof will follow the same course as for the universal deductions; and the same terms may be used.

It is clear then in this figure also when and how a deduction can be formed, and when the conclusion is possible, and when it is simple. It is evident also that all deductions in this figure are imperfect, and that they are made perfect by means of the first figure.

23 · It is clear from what has been said that the deductions in these figures are made perfect by means of the universal deductions in the first figure and are reduced to them. That every deduction without qualification can be so treated, will be clear presently, when it has been proved that every deduction is formed through one or other of these figures.

It is necessary that every demonstration and every deduction should prove either that something belongs or that it does not, and this either universally or in part, and further either probatively or hypothetically. One sort of hypothetical proof is the *reductio ad impossibile.* Let us speak first of probative deductions; for after it has been proved in their case, the truth of our contention will be clear with regard to those which are proved *per impossibile,* and in general hypothetically.

If then one wants to deduce that A belongs or does not belong to B, one must assume something of something. If now A should be assumed of B, the proposition originally in question will have been assumed. But if A should be assumed of C, but C should not be assumed of anything, nor anything of it, nor anything else of A, no deduction will be possible. For nothing necessarily follows from the assumption of some one thing concerning some one thing. Thus we must take another proposition as well. If then A be assumed of something else, or something else of A, or something different of C, nothing prevents a deduction being formed, but it will not be in relation to B through the propositions taken. Nor when C belongs to something else, and that to something else and so on, no connexion however being made with B, will a deduction be possible in relation to B. For in general we stated that no deduction can establish the attribution of one thing to another, unless some middle term is taken, which is somehow related to each by way of predication. For a deduction in general is made out of propositions, and a deduction referring to *this* out of propositions with the same reference, and a deduction relating *this* to *that* proceeds through propositions which relate this to that. But it is impossible to take a proposition in reference to *B*, if we neither affirm nor deny anything of it; or again to take a proposition relating *A* to *B*, if we take nothing common, but affirm or deny peculiar attributes of each. So we must take a middle term relating to both, which will connect the predications, if we are to have a deduction relating this to that. If then we must take something common in relation to both, and this is possible in three ways (either by predicating *A* of *C*, and *C* of *B*, or *C* of both, or both of *C*), and these are the figures of which we have spoken, it is clear that every deduction must be made in one or other of these figures. The argument is the same if several middle terms should be necessary to establish the relation to *B;* for the figure will be the same whether there is one middle term or many.

It is clear then that probative deductions are effected by means of the aforesaid figures; the following considerations will show that *reductiones ad impossibile* also are effected in the same way. For all who effect an argument *per impossibile* deduce what is false, and prove the original conclusion hypothetically when something impossible results from the assumption of its contradictory; e.g. that the diagonal of the square is incommensurate with the side, because odd numbers are equal to evens if it is supposed to be commensurate. One deduces that odd numbers come out equal to evens, and one proves hypothetically the incommensurability of the diagonal, since a falsehood results from its contradictory. For this we found to be deducing *per impossibile,* viz. proving something impossible by means of an hypothesis conceded at the beginning. Consequently, since the falsehood is established in reductions *ad impossibile* by a probative deduction, and the original conclusion is proved hypothetically, and we have already stated that probative deductions are effected by means of these figures, it is evident that deductions *per impossibile* also will be made through these figures. Likewise all the other hypothetical deductions; for in every case the deduction leads up to the substituted proposition; but the original thesis is reached by means of a concession or some other hypothesis. But if this is true, every demonstration and every deduction must be formed by means of the three figures mentioned above. But when this has been shown it is clear that every deduction is perfected by means of the first figure and is reducible to the universal deductions in this figure.

24 · Further in every deduction one of the terms must be affirmative, and universality must be present: unless one of the premisses is universal either a deduction will not be possible, or it will not refer to the subject proposed, or the original position will be begged. Suppose we have to prove that pleasure in music is good. If one should claim that pleasure is good without adding 'every', no deduction will be possible; if one should claim that some pleasure is good, then if it is different from pleasure in music, it is not relevant to the subject proposed; if it is this very

pleasure, one is assuming that which was originally proposed. This is more obvious in geometrical proofs, e.g. that the angles at the base of an isosceles triangle are equal. Suppose the lines *A* and *B* have been drawn to the centre. If then one should assume that the angle *AC* is equal to the angle *BD*, without claiming generally that angles of semicircles are equal; and again if one should assume that the angle *C* is equal to the angle *D*, without the additional assumption that every angle of a segment is equal to every other angle of the same segment; and further if one should assume that when equal angles are taken from the whole angles, which are themselves equal, the remainders *E* and *F* are equal, he will beg the original position, unless he also assumes that when equals are taken from equals the remainders are equal.

It is clear then that in every deduction there must be a universal, and that a universal is proved only when all the terms are universal, while a particular is proved in both cases; consequently if the conclusion is universal, the terms also must be universal, but if the terms are universal it is possible that the conclusion may not be universal. And it is clear also that in every deduction either both or one of the propositions must be like the conclusion. I mean not only in being affirmative or negative, but also in being necessary, simple, or possible. We must consider also the other forms of predication.

It is clear also when a deduction in general can be made and when it cannot; and when a potential, when a perfect deduction can be formed; and that if a deduction is formed the terms must be arranged in one of the ways that have been mentioned.

25 · It is clear too that every demonstration will proceed through three terms and no more, unless the same conclusion is established by different pairs of propositions; e.g. *E* may be established through *A* and *B*, and through *C* and *D*, or through *A* and *B*, or *A* and *C* and *D*. For nothing prevents there being several middles for the same terms. But in that case there is not one but several deductions. Or again when each of *A* and *B* is obtained by deduction, e.g. *A* by means of *D* and *E*, and again *B* by means of *F* and *G*. Or one may be obtained by deduction, the other by induction. But thus also the deductions are many; for the conclusions are many, e.g. *A* and *B* and *C*.

But if this can be called one deduction, not many, the same conclusion may be reached by several terms in this way, but it cannot be reached as *C* is established by means of *A* and *B*. Suppose that *E* is inferred from *A*, *B*, *C*, and *D*. It is necessary then that of these one should be related to another as whole to part; for it has already been proved that if a deduction is formed some of its terms must be related in this way. Suppose then that *A* stands in this relation to *B*. Some conclusion then follows from them. It must either be *E* or one or other of *C* and *D*, or something other than these.

If it is *E* the deduction will have *A* and *B* for its sole premisses. But if *C* and *D* are so related that one is whole, the other part, some conclusion will follow from them also; and it must be either *E*, or one or other of *A* and *B*, or something other than these. And if it is *E*, or *A* or *B*, either the deductions will be more than one, or the same thing happens to be inferred by means of several terms in the sense which we saw to be possible. But if the conclusion is other than *E* or *A* or *B*, the deductions will be many, and unconnected with one another. But if *C* is not related to *D* as to make a deduction, the propositions will have been assumed to no purpose, unless for the sake of induction or of obscuring the argument or something of the sort.

But if from *A* and *B* there follows not *E* but some other conclusion, and if from *C* and *D* either *A* or *B* follows or something else, then there are several deductions, and they do not establish the conclusion proposed; for we assumed that the deduction proved *E*. And if no conclusion follows from *C* and *D*, it turns out that these propositions have been assumed to no purpose, and the deduction does not prove the original proposition.

So it is clear that every demonstration and every deduction will proceed through three terms only.

This being evident, it is clear that a conclusion follows from two propositions and not from more than two for the three terms make two propositions unless a new proposition is assumed, as was said at the beginning, to perfect the deductions. It is clear therefore that in whatever deductive argument the propositions through which the main conclusion follows (for some of the preceding conclusions must be propositions) are not even in number, this argument either has not been deduced or it has assumed more than was necessary to establish its thesis.

If then deductions are taken with respect to their main propositions, every deduction will consist of an even number of propositions and an odd number of terms (for the terms exceed the propositions by one), and the conclusions will be half the number of the propositions. But whenever a conclusion is reached by means of preliminary deductions or by means of several continuous middle terms, e.g. *AB* by means of *C* and *D*, the number of the terms will similarly exceed that of the propositions by one (for the extra term must either be added outside or inserted; but in either case it follows that the relations of predication are one fewer than the terms related, and the propositions will be equal in number to the relations of predication). The propositions however will not always be even, the terms odd; but they will alternate—when the propositions are even, the terms must be odd; when the terms are even, the propositions must be odd; for along with one term one proposition is added, if a term is added from any quarter. Consequently since the propositions were (as we saw) even, and the terms odd, we must make them alternately even and odd at each addition. But the conclusions will not follow the same arrangement either in respect to the terms or to the propositions. For if one term is added, conclusions will be added less by one than the pre-existing terms; for the conclusion is drawn not in relation to the single term last added, but in relation to all the rest, e.g. if to *ABC* the term *D* is added, two conclusions are thereby added, one in relation to *A*, the other in relation to *B*. Similarly with any further additions. And similarly too if the term is inserted in the middle; for a deduction will not be effected in relation to one term only. Consequently the conclusions will be much more numerous than the terms or the propositions.

26 · Since we understand the subjects with which deductions are concerned, what sort of conclusion is established in each figure, and in how many ways this is done, it is evident to us both what sort of problem is difficult and what sort is easy to prove. For that which is concluded in many figures and through many moods is easier; that which is concluded in few figures and through few moods is more difficult to attempt. The universal affirmative is proved by means of the first figure only and by this in only one way; the negative is proved both through the first figure and through the second, through the first in one way, through the second in two. The particular affirmative is proved through the first and through the last figure, in one way through the first, in three through the last. The particular negative is proved in all the figures, but once in the first, in two ways in the second, in three in the third. It is clear then that the universal affirmative is most difficult to establish and most easy to overthrow. In general, universals are easier game for the destroyer than particulars; for whether the predicate belongs to none or not to some, they are destroyed; and the particular negative is proved in all the figures, the universal negative in two. Similarly with negatives: the original statement is destroyed, whether the predicate belongs to all or to some; and this we found possible in two figures. But particular statements can be refuted in one way only—by proving that the predicate belongs either to all or to none. But particular statements are easier to *establish;* for proof is possible in more figures and through more moods. And in general we must not forget that it is possible to refute statements by means of one another, I mean, universal statements by means of particular, and particular statements by means of universal; but it is not possible to establish universal statements by means of particular, though it is possible to establish particular statements by means of universal. At the same time it is evident that it is easier to refute than to establish.

The manner in which every deduction is produced, the number of the terms and propositions through which it proceeds, the relation of the propositions to one another, the character of the problem proved in each figure, and the number of the figures appropriate to each problem, all these matters are clear from what has been said.

27 · We must now state how we may ourselves always have a supply of deductions in reference to the problem proposed and by what road we may reach the principles relative to the problem; for no doubt we ought not only to investigate the construction of deductions, but also to have the power of making them.

Of all the things which exist some are such that they cannot be predicated of anything else truly and universally, e.g. Cleon and Callias, i.e. the individual and sensible, but other things may be predicated of them (for each of these is both man and animal); and some things are themselves predicated of others, but nothing prior is predicated of them; and some are predicated of others, and yet others of them, e.g. man of Callias and animal of man. It is clear then that some things are naturally not said of anything; for as a rule each sensible thing is such that it cannot be predicated of anything, save incidentally—for we sometimes say that that white object is

Socrates, or that that which approaches is Callias. We shall explain in another place[12] that there is an upward limit also to the process of predicating; for the present we must assume this. Of these it is not possible to demonstrate another predicate, save as a matter of opinion, but these may be predicated of other things. Neither can individuals be predicated of other things, though other things can be predicated of them. Whatever lies between these limits can be spoken of in both ways: they may be said of others, and others said of them. And as a rule arguments and inquiries are concerned with these things.

We must select the propositions suitable to each problem in this manner: first we must lay down the subject and the definitions and the properties of the thing; next we must lay down those attributes which follow the thing, and again those which the thing follows, and those which cannot belong to it. (Those to which it cannot belong need not be selected, because the negative is convertible.) Of the attributes which follow we must distinguish those which fall within the definition, those which are predicated as properties, and those which are predicated as accidents, and of the latter those which apparently and those which really belong. The larger the supply a man has of these, the more quickly will he reach a conclusion; and in proportion as he apprehends those which are truer, the more cogently will he demonstrate.

But he must select not those which follow some of the thing but those which follow the thing as a whole, e.g. not what follows some man but what follows every man; for deduction proceeds through universal propositions. If it is indefinite, it is uncertain whether the proposition is universal, but if it is definite, the matter is clear. Similarly one must select those attributes which the subject follows as wholes, for the reason given. But that which follows one must not suppose to follow as a whole, e.g. that every animal follows man or every science music, but only that it follows, without qualification, as indeed we state it in a proposition—for the other statement is useless and impossible, e.g. that every man is every animal or justice is every good. But that which something follows receives the mark 'every'. Whenever the subject, for which we must obtain the attributes that follow, is contained by something else, what follows or does not follow the universal must not be selected in dealing with the subordinate term (for these attributes have been taken in dealing with the superior term; for what follows animal also follows man, and what does not belong to animal does not belong to man); but we must choose those attributes which are peculiar to each subject. For some things are peculiar to the species as distinct from the genus; for there must be attributes peculiar to the different species. Nor in the case of the universal should we select those things which the contained term follows, e.g. taking for animal what man follows. It is necessary indeed, if animal follows man, that it should follow all these also. But these belong more properly to the choice of what concerns man. One must take also what follows a thing—and what it follows—for the most part; for in the case of problems about what holds for the most part, deductions depend on propositions, either all or some, which hold for the most part (for the conclusion of each deduction is similar to its

[12]See *Posterior Analytics* I 19–22.

principles). Again, we should not select things which follow everything; for no deduction can be made from them (the reason why this is so will be made clear in what follows).

28 · If men wish to establish something about some whole, they must look to the subjects of that which is being established (the subjects of which it happens to be asserted), and the attributes which follow that of which it is to be predicated. For if any of these subjects is the same as any of these attributes, the one must belong to the other. But if the purpose is to establish not a universal but a particular proposition, they must look for the terms which each follows; for if any of these are identical, the attribute must belong to some of the subject. Whenever the one term has to belong to none of the other, one must look to the consequents of the subject, and to those attributes which cannot be present in the predicate in question; or conversely to the attributes which cannot be present in the subject, and to the consequents of the predicate. If any members of these groups are identical, one of the terms in question cannot belong to any of the other. For sometimes a deduction in the first figure results, sometimes a deduction in the second. But if the object is to establish a particular negative proposition, we must find antecedents of the subject in question and attributes which cannot belong to the predicate in question. If any members of these two groups are identical, it follows that one of the terms in question does not belong to some of the other.

Perhaps each of these statements will become clearer in the following way. Suppose the consequents of A are designated by B, the antecedents of A by C, attributes which cannot belong to A by D. Suppose again that the attributes of E are designated by F, the antecedents of E by G, and attributes which cannot belong to E by H. If then one of the Cs should be identical with one of the Fs, A must belong to every E; for F belongs to every E, and A to every C: consequently A belongs to every E. If C and G are identical, A must belong to some E; for A follows C, and E follows every G. If F and D are identical, A will belong to none of the Es by a preliminary deduction; for since the negative is convertible, and F is identical with D, A will belong to none of the Fs, but F belongs to every E. Again, if B and H are identical, A will belong to none of the Es; for B will belong to every A, but to no E; for it was assumed to be identical with H, and H belonged to none of the Es. If D and G are identical, A will not belong to some of the Es; for it will not belong to G, because it does not belong to D; but G falls under E; consequently A will not belong to some of the Es. If B is identical with G, there will be a converted deduction; for E will belong to every A, since B belongs to A and E to B (for B was found to be identical with G); but that A should belong to every E is not necessary, but it must belong to some E because it is possible to convert the universal statement into a particular.

It is clear then that in every problem we must look to the aforesaid relations of the subject and predicate; for all deductions proceed through these. But if we are seeking consequents and antecedents we must look especially for those which are primary and universal, e.g. in reference to E we must look to KF rather than to F alone, and in reference to A we must look to KC rather than to C alone. For if A

belongs to KF, it belongs both to F and to E; but if it does not follow KF, it may yet follow F. Similarly we must consider the antecedents of A itself; for if a term follows the primary antecedents, it will follow those also which are subordinate, but if it does not follow the former, it may yet follow the latter.

It is clear too that the inquiry proceeds through the three terms and the two propositions, and that all the deductions proceed through the aforesaid figures. For it is proved that A belongs to every E, whenever an identical term is found among the Cs and Fs. This will be the middle term; A and E will be the extremes. So the first figure is formed. And A will belong to some E, whenever C and G are apprehended to be the same. This is the last figure; for G becomes the middle term. And A will belong to no E, when D and F are identical. Thus we have both the first figure and the middle figure; the first, because A belongs to no F, since the negative is convertible, and F belongs to every E; the middle figure because D belongs to no A, and to every E. And A will not belong to some E, whenever D and G are identical. This is the last figure; for A will belong to no G, and E will belong to every G. Clearly then all the deductions proceed through the aforesaid figures, and we must not select consequents of everything, because no deduction is produced from them. For (as we saw) it is not possible at all to establish a proposition from consequents, and it is not possible to refute by means of a consequent of everything; for the middle term must belong to the one, and not belong to the other.

It is clear too that other methods of inquiry by selection are useless to produce a deduction, e.g. if the consequents of the terms in question are identical, or if the antecedents of A are identical with those attributes which cannot belong to E, or if those attributes are identical which cannot belong to either term; for no deduction is produced by means of these. For if the consequents are identical, e.g. B and F, we have the middle figure with both propositions affirmative; if the antecedents of A are identical with attributes which cannot belong to E, e.g. C with H, we have the first figure with its proposition relating to the minor extreme negative. If attributes which cannot belong to either term are identical, e.g. C and H, both propositions are negative, either in the first or in the middle figure. But no deduction is possible in these ways.

It is evident too that we must find out which terms in this inquiry are identical, not which are different or contrary, first because the object of our investigation is the middle term, and the middle term must be not diverse but identical. Secondly, 45a1
wherever it happens that a deduction results from taking contraries or terms which cannot belong to the same thing, all arguments can be reduced to the aforesaid moods, e.g. if B and F are contraries or cannot belong to the same thing. For if these are taken, a deduction will be formed to prove that A belongs to none of the Es, not however from the assumptions made but in the aforesaid mood. For B will belong to every A and to no E. Consequently B must be identical with one of the Hs. [Again, if B and G cannot belong to the same thing, it follows that A will not belong to some of the Es; for then too we shall have the middle figure; for B will belong to every A and to no E. Consequently B must be identical with some of the Hs. For the fact that B and G cannot belong to the same thing differs in no way from the fact that B is

identical with some of the *Hs*; for that includes everything which cannot belong to *E*.][13]

It is clear then that from these inquiries taken by themselves no deduction results; but if *B* and *F* are contraries *B* must be identical with one of the *H*s, and the deduction results through these terms. It turns out then that those who inquire in this manner are looking gratuitously for some other way than the necessary way because they have failed to observe the identity of the *B*s with the *H*s.

29 · Deductions which lead to impossible conclusions are similar to probative deductions; they also are formed by means of the consequents and antecedents of the terms in question. In both cases the same inquiry is involved. For what is proved probatively may also be deduced *per impossibile* by means of the same terms; and what is proved *per impossibile* may also be proved probatively, e.g. that *A* belongs to no *E*. For suppose *A* to belong to some *E*: then since *B* belongs to every *A* and *A* to some *E*, *B* will belong to some of the *E*s; but it was assumed that it belongs to none. Again we may prove that *A* belongs to some *E*; for if *A* belonged to no *E*, and *E* belongs to every *G*, *A* will belong to none of the *G*s; but it was assumed to belong to all. Similarly with the other problems. The proof *per impossibile* will always and in all cases be from the consequents and antecedents of the terms in question. Whatever the problem, the same inquiry is necessary whether one wishes to use a probative deduction or a reduction to impossibility. For both the demonstrations start from the same terms; e.g. suppose it has been proved that *A* belongs to no *E*, because it turns out that otherwise *B* belongs to some *E* and this is impossible—if now it is assumed that *B* belongs to no *E* and to every *A*, it is clear that *A* will belong to no *E*. Again if it has been deduced probatively that *A* belongs to no *E*, assume that *A* belongs to some *E* and it will be proved *per impossibile* to belong to no *E*. Similarly with the rest. In all cases it is necessary to find some common term other than the subjects of inquiry, to which the deduction establishing the false conclusion may relate, so that if this proposition is converted, and the other remains as it is, the deduction will be probative by means of the same terms. For the probative deduction differs from the *reductio ad impossibile* in this: in the probative both propositions are laid down in accordance with the truth, in the *reductio ad impossibile* one is assumed falsely.

These points will be made clearer by the sequel,[14] when we discuss reduction to impossibility: at present this much must be clear, that we must look to the same terms whether we wish to use a probative deduction or a reduction to impossibility. In the other hypothetical deductions (I mean those which proceed by substitution or by positing a certain quality), the inquiry will be directed to the terms of the problem to be proved—not the terms of the original problem, but the substitutes; and the method of the inquiry will be the same as before. But we must consider and determine in how many ways hypothetical deductions are possible.

Each of the problems then can be proved in the manner described; but it is

[13]Ross excises the passage in brackets.
[14]See *Prior Analytics* II 14.

possible to deduce some of them in another way, e.g. universal problems by the inquiry which leads up to a particular conclusion, with the addition of an hypothesis. For if the Cs and the Gs should be identical, but E should be assumed to belong to the Gs only, then A would belong to every E; and again if the Ds and the Gs should be identical, but E should be predicated of the Gs only, it follows that A will belong to none of the Es. Clearly then we must consider the matter in this way also. The method is the same whether the relation is necessary or possible. For the inquiry will be the same, and the deduction will proceed through terms arranged in the same order whether a possible or a simple proposition is proved. We must find in the case of possible relations, as well as terms that belong, terms which can belong though they actually do not; for we have proved that a deduction which establishes a possible relation proceeds through these terms as well. Similarly also with the other modes of predication.

It is clear then from what has been said not only that all deductions can be formed in this way, but also that they cannot be formed in any other. For every deduction has been proved to be formed through one of the aforementioned figures, and these cannot be composed through other terms than the consequents and antecedents of the terms in question; for from these we obtain the propositions and find the middle term. Consequently a deduction cannot be formed by means of other terms.

30 · The method is the same in all cases, in philosophy and in any art or study. We must look for the attributes and the subjects of both our terms, and we must supply ourselves with as many of these as possible, and consider them by means of the three terms, refuting statements in one way, establishing them in another, in the pursuit of truth starting from an arrangement of the terms in accordance with truth, while if we look for dialectical deductions we must start from plausible propositions. The principles of deductions have been stated in general terms, both how they are characterized and how we must hunt for them, so as not to look to everything that is said about the terms of the problem or to the same points whether we are establishing or refuting, or again whether we are establishing of all or of some, and whether we are refuting of all or some; we must look to fewer points and they must be definite. We have also stated how we must select with reference to each thing that is, e.g. about good or knowledge. But in each science the principles which are peculiar are the most numerous. Consequently it is the business of experience to give the principles which belong to each subject. I mean for example that astronomical experience supplies the principles of astronomical science; for once the phenomena were adequately apprehended, the demonstrations of astronomy were discovered. Similarly with any other art or science. Consequently, if the attributes of the thing are apprehended, our business will then be to exhibit readily the demonstrations. For if none of the true attributes of things had been omitted in the survey, we should be able to discover the proof and demonstrate everything which admitted of proof, and to make that clear, whose nature does not admit of proof.

Thus we have explained fairly well in general terms how we must select propositions: we have discussed the matter precisely in the treatise concerning dialectic.[15]

31 · It is easy to see that division by genera is a small part of the method we have described; for division is, so to speak, a weak deduction; for what it ought to prove, it begs, and it always deduces something more general than the attribute in question. First, this very point had escaped all those who used the method of division; and they attempted to persuade men that it was possible to make a demonstration of substance and essence. Consequently they did not understand what it is possible to deduce by division, nor did they understand that it was possible to deduce in the manner we have described. In demonstrations, when there is a need to deduce that something belongs, the middle term through which the deduction is formed must always be inferior to and not comprehend the first of the extremes. But division has a contrary intention; for it takes the universal as middle. Let animal be the term signified by A, mortal by B, and immortal by C, and let man, whose definition is to be got, be signified by D. The man who divides assumes that every animal is either mortal or immortal: i.e. whatever is A is all either B or C. Again, always dividing, he lays it down that man is an animal, so he assumes A of D as belonging to it. Now the deduction is that every D is either B or C, consequently man must be either mortal or immortal, but it is not necessary that man should be a mortal animal—this is begged: and this is what ought to have been deduced. And again, taking A as mortal animal, B as footed, C as footless, and D as man, he assumes in the same way that A inheres either in B or in C (for every mortal animal is either footed or footless), and he assumes A of D (for he assumed man to be a mortal animal); consequently it is necessary that man should be either a footed or a footless animal; but it is not necessary that man should be footed—this he assumes: and it is just this again which he ought to have proved. Always dividing then in this way it turns out that they assume as middle the universal term, and as extremes that which ought to have been the subject of proof and the *differentiae*. In conclusion, they do not make it clear, and show it to be necessary, that this is man or whatever the subject of inquiry may be; for they pursue the other method altogether, never even suspecting the presence of the rich supply of evidence which might be used.

It is clear that it is neither possible to refute by this method, nor to deduce about an accident or property of a thing, nor about its genus, nor in cases in which it is unknown whether it is thus or thus, e.g. whether the diagonal is incommensurate or commensurate. For if he assumes that every length is either commensurate or incommensurate, and the diagonal is a length, he has deduced that the diagonal is either incommensurate or commensurate. But if he should assume that it is incommensurate, he will have assumed what he ought to have proved. He cannot then prove it; for this is his method, but proof is not possible by this method. (Let A stand for incommensurate or commensurate, B for length, C for diagonal). It is clear then that this method of investigation is not suitable for every inquiry, nor is it useful in those cases in which it is thought to be most suitable.

[15]i.e. the *Topics*.

32 · From what has been said it is clear from what elements demonstrations are formed and in what manner, and to what points we must look in each problem. Our next business is to state how we can reduce deductions to the aforementioned figures; for this part of the inquiry still remains. If we should investigate the production of deductions and had the power of discovering them, and further if we could resolve the deductions produced into the aforementioned figures, our original project would be brought to a conclusion. It will happen at the same time that what has been already said will be confirmed and its truth made clearer by what we are about to say. For everything that is true must in every respect agree with itself.

First then we must attempt to select the two propositions of the deduction (for it is easier to divide into large parts than into small, and the composite parts are larger than the elements out of which they are made); next we must inquire which are universal and which particular, and if both have not been stated, we must ourselves assume the one which is missing. For sometimes men put forward the universal, but do not posit the proposition which is contained in it, either in writing or in discussion: or men put these forward, but omit those through which they are inferred, and invite the concession of others to no purpose. We must inquire then whether anything unnecessary has been assumed, or anything necessary has been omitted, and we must posit the one and take away the other, until we have reached the two propositions; for unless we have these, we cannot reduce arguments put forward in the way described. In some arguments it is easy to see what is wanting, but some escape us, and appear to be deductions, because something necessary results from what has been laid down, e.g. if the assumptions were made that substance is not annihilated by the annihilation of what is not substance, and that if the elements out of which a thing is made are annihilated, then that which is made out of them is destroyed: these propositions being laid down, it is necessary that any part of substance is substance; this has not however been deduced from the assumptions, but propositions are wanting. Again if it is necessary that animal should exist, if man does, and that substance should exist, if animal does, it is necessary that substance should exist if man does; but as yet the conclusion has not been deduced; for the propositions are not in the shape we described.

We are deceived in such cases because something necessary results from what is assumed, since deduction also is necessary. But that which is necessary is wider than deduction; for every deduction is necessary, but not everything which is necessary is a deduction. Consequently, though something results when certain propositions are assumed, we must not try to reduce it directly, but must first take the two propositions, then divide them into their terms. We must take that term as middle which is stated in both the propositions; for it is necessary that the middle should be found in both in all the figures.

If then the middle term is a predicate and a subject of predication, or if it is a predicate, and something else is denied of it, we shall have the first figure; if it both is a predicate and is denied of something, the middle figure; if other things are predicated of it, or one is denied, the other predicated, the last figure. For it was thus that we found the middle term placed in each figure. It is placed similarly too if the propositions are not universal; for the middle term is determined in the same way. Clearly then, if the same term is not said more than once in the course of an argument, a deduction cannot be made; for a middle term has not been taken. Since we know what sort of problem is established in each figure, and in which the universal and in what sort the particular is established, clearly we must not look for all the figures, but for that which is appropriate to the problem in hand. If it is established in more figures than one, we shall recognize the figure by the position of the middle term.

33 · Men are frequently deceived about deduction because the inference is necessary, as has been said above; sometimes they are deceived by the similarity in the positing of the terms; and this ought not to escape our notice. E.g. if *A* is said of *B*, and *B* of *C*: it would seem that a deduction is possible since the terms stand thus; but nothing necessary results, nor does a deduction. Let *A* represent being eternal, *B* Aristomenes as an object of thought, *C* Aristomenes. It is true then that *A* belongs to *B*. For Aristomenes as an object of thought is eternal. But *B* also belongs to *C*; for Aristomenes is Aristomenes as an object of thought. But *A* does not belong to *C*; for Aristomenes is perishable. For no deduction was made although the terms stood thus: that required that the proposition *AB* should be stated universally. But this is false, that every Aristomenes who is an object of thought is eternal, since Aristomenes is perishable. Again let *C* stand of Miccalus, *B* for musical Miccalus, *A* for perishing to-morrow. It is true to predicate *B* for *C*; for Miccalus is musical Miccalus. Also *A* can be predicted of *B*; for musical Miccalus might perish to-morrow. But to say *A* of *C* is false at any rate. This argument then is identical with the former; for it is not true universally that musical Miccalus perishes to-morrow; but unless this is assumed, no deduction (as we have shown) is possible.

This deception then arises through ignoring a small distinction. For we accept the conclusion as though it made no difference whether we said 'This belongs to that' or 'That belongs to all of that'.

48a1 34 · Men will frequently fall into error through not setting out the terms of the proposition well, e.g. suppose *A* to be health, *B* disease, *C* man. It is true to say that *A* cannot belong to any *B* (for health belongs to no disease) and again that *B* belongs to every *C* (for every man is capable of disease). It would seem to follow that health cannot belong to any man. The reason for this is that the terms are not set out well in expression, since if the things which are in the conditions are substituted, no deduction can be made, e.g. if healthy is substituted for health and diseased for disease. For it is not true to say that being healthy cannot belong to one who is diseased. But unless this is assumed no conclusion results, save in respect of possibility; but such a conclusion is not impossible; for it is possible that health should belong to no man. Again the falsity may occur in a similar way in the middle figure: it is not possible that health should belong to any disease, but it is possible that health should belong to every man, consequently it is not possible that disease should belong to any man. In the third figure the falsity results in reference to possibility. For health and disease, and knowledge and ignorance, and in general contraries, may belong to the same thing, but cannot belong to one another. This is not in agreement with what was said before; for we stated that when several things could belong to the same thing, they could belong to one another.

It is evident then that in all these cases the error arises from the setting out of the terms; for if the things that are in the conditions are substituted, no falsity arises. It is clear then that in such propositions what possesses the condition ought always to be substituted for the condition and taken as the term.

35 · We must not always seek to set out the terms in a single word; for we shall often have phrases to which no single name is equivalent. Hence it is difficult to reduce deductions with such terms. Sometimes too error will result from such a search, e.g. the belief that deduction can establish something immediate. Let *A* stand for two right angles, *B* for triangle, *C* for isosceles triangle. *A* then belongs to *C* because of *B*; but *A* belongs to *B* not in virtue of anything else (for the triangle in virtue of its own nature contains two right angles); consequently there will be no middle term for *AB*, although it is demonstrable. For it is clear that the middle must not always be assumed to be an individual thing, but sometimes a phrase, as happens in the case mentioned.

36 · That the first term belongs to the middle, and the middle to the extreme, must not be understood in the sense that they can always be predicated of one another or that the first term will be predicated of the middle in the same way as 48b1 the middle is predicated of the last term. The same holds if the premisses are negative. But we must suppose that 'to belong' has as many meanings as the ways in which 'to be' and 'it is true to say this is that' are used. Take for example the statement that there is a single science of contraries. Let *A* stand for there being a single science, and *B* for things which are contrary to one another. Then *A* belongs to *B*, not in the sense that contraries are a single science, but in the sense that it is true to say of the contraries that there is a single science of them.

It happens sometimes that the first term is said of the middle, but the middle is not said of the third term, e.g. if wisdom is knowledge, and wisdom is of the good, the conclusion is that there is knowledge of the good. The good then is not knowledge, though wisdom is knowledge. Sometimes the middle term is said of the third, but the first is not said of the middle, e.g. if there is a science of everything that has a quality, or is a contrary, and the good both is a contrary and has a quality, the conclusion is that there is a science of the good—but the good is not a science, nor is that which has a quality or is a contrary, though the good is both of these. Sometimes neither the first term is said of the middle, nor the middle of the third, while the first is sometimes said of the third, and sometimes not; e.g. if there is a genus of that of which there is a science, and there is a science of the good, we conclude that there is a genus of the good. But nothing is predicated of anything. And if that of which there is a science is a genus, and there is a science of the good, we conclude that the good is a genus. The first term then is predicated of the extreme, but the terms are not said of one another.

The same holds good where the relation is negative. For 'that does not belong to this' does not always mean that this is not that, but sometimes that this is not of that or for that, e.g. there is not a motion of a motion or a becoming of a becoming, but there is a becoming of pleasure; so pleasure is not a becoming. Or again it may be said that there is a sign of laughter, but there is not a sign of a sign, consequently laughter is not a sign. This holds in the other cases too, in which a problem is refuted because the genus is asserted in a particular way in relation to it. Again take the inference: opportunity is not the right time; for opportunity belongs to God, but the right time does not, since nothing is useful to God. We must take as terms opportunity, right time, God; but the proposition must be understood according to the case of the noun. For we state this universally without qualification, that the terms ought always to be stated in the nominative, e.g. man, good, contraries, not in oblique cases, e.g. of man, of good, of contraries, but the propositions ought to be understood with reference to the cases of each term—either the dative, e.g. 'equal to this', or the genitive, e.g. 'double of this', or the accusative, e.g. 'that which strikes or sees this', or the nominative, e.g. 'man is an animal', or in whatever other way the word falls in the proposition.

37 · The expressions 'this belongs to that' and 'this holds true of that' must be understood in as many ways as there are different categories, and these categories must be taken either with or without qualification, and further as simple or compound; the same holds good of negative expressions. We must consider these points and define them better.

38 · A term which is repeated in the propositions ought to be joined to the first extreme, not to the middle. I mean for example that if a deduction should be made proving that there is knowledge of justice, that it is good, the expression 'that it is good' (or '*qua* good') should be joined to the first term. Let *A* stand for knowledge that it is good, *B* for good, *C* for justice. It is true to predicate *A* of *B*. For of the good there is knowledge that it is good. Also it is true to predicate *B* of *C*. For justice is identical with a good. In this way an analysis of the argument can be made. But if the expression 'that it is good' were added to *B*, there will be no analysis; for *A* will be true of *B*, but *B* will not be true of *C*. For to predicate of justice the term 'good that it is good' is false and not intelligible. Similarly if it should be proved that the healthy is an object of knowledge *quâ* good, or goat-stag an object of knowledge *quâ* not existing, or man perishable *quâ* an object of sense: in every case in which an addition is made to the predicate, the repetition must be joined to the extreme.

The position of the terms is not the same when something is deduced without qualification and when the deduction relates to some particular thing or way or condition, e.g. when the good is proved to be an object of knowledge and when it is proved to be an object of knowledge that it is good. If it has been proved to be an object of knowledge without qualification, we must put as middle term that which is, but if we add the qualification 'that it is good', the middle term must be that which is something. Let *A* stand for knowledge that it is something, *B* stand for something, and *C* stand for good. It is true to predicate *A* of *B*; for *ex hypothesi* there is knowledge of that which is something, that it is something. *B* too is true of *C*; for that which *C* represents is something. Consequently *A* is true of *C*: there will then be knowledge of the good, that it is good: for *ex hypothesi* the term something indicates the thing's proper substance. But if being were taken as middle and being (without qualification) were joined to the extreme, not being something, we should not have had a deduction that there is knowledge of the good, that it is good, but that it is; e.g. let *A* stand for knowledge that it is, *B* for being, *C* for good. Clearly then in particular deductions we must take the terms in the way stated.

39 · We ought also to substitute terms which have the same value, word for word, and phrase for phrase, and word and phrase, and always take a word in preference to a phrase; for thus the setting out of the terms will be easier. For example if it makes no difference whether we say that the supposable is not the genus of the opinable or that the opinable is not identical with a particular kind of supposable (for what is meant is the same), it is better to take as terms the supposable and the opinable in preference to the phrase suggested.

40 · Since for pleasure to be good and for pleasure to be the good are not identical, we must not set out the terms in the same way; but if the deduction is to prove that pleasure is the good, the term must be the good, but if the object is to prove that pleasure is good, the term will be good. Similarly in all other cases.

41 · It is not the same, either in fact or in speech, for *A* to belong to all of that to which *B* belongs, and for *A* to belong to all of that to all of which *B* belongs; for nothing prevents *B* from belonging to *C*, though not to every *C*: e.g. let *B* stand for beautiful, and *C* for white. If beauty belongs to something white, it is true to say that beauty belongs to that which is white; but not perhaps to everything that is white. If then *A* belongs to *B*, but not to everything of which *B* is predicated, then whether *B* belongs to every *C* or merely belongs to *C*, it is not necessary that *A* should belong, I do not say to every *C*, but even to *C* at all. But if *A* belongs to everything of which *B* is truly said, it will follow that *A* can be said of all of that of all of which *B* is said. If however *A* is said of that of all of which *B* may be said, nothing prevents *B* belonging to *C*, and yet *A* not belonging to every *C* or to any *C* at all. If then we take three terms it is clear that the expression '*A* is said of all of which *B* is said' means this, '*A* is said of all the things of which *B* is said'. And if *B* is said of all of a third term, so also is *A*; but if *B* is not said of all of the third term, there is no necessity that *A* should be said of all of it.

We must not suppose that something absurd results through setting out the terms; for we do not use the existence of this particular thing, but imitate the geometrician who says that this line is a foot long, and straight, and without breadth, when it is not,[16] but does not use those propositions in the sense of deducing

[16]Omitting τήν before ποδιαίαν, and reading οὖσαν for οὔσας.

anything from them. For in general, unless there is something related as whole to part and something else related to this as part to whole, the prover does not prove from them, and so no deduction is formed. We use the process of setting out terms like perception by sense, in the interests of the student—not as though it were impossible to demonstrate without them, as it is to demonstrate without the premisses of the deduction.

42 · We should not forget that in the same deduction not all conclusions are reached through one figure, but one through one figure, another through another. Clearly then we must analyse arguments in accordance with this. Since not every problem is proved in every figure, but certain problems in each figure, it is clear from the conclusion in what figure the premisses should be sought.

43 · In reference to those arguments aiming at a definition which have been directed toward some part of the definition, we must take as a term the point to which the argument has been directed, not the whole definition; for so we shall be less likely to be disturbed by the length of the term: e.g. if a man proves that water is a drinkable liquid, we must take as terms drinkable and water.

44 · Further we must not try to reduce hypothetical deductions; for with the given premisses it is not possible to reduce them. For they have not been proved by deduction, but assented to by agreement. For instance if a man should suppose that unless there is one faculty of contraries, there cannot be one science, and should then argue that not every faculty is of contraries, e.g. of what is healthy and what is sickly; for the same thing will then be at the same time healthy and sickly. He has shown that there is not one faculty of all contraries, but he has not proved that there is not a science. And yet one must agree. But the agreement does not come from a deduction, but from an hypothesis. This argument cannot be reduced; but the proof that there is not a single faculty can. The latter argument no doubt was a deduction; but the former was an hypothesis.

The same holds good of arguments which are brought to a conclusion *per impossibile*. These cannot be analysed either; but the reduction to what is impossible can be analysed since it is proved by deduction, though the rest of the argument cannot, because the conclusion is reached from an hypothesis. But these differ from the previous arguments; for in the former a preliminary agreement must be reached if one is to accept the conclusion (e.g. an agreement that if there is proved to be one faculty of contraries, then contraries fall under the same science); whereas in the latter, even if no preliminary agreement has been made, men still accept the reasoning, because the falsity is patent, e.g. the falsity of what follows from the assumption that the diagonal is commensurate, viz. that then odd numbers are equal to evens.

Many other arguments are brought to a conclusion by the help of an hypothesis; these we ought to consider and mark out clearly. We shall describe in the sequel[17] their differences, and the various ways in which hypothetical arguments 50b1 are formed; but at present this much must be clear, that it is not possible to resolve such deductions into the figures. And we have explained the reason.

45 · Whatever problems are proved in more than one figure, if they have been deduced in one figure, can be reduced to another figure, e.g. a negative deduction in the first figure can be reduced to the second, and one in the middle figure to the first, not all however but some only. The point will be clear in the sequel. If *A* belongs to no *B*, and *B* to every *C*, then *A* belongs to no *C*. Thus the first figure; but if the negative is converted, we shall have the middle figure. For *B* belongs to no *A*, and to every *C*. Similarly if the deduction is not universal but particular, i.e. if *A* belongs to no *B*, and *B* to some *C*. Convert the negative and you will have the middle figure.

The universal deductions in the second figure can be reduced to the first, but only one of the two particular deductions. Let *A* belong to no *B* and to every *C*. Convert the negative, and you will have the first figure. For *B* will belong to no *A*, and *A* to every *C*. But if the affirmative concerns *B*, and the negative *C*, *C* must be made first term. For *C* belongs to no *A*, and *A* to every *B*; therefore *C* belongs to no *B*. *B* then belongs to no *C*; for the negative is convertible.

But if the deduction is particular, whenever the negative concerns the major extreme, reduction to the first figure will be possible, i.e. if *A* belongs to no *B* and to some *C*: convert the negative and you will have the first figure. For *B* will belong to no *A*, and *A* to some *C*. But when the affirmative concerns the major extreme, no analysis will be possible, i.e. if *A* belongs to every *B*, but not to every *C*; for *AB* does not admit of conversion, nor would there be a deduction if it did.

Again deductions in the third figure cannot all be analysed into the first, though all in the first figure can be analysed into the third. Let *A* belong to *B* and *B* to some *C*. Since the particular affirmative is convertible, *C* will belong to some *B*; but *A* belonged to every *B*; so that the third figure is formed. Similarly if the deduction is negative; for the particular affirmative is convertible; therefore *A* will belong to no *B*, and to some *C*.

Of the deductions in the last figure one only cannot be analysed into the first, 51a1 viz. when the negative is not universal: all the rest can be analysed. Let *A* and *B* be predicated of every *C*; then *C* can be converted partially with either *A* or *B*; *C* then belongs to some *B*. Consequently we shall get the first figure, if *A* belongs to every *C*, and *C* to some *B*. If *A* belongs to every *C* and *B* to some *C*, the argument is the same; for *C* is convertible in reference to *B*. But if *B* belongs to every *C* and *A* to some *C*, the first term must be *B*; for *B* belongs to every *C*, and *C* to some *A*, therefore *B* belongs to some *A*. But since the particular is convertible, *A* will belong to some *B*. If the deduction is negative, when the terms are universal we must take them in a similar way. Let *B* belong to every *C*, and *A* to no *C*; then *C* will belong to some *B*, and *A* to no *C*; and so *C* will be middle term. Similarly if the negative is universal, the affirmative particular; for *A* will belong to no *C*, and *C* to some of the

[17]This promise is not kept in Aristotle's extant works.

Bs. But if the negative is particular, no analysis will be possible, i.e. if B belongs to every C, and A does not belong to some C: convert BC and both propositions will be particular.

It is clear that in order to analyse the figures into one another the proposition which concerns the minor extreme must be converted in both the figures; for when this is altered, the transition to the other figure is made.

One of the deductions in the middle figure can, the other cannot, be analysed into the third figure. Whenever the universal is negative, analysis is possible. For if A belongs to no B and to some C, both B and C alike are convertible in relation to A, so that B belongs to no A, and C to some A. A therefore is middle term. But when A belongs to every B, and not to some C, analysis will not be possible; for neither of the propositions is universal after conversion.

Deductions in the third figure can be analysed into the middle figure, whenever the negative is universal, i.e. if A belongs to no C, and B to some of every C. For C then will belong to no A and to some B. But if the negative is particular, no analysis will be possible; for the particular negative does not admit of conversion.

It is clear then that the same deductions cannot be analysed in these figures which could not be analysed into the first figure, and that when deductions are reduced to the first figure these alone are confirmed by reduction to what is impossible.

It is clear from what we have said how we ought to reduce deductions, and that the figures may be analysed into one another.

46 · In establishing or refuting, it makes some difference whether we suppose the expressions 'not to be this' and 'to be not-this' are identical or different in meaning, e.g. 'not to be white' and 'to be not-white'. For they do not mean the same thing, nor is 'to be not-white' the negation of 'to be white', but rather 'not to be white'. The reason for this is as follows. The relation of 'he can walk' to 'he can not-walk' is similar to the relation of 'it is white' to 'it is not-white'; so is that of 'he knows what is good' to 'he knows what is not-good'. For there is no difference between the expressions 'he knows what is good' and 'he is knowing what is good', or 'he can walk' and 'he is able to walk': therefore there is no difference between their opposites 'he cannot walk'—'he is not able to walk'. If then 'he is not able to walk' means the same as 'he is able not to walk', these will belong at the same time to the same person (for the same man can both walk and not-walk, and is possessed of knowledge of what is good and of what is not-good), but an affirmation and a denial which are opposed to one another do not belong at the same time to the same thing. As then not to know what is good is not the same as to know what is not good, so to be not-good is not the same as not to be good. For when two pairs correspond, if the one pair are different from one another, the other pair also must be different. Nor is to be not-equal the same as not to be equal; for there is something underlying the one, viz. that which is not-equal, and this is the unequal, but there is nothing underlying the other. That is why not everything is either equal or unequal, but everything is equal or is not equal. Further the expressions 'it is a not-white log' and

'it is not a white log' do not belong at the same time. For if it is a not-white log, it must be a log: but that which is not a white log need not be a log at all. Therefore it is clear that 'it is not-good' is not the denial of 'it is good'. If then of every single thing either the affirmation or the negation is true if it is not a negation clearly it must in a sense be an affirmation. But every affirmation has a corresponding negation. The negation then of this is 'it is not not-good'.

The relation of these to one another is as follows. Let *A* stand for to be good, *B* for not to be good, let *C* stand for to be not-good and be placed under *B*, and let *D* stand for not to be not-good and be placed under *A*. Then either *A* or *B* will belong to everything, but they will never belong to the same thing; and either *C* or *D* will belong to everything, but they will never belong to the same thing. And *B* must belong to everything to which *C* belongs. For if it is true to say it is not-white, it is true also to say it is not white; for it is impossible that a thing should simultaneously be white and be not-white, or be a not-white log and be a white log; consequently if the affirmation does not belong, the denial must belong. But *C* does not always belong to *B*; for what is not a log at all, cannot be a not-white log either. On the other hand *D* belongs to everything to which *A* belongs. For either *C* or *D* belongs to everything to which *A* belongs. But since a thing cannot be simultaneously not-white and white, *D* must belong to everything to which *A* belongs. For of that which is white it is true to say that it is not not-white. But *A* is not true of every *D*. For of that which is not a log at all it is not true to say *A*, viz. that it is a white log. Consequently *D* is true, but *A* is not true, i.e. that it is a white log. It is clear also that *A* and *C* cannot together belong to the same thing, and that *B* and *D* may belong to the same thing.

Privative terms are similarly related to positive terms in respect of this arrangement. Let *A* stand for equal, *B* for not equal, *C* for unequal, *D* for not unequal.

In many things also, to some of which something belongs which does not belong to others, the negation may be true in a similar way, viz. that all are not white or that each is not white, while that each is not-white or all are not-white is false. Similarly also 'every animal is not-white' is not the negation of 'every animal is white' (for both are false) but rather 'not every animal is white'.

Since it is clear that 'it is not-white' and 'it is not white' mean different things, and one is an affirmation, the other a denial, it is evident that the method of proving each cannot be the same, e.g. that whatever is an animal is not white or may not be white, and that it is true to call it not-white; for this means that it is not-white. But we may prove that it is true to call it white or not-white in the same way—for both are proved constructively by means of the first figure. For the expression 'it is true' stands on a similar footing to 'it is'. For the negation of 'it is true to call it white' is not 'it is true to call it not-white' but 'it is not true to call it white'. If then it is to be true to say that whatever is a man is musical or is not-musical, we must assume that whatever is an animal either is musical or is not-musical; and the proof has been made. That whatever is a man is not musical is proved destructively in the three ways mentioned.

In general whenever *A* and *B* are such that they cannot belong at the same time to the same thing, and one of the two necessarily belongs to everything, and again *C* and *D* are related in the same way, and *A* follows *C* but the relation cannot be converted, then *D* must follow *B* and the relation cannot be converted. And *A* and *D* may belong to the same thing, but *B* and *C* cannot. First it is clear from the following consideration that *D* follows *B*. For since either *C* or *D* necessarily belongs to everything; and since *C* cannot belong to that to which *B* belongs, because it carries *A* along with it and *A* and *B* cannot belong to the same thing; it is clear that *D* must follow *B*. Again since *C* does not convert with *A*, but *C* or *D* belongs to everything, it is possible that *A* and *D* should belong to the same thing. But *B* and *C* cannot belong to the same thing, because *A* follows *C*; and so something impossible results. It is clear then that *B* does not convert with *D* either, since it is possible that *D* and *A* should belong at the same time to the same thing.

It results sometimes even in such an arrangement of terms that one is deceived through not apprehending the opposites rightly, one of which must belong to everything: e.g. we may reason that if *A* and *B* cannot belong at the same time to the same thing, but it is necessary that one of them should belong to whatever the other does not belong to; and again *C* and *D* are related in the same way; and *A* follows everything which *C* follows: it will result that *B* belongs necessarily to everything to which *D* belongs—but this is false. Assume that *F* stands for the negation of *A* and *B*, and again that *H* stands for the negation of *C* and *D*. It is necessary then that either *A* or *F* should belong to everything; for either the affirmation or the denial must belong. And again either *C* or *H* must belong to everything; for they are related as affirmation and denial. And *ex hypothesi A* belongs to everything to which *C* belongs. Therefore *H* belongs to everything to which *F* belongs. Again since either *F* or *B* belongs to everything, and similarly either *H* or *D*, and since *H* follows *F*, *B* must follow *D*; for we know this. If then *A* follows *C*, *B* must follow *D*. But this is false; for as we proved the relation of consequence is reversed in terms so constituted. No doubt it is not necessary that *A* or *F* should belong to everything, or that *F* or *B* should belong to everything; for *F* is not the denial of *A*. For not-good is the negation of good; and not-good is not identical with neither good nor not-good. Similarly also with *C* and *D*. For two negations have been assumed in respect to one term.

BOOK II

1 · We have already explained the number of the figures, the character and number of the propositions, when and how a deduction is formed; further what we must look for when refuting and establishing propositions, and how we should investigate a given problem in any branch of inquiry, also by what means we shall obtain principles appropriate to each subject. Since some deductions are universal, others particular, all the universal deductions give more than one result, and of

particular deductions the affirmative yield more than one, the negative yield only the stated conclusion. For all propositions are convertible save only the particular negative; and the conclusion states one thing about another. Consequently all other deductions yield more than one conclusion, e.g. if *A* has been proved to belong to every or to some *B*, then *B* must belong to some *A*; and if *A* has been proved to belong to no *B*, then *B* belongs to no *A*. This is a different conclusion from the former. But if *A* does not belong to some *B*, it is not necessary that *B* should not belong to some *A*; for it may belong to every *A*.

This then is the reason common to all deductions whether universal or particular. But it is possible to give another reason concerning those which are universal. For all the things that are subordinate to the middle term or to the conclusion may be proved by the same deduction, if the former are placed in the middle, the latter in the conclusion; e.g. if the conclusion *AB* is proved through *C*, then *A* must be said of all of whatever is subordinate to *B* or *C*; for if *D* is in *B* as in a whole, and *B* is in *A*, then *D* will be in *A*. Again if *E* is in *C* as in a whole, and *C* is in *A*, then *E* will be in *A*. Similarly if the deduction is negative. In the second figure it will be possible to deduce only that which is subordinate to the conclusion, e.g. if *A* belong to no *B* and to every *C*; we conclude that *B* belongs to no *C*. If then *D* is subordinate to *C*, clearly *B* does not belong to it. But that *B* does not belong to what is subordinate to *A*, is not clear by means of the deduction. And yet *B* does not belong to *E*, if *E* is subordinate to *A*. But while it has been proved through the deduction that *B* belongs to no *C*, it has been assumed without proof that *B* does not belong to *A*, consequently it does not result through the deduction that *B* does not belong to *E*.

But in particular deductions there will be no necessity of inferring what is subordinate to the conclusion (for a deduction does not result when this is particular), but whatever is subordinate to the middle term may be inferred, not however through the deduction, e.g. if *A* belongs to every *B* and *B* to some *C*. Nothing can be inferred about that which is subordinate to *C*; something can be inferred about that which is subordinate to *B*, but not through the preceding deduction. Similarly in the other figures: that which is subordinate to the conclusion cannot be proved; the other subordinate can be proved, only not through the deduction, just as in the universal deductions what is subordinate to the middle term is proved (as we saw) from a proposition which is not demonstrated; consequently either a conclusion is not possible there or else it is possible here too.

2 · It is possible for the premisses of the deduction to be true, or to be false, or to be the one true, the other false. The conclusion is either true or false necessarily. From true premisses it is not possible to draw a false conclusion; but a true conclusion may be drawn from false premisses—true however only in respect to the fact, not to the reason. The reason cannot be established from false premisses: why this is so will be explained in the sequel.[18]

[18] See 57a40–b17.

First then that it is not possible to draw a false conclusion from true premisses, is made clear by this consideration. If it is necessary that *B* should be when *A* is, it is necessary that *A* should not be when *B* is not. If then *A* is true, *B* must be true: otherwise it will turn out that the same thing both is and is not at the same time. But this is impossible. (Let it not, because *A* is laid down as a single term, be supposed that it is possible, when a single fact is given, that something should necessarily result. For that is not possible. For what results necessarily is the conclusion, and the means by which this comes about are at the least three terms, and two relations or propositions. If then it is true that *A* belongs to all that to which *B* belongs, and that *B* belongs to all that to which *C* belongs, it is necessary that *A* should belong to all that to which *C* belongs, and this cannot be false; for then the same thing will belong and not belong at the same time. So *A* is posited as one thing, being two premisses taken together.) The same holds good of negative deductions: it is not possible to prove a false conclusion from truths.

But from what is false a true conclusion may be drawn, whether both the premisses are false or only one (provided that this is not either of the premisses indifferently, but the second, if it is taken as wholly false; but if it is not taken as wholly false, it does not matter which of the two is false). Let *A* belong to the whole of *C*, but to no *B*, neither let *B* belong to *C*. This is possible, e.g. animal belongs to no stone, nor stone to any man. If then *A* is taken to belong to every *B* and *B* to every *C*, *A* will belong to every *C*; consequently though both the premisses are false the conclusion is true; for every man is an animal. Similarly with the negative. For it is possible that neither *A* nor *B* should belong to any *C*, although *A* belongs to every *B*, e.g. if the same terms are taken and man is put as middle; for neither animal nor man belongs to any stone, but animal belongs to every man. Consequently if one term is taken to belong to none of that to which it does belong, and the other term is taken to belong to all of that to which it does not belong, though both the premisses
54a1 are false the conclusion will be true. A similar proof may be given if each premiss is partially false.

But if one only of the premisses is false, when the first premiss is wholly false, i.e. *AB*, the conclusion will not be true, but if *BC* is wholly false, a true conclusion will be possible. I mean by wholly false the contrary of the truth, e.g. if what belongs to none is assumed to belong to all, or if what belongs to all is assumed to belong to none. Let *A* belong to no *B*, and *B* to every *C*. If then the proposition *BC* which I take is true, and *AB* is wholly false, viz. that *A* belongs to every *B*, it is impossible that the conclusion should be true; for *A* belonged to none of the *C*s, since *A* belonged to nothing to which *B* belonged, and *B* belonged to every *C*. Similarly there cannot be a true conclusion if *A* belongs to every *B*, and *B* to every *C*, but while the true proposition *BC* is assumed, the wholly false *AB* is also assumed, viz. that *A* belongs to nothing to which *B* belongs—here the conclusion must be false. For *A* will belong to every *C*, since *A* belongs to everything to which *B* belongs, and *B* to every *C*. It is clear then that when the first premiss is wholly false, whether affirmative or negative, and the other premiss is true, the conclusion cannot be true.

But if the premiss is not wholly false, a true conclusion is possible. For if *A* belongs to every *C* and to some *B*, and if *B* belongs to every *C*, e.g. animal to every swan and to some white thing, and white to every swan, then if we assume that *A* belongs to every *B*, and *B* to every *C*, *A* will belong to every *C* truly; for every swan is an animal. Similarly if *AB* is negative. For it is possible that *A* should belong to some *B* and to no *C*, and that *B* should belong to every *C*, e.g. animal to some white thing, but to no snow, and white to all snow. If then one should assume that *A* belongs to no *B*, and *B* to every *C*, then *A* will belong to no *C*.

But if the proposition *AB*, which is assumed, is wholly true, and *BC* is wholly false, a true deduction will be possible; for nothing prevents *A* belonging to every *B* and to every *C*, though *B* belongs to no *C*, e.g. these being species of the same genus which are not subordinate one to the other—for animal belongs both to horse and to man, but horse to no man. If then it is assumed that *A* belongs to every *B* and *B* to every *C*, the conclusion will be true, although the proposition *BC* is wholly false. Similarly if the proposition *AB* is negative. For it is possible that *A* should belong neither to any *B* nor to any *C*, and that *B* should not belong to any *C*, e.g. a genus to species of another genus—for animal belongs neither to music nor to medicine, nor does music belong to the medicine. If then it is assumed that *A* belongs to no *B*, and *B* to every *C*, the conclusion will be true.

And if *BC* is not wholly false but in part only, even so that conclusion may be true. For nothing prevents *A* belonging to the whole of *B* and of *C*, while *B* belongs to some *C*, e.g. a genus to its species and difference—for animal belongs to every man and to every footed thing, and man to some footed things though not to all. If then it is assumed that *A* belongs to every *B*, and *B* to every *C*, *A* will belong to every *C*; and this *ex hypothesi* is true. Similarly if the proposition *AB* is negative. For it is possible that *A* should neither belong to any *B* nor to any *C*, though *B* belongs to some *C*, e.g. a genus to the species of another genus and its difference for animal neither belongs to any wisdom nor to any speculative science, but wisdom belongs to some speculative sciences. If then it should be assumed that *A* belongs to no *B*, and *B* to every *C*, *A* will belong to no *C*; and this *ex hypothesi* is true.

In particular deductions it is possible when the first proposition is wholly false, and the other true, that the conclusion should be true; also when the first is false in part, and the other true; and when the first is true, and the particular is false; and when both are false. For nothing prevents *A* belonging to no *B*, but to some *C*, and *B* to some *C*, e.g. animal belongs to no snow, but to some white thing, and snow to some white thing. If then snow is taken as middle, and animal as first term, and it is assumed that *A* belongs to the whole of *B*, and *B* to some *C*, then *AB* is wholly false, *BC* true, and the conclusion true. Similarly if the proposition *AB* is negative; for it is possible that *A* should belong to the whole of *B*, but not to some *C*, although *B* belongs to some *C*, e.g. animal belongs to every man, but does not follow some white, but man belongs to some white; consequently if man be taken as middle term and it is assumed that *A* belongs to no *B* but *B* belongs to some C, the conclusion will be true although the proposition *AB* is wholly false.

If the proposition *AB* is false in part, the conclusion may be true. For nothing prevents A belonging both to some *B* and to some *C*, and *B* belonging to some *C*, e.g. animal to something beautiful and to something great, and beautiful belonging to something great. If then *A* is assumed to belong to every *B*, and *B* to some *C*, the 55a1 proposition *AB* will be partially false, *BC* will be true, and the conclusion true. Similarly if the proposition *AB* is negative. For the same terms will serve, and in the same positions, to prove the point.

Again if *AB* is true, and *BC* is false, the conclusion may be true. For nothing prevents *A* belonging to the whole of *B* and to some *C*, while *B* belongs to no *C*, e.g. animal to every swan and to some black things, though swan belongs to no black thing. Consequently if it should be assumed that *A* belongs to every *B*, and *B* to some *C*, the conclusion will be true, although *BC* is false. Similarly if the proposition *AB* is negative. For it is possible that *A* should belong to no *B*, and not to some *C*, while *B* belongs to no *C*, e.g. a genus to the species of another genus and to the accident of its own species—for animal belongs to no number and to some white things, and number belongs to nothing white. If then number is taken as middle, and it is assumed that *A* belongs to no *B*, and *B* to some *C*, then *A* will not belong to some *C*, which *ex hypothesi* is true. And the proposition *AB* is true, *BC* false.

Also if *AB* is partially false, and *BC* is false too, the conclusion may be true. For nothing prevents *A* belonging to some *B* and to some *C*, though *B* belongs to no *C*, e.g. if *B* is the contrary of *C*, and both are accidents of the same genus—for animal belongs to some white things and to some black things, but white belongs to no black thing. If then it is assumed that *A* belongs to every *B*, and *B* to some *C*, the conclusion will be true. Similarly if *AB* is negative; for the same terms arranged in the same way will serve for the proof.

Also though both premisses are false the conclusion may be true. For it is possible that *A* may belong to no *B* and to some *C*, while *B* belongs to no *C*, e.g. a genus in relation to the species of another genus, and to the accident of its own species for animal belongs to no number, but to some white things, and number to nothing white. If then it is assumed that *A* belongs to every *B* and *B* to some *C*, the conclusion will be true, though both propositions are false. Similarly also if *AB* is negative. For nothing prevents *A* belonging to the whole of *B*, and not to some *C*, while *B* belongs to no *C*, e.g. animal belongs to every swan, and not to some black things, and swan belongs to nothing black. Consequently if it is assumed that *A* 55b1 belongs to no *B*, and *B* to some *C*, then *A* does not belong to some *C*. The conclusion then is true, but the propositions are false.

3 · In the middle figure it is possible in every way to reach a true conclusion through false premisses, whether the deductions are universal or particular, viz. when both propositions are wholly false; when each is partially false; when one is true, the other [wholly] false (it does not matter which of the two premisses is false). [if both premisses are partially false; if one is quite true, the other partially false; if one is wholly false, the other partially true.][19] For if *A* belongs to no *B* and to every

[19]Ross excises the bracketed phrases.

C, e.g. animal to no stone and to every horse, then if the propositions are stated contrariwise and it is assumed that *A* belongs to every *B* and to no *C*, though the propositions are wholly false they will yield a true conclusion. Similarly if *A* belongs to every *B* and to no *C*; for we shall have the same deduction.

Again if one premiss is wholly false, the other wholly true; for nothing prevents *A* belonging to every *B* and to every *C*, though *B* belongs to no *C*, e.g. a genus to its co-ordinate species. For animal belongs to every horse and man, and no man is a horse. If then it is assumed that animal belongs to all of the one, and none of the other, the one premiss will be wholly false, the other wholly true, and the conclusion will be true whichever term the negative statement concerns.

Also if one premiss is partially false, the other wholly true. For it is possible that *A* should belong to some *B* and to every *C*, though *B* belongs to no *C*, e.g. animal to some white things and to every raven, though white belongs to no raven. If then it is assumed that *A* belongs to no *B*, but to the whole of *C*, the proposition *AB* is partially false, *AC* wholly true, and the conclusion true. Similarly if the negative is transposed: the proof can be made by means of the same terms. Also if the affirmative proposition is partially false, the negative wholly true, a true conclusion is possible. For nothing prevents *A* belonging to some *B*, but not to *C* as a whole, while *B* belongs to no *C*, e.g. animal belongs to some white things, but to no pitch, and white belongs to no pitch. Consequently if it is assumed that *A* belongs to the whole of *B*, but to no *C*, *AB* is partially false, *AC* is wholly true, and the conclusion is true.

And if both the propositions are partially false, the conclusion may be true. For it is possible that *A* should belong to some *B* and to some *C*, and *B* to no *C*, e.g. animal to some white things and to some black things, though white belongs to nothing black. If then it is assumed that *A* belongs to every *B* and to no *C*, both propositions are partially false, but the conclusion is true. Similarly, if the negative is transposed, the proof can be made by means of the same terms.

It is clear also that the same holds for particular deductions. For nothing prevents *A* belonging to every *B* and to some *C*, though *B* does not belong to some *C*, e.g. animal to every man and to some white things, though man will not belong to some white things. If then it is stated that *A* belongs to no *B* and to some *C*, the universal proposition is wholly false, the particular is true, and the conclusion is true. Similarly if *AB* is affirmative; for it is possible that *A* should belong to no *B*, and not to some *C*, though *B* does not belong to some *C*, e.g. animal belongs to nothing inanimate, and to some white things, and inanimate will not belong to some white things. If then it is stated that *A* belongs to *B* and not to some *C*, the *AB* which is universal is wholly false, *AC* is true, and the conclusion is true. Also a true conclusion is possible when the universal is true, and the particular is false. For nothing prevents *A* following neither *B* nor *C* at all, while *B* does not belong to some *C*, e.g. animal belongs to no number nor to anything inanimate, and number does not follow some inanimate things. If then it is stated that *A* belongs to no *B* and to some *C*, the conclusion will be true, and the universal proposition true, but the particular false. Similarly if the premiss which is stated universally affirmative. For it is possible that *A* should belong both to *B* and to *C* as wholes, though *B* does not follow some *C*, e.g. a genus in relation to its species and difference—for animal follows every man and footed things as a whole, but man does not follow every footed thing. Consequently if it is assumed that *A* belongs to the whole of *B*, but does not belong to some *C*, the universal proposition is true, the particular false, and the conclusion true.

It is clear too that though both propositions are false they may yield a true conclusion, since it is possible that *A* should belong both to *B* and to *C* as wholes, though *B* does not follow some *C*. For if it is assumed that *A* belongs to no *B* and to some *C*, the propositions are both false, but the conclusion is true. Similarly if the universal proposition is affirmative and the particular negative. For it is possible that *A* should follow no *B* and every *C*, though *B* does not belong to some *C*, e.g. animal follows no science but every man, though science does not follow every man. If then *A* is assumed to belong to the whole of *B*, and not to follow some *C*, the propositions are false but the conclusion is true.

4 · In the last figure a true conclusion may come through what is false, alike when both are wholly false, when each is partly false, when one is wholly true, the other false, when one is partly false, the other wholly true, and vice versa, and in every other way in which it is possible to alter the propositions. For nothing prevents neither *A* nor *B* from belonging to any *C*, while *A* belongs to some *B*, e.g. neither man nor footed follows anything inanimate, though man belongs to some footed things. If then it is assumed that *A* and *B* belong to every *C*, the propositions will be wholly false, but the conclusion true. Similarly if one is negative, the other affirmative. For it is possible that *B* should belong to no *C*, but *A* to every *C*, and that *A* should not belong to *B*, e.g. black belongs to no swan, animal to every swan, and animal not to everything black. Consequently if it is assumed that *B* belongs to every *C*, and *A* to no *C*, *A* will not belong to some *B*; and the conclusion is true, though the propositions are false.

Also if each is partly false, the conclusion may be true. For nothing prevents both *A* and *B* from belonging to some *C* while *A* belongs to some *B*, e.g. white and beautiful belong to some animals, and white to some beautiful things. If then it is stated that *A* and *B* belong to every *C*, the propositions are partially false, but the conclusion is true. Similarly if *AC* is stated as negative. For nothing prevents *A* from not belonging, and *B* from belonging, to some *C*, while *A* does not belong to every *B*, e.g. white does not belong to some animals, beautiful belongs to some animals, and white does not belong to everything beautiful. Consequently if it is assumed that *A* belongs to no *C*, and *B* to every *C*, both propositions are partly false, but the conclusion is true.

Similarly if one is wholly false, the other wholly true. For it is possible that both *A* and *B* should follow every *C*, though *A* does not belong to some *B*, e.g. animal and white follow every swan, though animal does not belong to everything white. Taking such terms, if one assumes that *B* belongs to the whole of *C*, but *A* does not belong to *C* at all, *BC* will be wholly true, *AC* wholly false, and the conclusion true.

Similarly if BC is false, AC true, the conclusion may be true. The same terms will serve for the proof. Also if both are affirmative, the conclusion may be true. For nothing prevents B from following every C, and A from not belonging to C at all, though A belongs to some B, e.g. animal belongs to every swan, black to no swan, and black to some animals. Consequently if it is assumed that A and B belong to every C, BC is wholly true, AC is wholly false, and the conclusion is true. Similarly if AC is true: the proof can be made through the same terms.

Again if one is wholly true, the other partly false, the conclusion may be true. For it is possible that B should belong to every C, and A to some C, while A belongs to some B, e.g. biped belongs to every man, beautiful not to every man, and beautiful to some bipeds. If then it is assumed that both A and B belong to the whole of C, BC is wholly true, AC partly false, the conclusion true. Similarly if AC is true and BC partly false, a true conclusion is possible: this can be proved, if the same terms as before are transposed. Also the conclusion may be true if one is negative, the other affirmative. For since it is possible that B should belong to the whole of C, and A to some C, and, when they are so, that A should not belong to every B, therefore if it is assumed that B belongs to the whole of C, and A to no C, the negative is partly false, the other wholly true, and the conclusion is true. Again since it has been proved that if A belongs to no C and B to some C, it is possible that A should not belong to some B, it is clear that if AC is wholly true, and BC partly false, it is possible that the conclusion should be true. For if it is assumed that A belongs to no C, and B to every C, AC is wholly true, and BC is partly false.

It is clear also in the case of particular deductions that a true conclusion may come through what is false, in every possible way. For the same terms must be taken as have been taken when the propositions are universal, positive terms in positive deductions, negative terms in negative. For it makes no difference to the setting out of the terms, whether one assumes that what belongs to none belongs to all or that what belongs to some belongs to all. The same applies to negative deductions.

It is clear then that if the conclusion is false, the premisses of the argument must be false, either all or some of them; but when the conclusion is true, it is not necessary that the premisses should be true, either one or all, yet it is possible, though no part of the deduction is true, that the conclusion may none the less be true; but not necessarily. The reason is that when two things are so related to one another, that if the one is, the other necessarily is, then if the latter is not, the former will not be either, but if the latter is, it is not necessary that the former should be. But it is impossible that the same thing should be necessitated by the being and by the not-being of the same thing. I mean, for example, that it is impossible that B should necessarily be great if A is white and that B should necessarily be great if A is not white. For whenever if this, A, is white it is necessary that that, B, should be great, and if B is great that C should not be white, then it is necessary if A is white that C should not be white. And whenever it is necessary, if one of two things is, that the other should be, it is necessary, if the latter is not, that the former should not be. If then B is not great A cannot be white. But if, if A is not white, it is necessary that B should be great, it necessarily results that if B is not great, B itself is great. But this is impossible. For if B is not great, A will necessarily not be white. If then if this is not white B must be great, it results that if B is not great, it is great, just as if it were proved through three terms.

5 · Circular and reciprocal proof means proof by means of the conclusion and by taking one of the propositions with its predication reversed and inferring the other which was assumed in the original deduction: e.g. suppose we had to prove that A belongs to every C, and it has been proved through B; suppose that A should now be proved to belong to B by assuming that A belongs to C, and C to B before; but the reverse was assumed, viz. that B belongs to C. Or suppose it is necessary to prove that B belongs to C, and A is assumed to belong to C, which was the conclusion and B to belong to A: the reverse was assumed before viz. that A belongs to B. In no other way is reciprocal proof possible. For if another term is taken as middle, the proof is not circular; for neither of the propositions assumed is the same as before; and if one of them is assumed, only *one* can be for if both of them are taken the same conclusion as before will result; but it must be different.

If the terms are not convertible, one of the propositions from which the deduction results must be undemonstrated; for it is not possible to demonstrate through these terms that the third belongs to the middle or the middle to the first. If the terms are convertible, it is possible to demonstrate everything reciprocally, e.g. if A and B and C are convertible with one another. Suppose AC has been proved through B as middle term, and again AB through the conclusion and the proposition BC converted, and similarly BC through the conclusion and the proposition AB converted. But it is necessary to prove both proposition CB and BA; for we have used these alone without demonstrating them. If then it is assumed that B belongs to every C, and C to every A, we shall have a deduction relating B to A. Again if it is assumed that C belongs to every A, and A to every B, C must belong to every B. In both these deductions the proposition CA has been assumed without being demonstrated: the others had been proved. Consequently if we succeed in demonstrating this, all will have been proved reciprocally. If then it is assumed that C belongs to every B, and B to every A, both the propositions assumed have been demonstrated, and C must belong to A.

It is clear then that only if the terms are convertible is circular and reciprocal demonstration possible (if the terms are not convertible, the matter stands as we said above). But it turns out that even in these we use for the demonstration the very thing that is being proved; for C is proved of B, and B of A, by assuming that C is said of A, and C is proved of A through these propositions, so that we use the conclusion for the demonstration.

In negative deductions reciprocal proof is as follows. Let B belong to every C, and A to no B: we conclude that A belongs to no C. If again it is necessary to conclude that A belongs to no B (which was previously assumed) A must belong to no C, and C to every B: thus the proposition is reversed. If it is necessary to conclude that B belongs to C, AB must no longer be converted as before; for the proposition that B belongs to no A is identical with the proposition that A belongs to no B. But we must assume that B belongs to all of that to none of which A belongs. Let A belong to no C (which was the conclusion) and assume that B belongs to all of that to none of which A belongs. It is necessary then that B should belong to every C. Consequently each of the three propositions has been made a conclusion, and this is circular demonstration, to assume the conclusion and the reverse of one of the propositions, and deduce the remaining one.

In particular deductions it is not possible to demonstrate the universal proposition through the others, but the particular can be demonstrated. Clearly it is impossible to demonstrate the universal; for what is universal is proved through propositions which are universal, but the conclusion is not universal, and the proof must start from the conclusion and the other proposition. Further a deduction cannot be made at all if the other proposition is converted; for the result is that both propositions are particular. But the particular may be proved. Suppose that A has been proved of some C through B. If then it is assumed that B belongs to every A, and the conclusion is retained, B will belong to some C; for we obtain the first figure and A is middle. But if the deduction is negative, it is not possible to prove the universal proposition, for the reason given above. But it is possible to prove the particular, if AB is converted as in the universal cases, i.e. B belongs to some of that to some of which A does not belong: otherwise no deduction results because the particular proposition is negative.

6 · In the second figure it is not possible to prove an affirmative proposition in this way, but a negative may be proved. An affirmative is not proved because both propositions are not affirmative (for the conclusion is negative) but an affirmative is (as we saw) proved from premisses which are both affirmative. The negative is proved as follows. Let A belong to every B, and to no C: we conclude that B belongs to no C. If then it is assumed that B belongs to every A, it is necessary that A should belong to no C; for we get the second figure, with B as middle. But if AB is negative, and the other affirmative, we shall have the first figure. For C belongs to every A, and B to no C, consequently B belongs to no A; neither, then, does A belong to B. Through the conclusion, therefore, and one proposition, we get no deduction, but if another is assumed in addition, a deduction will be possible. But if the deduction is not universal, the universal proposition cannot be proved, for the same reason as we gave above; but the particular can be proved whenever the universal is affirmative. Let A belong to every B, and not to every C: the conclusion is BC. If then it is assumed that B belongs to every A, but not to every C, A will not belong to some C, B being middle. But if the universal is negative, the proposition AC will not be proved by the conversion of AB; for it turns out that either both or one of the propositions is negative; consequently a deduction will not be possible. But the proof will proceed as in the universal cases, if it is assumed that A belongs to some of that to some of which B does not belong.

7 · In the third figure, when both propositions are taken universally, it is not possible to prove them reciprocally; for that which is universal is proved through

59a1 propositions which are universal, but the conclusion in this figure is always particular, so that it is clear that it is not possible at all to prove through this figure the universal proposition. But if one is universal, the other particular, proof will sometimes be possible, sometimes not. When both are affirmative, and the universal concerns the minor extreme, proof will be possible, but when it concerns the other extreme, impossible. Let A belong to every C and B to some C: the conclusion is AB. If then it is assumed that C belongs to every A, it has been proved that C belongs to some B, but that B belongs to some C has not been proved. And yet it is necessary, if C belongs to some B, that B should belong to some C. But it is not the same that this should belong to that, and that to this; but we must assume besides that if this belongs to some of that, that belongs to some of this. But if this is assumed the deduction no longer results from the conclusion and the other proposition. But if B belongs to every C, and A to some C, it will be possible to prove AC, when it is assumed that C belongs to every B, and A to some B. For if C belongs to every B and A to some B, it is necessary that A should belong to some C, B being middle.

And whenever one is affirmative, the other negative, and the affirmative is universal, the other can be proved. Let B belong to every C, and A not to some C: the conclusion is that A does not belong to some B. If then it is assumed further that C belongs to every B, it is necessary that A should not belong to some C, B being middle. But when the negative is universal, the other is not proved, except as before, viz. if it is assumed that *that* belongs to some of that, to some of which *this* does not belong, e.g. if A belongs to no C, and B to some C: the conclusion is that A does not belong to some C. If then it is assumed that C belongs to some of that to some of which A does not belong, it is necessary that C should belong to some B. In no other way is it possible by converting the universal proposition to prove the other; for in no other way can a deduction be formed.

[It is clear then that in the first figure reciprocal proof is made both through the third and through the first figure—if the conclusion is affirmative through the first; if the conclusion is negative through the last. For it is assumed that *that* belongs to all of that to none of which *this* belongs. In the middle figure, when the deduction is universal, proof is possible through the second figure and through the first, but when particular through the second and the last. In the third figure all proofs are made through itself. It is clear also that in the third figure and in the middle figure those deductions which are not made through those figures themselves either are not of the nature of circular proof or are imperfect.][20]

59b1 **8** · To convert is to alter the conclusion and make a deduction to prove that either the extreme does not belong to the middle or the middle to the last term. For it is necessary, if the conclusion has been converted and one of the propositions stands, that the other should be destroyed. For if it should stand, the conclusion also must stand. It makes a difference whether the conclusion is converted into its opposite or into its contrary. For the same deduction does not result whichever form the conversion takes. This will be made clear by the sequel. (By opposition I mean

[20]Ross excises this paragraph.

the relation of 'to every' to 'not to every', and of 'to some' to 'to none'; by contrarily I mean the relation of 'to every' to 'to none', and of 'to some' to 'not to some'.) Suppose that A has been proved of C, through B as middle term. If then it should be assumed that A belongs to no C, but to every B, B will belong to no C. And if A belongs to no C, and B to every C, A will belong, not to no B at all, but not to every B. For (as we saw) the universal is not proved through the last figure. In a word it is not possible to refute universally by conversion the proposition which concerns the major extreme; for the refutation always proceeds through the third figure; since it is necessary to take both propositions in reference to the minor extreme. Similarly if the deduction is negative. Suppose it has been proved that A belongs to no C through B. Then if it is assumed that A belongs to every C, and to no B, B will belong to no C. And if A and B belong to every C, A will belong to some B; but in the original premiss it belonged to no B.

If the conclusion is converted into its opposite, the deductions will be opposite and not universal. For one proposition is particular, so that the conclusion also will be particular. Let the deduction be affirmative, and let it be converted as stated. Then if A belongs not to every C, but to every B, B will belong not to every C. And if A belongs not to every C, but B belongs to every C, A will belong not to every B. Similarly if the deduction is negative. For if A belongs to some C, and to no B, B will belong, not to no C at all, but not to some C. And if A belongs to some C, and B to every C, as was originally assumed, A will belong to some B.

In particular deductions when the conclusion is converted into its opposite, both propositions may be refuted; but when it is converted into its contrary, neither. For the result is no longer, as in the universal cases, a refutation in which the conclusion reached by conversion lacks universality, but no refutation at all. Suppose that A has been proved of some C. If then it is assumed that A belongs to no C, and B to some C, A will not belong to some B; and if A belongs to no C, but to every B, B will belong to no C. Thus both are refuted. But neither can be refuted if the conclusion is converted into its contrary. For if A does not belong to some C, but to every B, then B will not belong to some C. But the original premiss is not yet refuted; for it is possible that B should belong to some C, and should not belong to some C. The universal AB cannot be affected by a deduction at all; for if A does not belong to some C, but B belongs to some C, neither of the propositions is universal. Similarly if the deduction is negative; for if it should be assumed that A belongs to every C, both are refuted; but if the assumption is that A belongs to some C, neither is. The demonstration is the same as before.

9 · In the second figure it is not possible to refute the proposition which concerns the major extreme by establishing something contrary to it, whichever form the conversion may take. For the conclusion will always be in the third figure, and in this figure (as we saw) there is no universal deduction. The other can be refuted in a manner similar to the conversion: I mean, if the conclusion is converted into its contrary, contrarily; if into its opposite, oppositely. Let A belong to every B and to no C: conclusion BC. If then it is assumed that B belongs to every C, and AB

stands, *A* will belong to every *C*, since the first figure is produced. If *B* belongs to every *C*, and *A* to no *C*, then *A* belongs not to every *B*: the figure is the last. But if *BC* is converted into its opposite, *AB* will be proved as before, *AC* oppositely. For if *B* belongs to some *C*, and *A* to no *C*, then *A* will not belong to some *B*. Again if *B* belongs to some *C*, and *A* to every *B*, *A* will belong to some *C*, so that the deduction is opposite. A similar proof can be given if the propositions are the other way about.

If the deduction is particular, when the conclusion is converted into its contrary neither proposition can be refuted, as also happened in the first figure, but if the conclusion is converted into its opposite, both can be refuted. Suppose that *A* belongs to no *B*, and to some *C*: the conclusion is *BC*. If then it is assumed that *B* belongs to some *C*, and *AB* stands, the conclusion will be that *A* does not belong to some *C*. But the original statement has not been refuted; for it is possible that *A* should belong to some *C* and also not to some *C*. Again if *B* belongs to some *C* and *A* to some *C*, no deduction will be possible; for neither of the assumptions is universal. Consequently *AB* is not refuted. But if the conclusion is converted into its opposite, both can be refuted. For if *B* belongs to every *C*, and *A* to no *B*, *A* will belong to no *C*; but it was assumed to belong to some *C*. Again if *B* belongs to every *C* and *A* to some *C*, *A* will belong to some *B*. The same demonstration can be given if the universal is affirmative.

10 · In the third figure when the conclusion is converted into its contrary, neither of the propositions can be refuted in any of the deductions, but when the conclusion is converted into its opposite, both may be refuted and in all the moods. Suppose it has been proved that *A* belongs to some *B*, *C* being taken as middle, and the propositions being universal. If then it is assumed that *A* does not belong to some *B*, but *B* belongs to every *C*, no deduction is formed about *A* and *C*. Nor if *A* does not belong to some *B*, but belongs to every *C*, will a deduction be possible about *B* and *C*. A similar proof can be given if the propositions are not universal. For either both propositions arrived at by the conversion must be particular, or the universal must refer to the minor extreme. But we found that no deduction is possible thus either in the first or in the middle figure. But if the conclusion is converted into its opposite, both the propositions can be refuted. For if *A* belongs to no *B*, and *B* to every *C*, then *A* belongs to no *C*; again if *A* belongs to no *B*, and to every *C*, *B* belongs to no *C*. And similarly if one is not universal. For if *A* belongs to no *B*, and *B* to some *C*, *A* will not belong to some *C*; if *A* belongs to no *B*, and to every *C*, *B* will belong to no *C*.

Similarly if the deduction is negative. Suppose it has been proved that *A* does not belong to some *B*, *BC* being affirmative, *AC* being negative; for it was thus that, as we saw, a deduction could be made. Whenever then the contrary of the conclusion is assumed a deduction will not be possible. For if *A* belongs to some *B*, and *B* to every *C*, no deduction is possible (as we saw) about *A* and *C*. Nor, if *A* belongs to some *B*, and to no *C*, was a deduction possible concerning *B* and *C*. Therefore the propositions are not refuted. But when the opposite of the conclusion is assumed, they are refuted. For if *A* belongs to every *B*, and *B* to *C*, *A* belongs to every *C*; but *A* was supposed originally to belong to no *C*. Again if *A* belongs to every *B*, and to no *C*, then *B* belongs to no *C*; but it was supposed to belong to every *C*. A similar proof is possible if the propositions are not universal. For *AC* becomes universal and negative, the other premiss particular and affirmative. If then *A* belongs to every *B*, and *B* to some *C*, it results that *A* belongs to some *C*; but it was supposed to belong to no *C*. Again if *A* belongs to every *B*, and to no *C*, then *B* belongs to no *C*; but it was assumed to belong to some *C*. If *A* belongs to some *B* and *B* to some *C*, no deduction results; nor yet if *A* belongs to some *B*, and to no *C*. Thus in the former case the propositions are refuted, in the latter they are not.

From what has been said it is clear how a deduction results in each figure when the conclusion is converted; and when it is contrary to the proposition, and when opposite. It is clear that in the first figure the deductions are formed through the middle and the last figures, and the proposition which concerns the minor extreme is always refuted through the middle figure, that which concerns the major through the last figure. In the second figure deductions proceed through the first and the last figures, and the proposition which concerns the minor extreme is always refuted through the first figure, that which concerns the major extreme through the last. In the third figure the deductions proceed through the first and the middle figures; the proposition which concerns the major is always refuted through the first figure, that which concerns the minor through the middle figure.

11 · It is clear then what conversion is, how it is effected in each figure, and what deduction results. Deduction *per impossibile* is proved when the contradictory of the conclusion is posited and another proposition is assumed; it can be made in all the figures. For it resembles conversion, differing only in this: conversion takes place after a deduction has been formed and both the propositions have been assumed, but a reduction to the impossible takes place not because the opposite has been agreed to already, but because it is clear that it is true. The terms are alike in both, and the premisses of both are assumed in the same way. For example if *A* belongs to every *B*, *C* being middle, then if it is supposed that *A* does not belong to every *B* or belongs to no *B*, but to every *C* (which was true), it follows that *C* belongs to no *B* or not to every *B*. But this is impossible; consequently the supposition is false; its opposite then is true. Similarly in the other figures; for whatever moods admit of conversion admit also of deduction *per impossibile*.

All the problems can be proved *per impossibile* in all the figures, excepting the universal affirmative, which is proved in the middle and third figures, but not in the first. Suppose that *A* belongs not to every *B*, or to no *B*, and take besides another proposition concerning either of the terms, viz. that *C* belongs to every *A*, or that *B* belongs to every *D*; thus we get the first figure. If then it is supposed that *A* does not belong to every *B*, no deduction results whichever term the assumed proposition concerns; but if it is supposed that *A* belongs to no *B*, when *BD* is assumed as well we shall deduce what is false, but not the problem proposed. For if *A* belongs to no *B*, and *B* belongs to every *D*, *A* belongs to no *D*. Let this be impossible: it is false then that A belongs to no B. But the universal affirmative is not necessarily true if the universal negative is false. But if CA is assumed as well, no deduction results, nor does it do so when it is supposed that A does not belong to every B. Consequently it is clear that the universal affirmative cannot be proved in the first figure *per impossibile*.

But the particular affirmative and the universal and particular negatives can all be proved. Suppose that A belongs to no B, and let it have been assumed that B belongs to every or to some C. Then it is necessary that A should belong to no C or not to every C. But this is impossible (for let it be true and clear that A belongs to every C); consequently if this is false, it is necessary that A should belong to some B. But if the other proposition assumed relates to A, no deduction will be possible. Nor can a conclusion be drawn when the contrary of the conclusion is supposed, i.e. that A does not belong to some B. Clearly then we must suppose the opposite.

Again suppose that A belongs to some B, and let it have been assumed that C belongs to every A. It is necessary then that C should belong to some B. But let this be impossible, so that the supposition is false: in that case it is true that A belongs to no B. We may proceed in the same way if CA has been taken as negative. But if the proposition assumed concerns B, no deduction will be possible. If the contrary is supposed, we shall have a deduction and an impossible conclusion, but the problem in hand is not proved. Suppose that A belongs to every B, and let it have been assumed that C belongs to every A. It is necessary then that C should belong to every B. But this is impossible, so that it is false that A belongs to every B. But we have not yet shown it to be necessary that A belongs to no B, if it does not belong to every B. Similarly if the other proposition taken concerns B; we shall have a deduction and a conclusion which is impossible, but the supposition is not refuted. Therefore it is the opposite that we must suppose.

To prove that A does not belong to every B, we must suppose that it belongs to every B; for if A belongs to every B, and C to every A, then C belongs to every B; so that if this is impossible, the supposition is false. Similarly if the other proposition assumed concerns B. The same results if CA is negative; for thus also we get a deduction. But if the negative concerns B, nothing is proved. If the supposition is that A belongs not to every but to some B, it is not proved that A belongs not to every B, but that it belongs to no B. For if A belongs to some B, and C to every A, then C will belong to some B. If then this is impossible, it is false that A belongs to some B; consequently it is true that A belongs to no B. But if this is proved, the truth is refuted as well; for the original conclusion was that A belongs to some B, and does not belong to some B. Further nothing impossible results from the supposition; for then the supposition would be false, since it is impossible to deduce a false conclusion from true premisses; but in fact it is true; for A belongs to some B. Consequently we must not suppose that A belongs to some B, but that it belongs to every B. Similarly if we should be proving that A does not belong to some B; for if not to belong to some and to belong not to every are the same, the demonstration of both will be identical.

It is clear then that not the contrary but the opposite ought to be supposed in all the deductions. For thus we shall have the necessity, and the claim we make will be reputable. For if of everything either the affirmation or the negation holds good, then if it is proved that the negation does not hold, the affirmation must be true. Again if it is not admitted that the affirmation is true, the claim that the negation is true will be reputable. But in neither way does it suit to maintain the contrary; for it is not necessary that if the universal negative is false, the universal affirmative should be true, nor is it reputable that if the one is false the other is true.

12 · It is clear then that in the first figure all problems except the universal affirmative are proved *per impossibile*. But in the middle and the last figures this also is proved. Suppose that *A* does not belong to every *B*, and let it have been assumed that *A* belongs to every *C*. If then *A* belongs not to every *B*, but to every *C*, *C* will not belong to every *B*. But this is impossible (for suppose it to be clear that *C* belongs to every *B*); consequently the supposition is false. It is true then that *A* belongs to every *B*. But if the contrary is supposed, we shall have a deduction and a result which is impossible; but the problem in hand is not proved. For if *A* belongs to no *B*, and to every *C*, *C* will belong to no *B*. This is impossible; so that it is false that *A* belongs to no *B*. But though this is false, it does not follow that it is true that *A* belongs to every *B*.

If we want to prove that *A* belongs to some *B*, suppose that *A* belongs to no *B*, and let *A* belong to every *C*. It is necessary then that *C* should belong to no *B*. Consequently, if this is impossible, *A* must belong to some *B*. But if it is supposed that *A* does not belong to some *B*, we shall have the same results as in the first figure.

Again suppose that *A* belongs to some *B*, and let *A* belong to no *C*. It is necessary then that *C* should not belong to some *B*. But originally it belonged to every *B*; consequently the supposition is false; *A* then will belong to no *B*.

If we want to prove that *A* does not belong to every *B*, suppose it does belong to every *B*, and to no *C*. It is necessary then that *C* should belong to no *B*. But this is impossible; so that it is true that *A* does not belong to every *B*. It is clear then that all the deductions can be formed in the middle figure.

13 · Similarly they can all be formed in the last figure. Suppose that *A* does not belong to some *B*, but *C* belongs to every *B*; then *A* does not belong to some *C*. If then this is impossible, it is false that *A* does not belong to some *B*; so that it is true that *A* belongs to every *B*. But if it is supposed that *A* belongs to no *B*, we shall have a deduction and a conclusion which is impossible; but the problem in hand is not proved; for if the contrary is supposed, we shall have the same results as before.

But to prove that *A* belongs to some *B*, this supposition must be made. If *A* belongs to no *B*, and *C* to some *B*, *A* will belong not to every *C*. If then this is false, it is true that *A* belongs to some *B*.

To prove that *A* belongs to no *B*, suppose *A* belongs to some *B*, and let it have been assumed that *C* belongs to every *B*. Then it is necessary that *A* should belong to some *C*. But *ex hypothesi* it belongs to no *C*, so that it is false that *A* belongs to some *B*. But if it is supposed that *A* belongs to every *B*, the problem is not proved.

But this supposition must be made if we are to prove that *A* belongs not to every *B*. For if *A* belongs to every *B* and *C* to every *B*, then *A* belongs to some *C*. But this we assumed not to be so, so it is false that *A* belongs to every *B*. But in that case it is true that *A* belongs not to every *B*. If however it is supposed that *A* belongs to some *B*, we shall have the same result as before.

It is clear then that in all the deductions which proceed *per impossibile* the opposite must be supposed. And it is plain that in the middle figure an affirmative conclusion, and in the last figure a universal conclusion, are proved in a way.

14 · Demonstration *per impossibile* differs from probative demonstration in that it posits what it wishes to refute by reduction to a statement admitted to be false; whereas probative demonstration starts from admitted positions. Both, indeed, take two propositions that are admitted, but the latter takes the premisses from which the deduction starts, the former takes one of these, along with the contradictory of the conclusion. Also in the probative case it is not necessary that the conclusion should be familiar, nor that one should suppose beforehand that it is true or not; in the other it is necessary to suppose beforehand that it is not true. It makes no difference whether the conclusion is affirmative or negative; the method is the same in both cases.

Everything which is concluded probatively can be proved *per impossibile,* and that which is proved *per impossibile* can be proved probatively, through the same terms. Whenever the deduction is formed in the first figure, the truth will be found in the middle or the last figure, if negative in the middle, if affirmative in the last. Whenever the deduction is formed in the middle figure, the truth will be found in the first, whatever the problem may be. Whenever the deduction is formed in the last figure, the truth will be found in the first and middle figures, if affirmative in the first, if negative in the middle. Suppose that *A* has been proved to belong to no *B*, or not to every *B*, through the first figure. Then the supposition must have been that *A* belongs to some *B*, and it was assumed that *C* belongs to every *A* and to no *B*. For thus the deduction was made and the impossible conclusion reached. But this is the middle figure, if *C* belongs to every *A* and to no *B*. And it is clear from this that *A* belongs to no *B*. Similarly if *A* has been proved not to belong to every *B*. For the supposition is that *A* belongs to every *B*; and it was assumed that *C* belongs to every *A* but not to every *B*. Similarly too, if *CA* should be negative; for thus also we have the middle figure. Again suppose it has been proved that *A* belongs to some *B*. The supposition here is that *A* belongs to no *B*; and it was assumed that *B* belongs to every *C*, and *A* either to every or to some *C*; for in this way we shall get what is impossible. But if *A* and *B* belong to every *C*, we have the last figure. And it is clear from this that *A* must belong to some *B*. Similarly if *B* or *A* should be assumed to belong to some *C*.

Again suppose it has been proved in the middle figure that *A* belongs to every *B*. Then the supposition must have been that *A* belongs not to every *B*, and it was assumed that *A* belongs to every *C*, and *C* to every *B*; for thus we shall get what is impossible. But if *A* belongs to every *C*, and *C* to every *B*, we have the first figure.

Similarly if it has been proved that *A* belongs to some *B*; for the supposition then must have been that *A* belongs to no *B*, and it was assumed that *A* belongs to every *C*, and *C* to some *B*. If the deduction is negative, the supposition must have been that *A* belongs to some *B*, and it was assumed that *A* belongs to no *C*, and *C* to every *B*, so that the first figure results. If the deduction is not universal, but proof has been given that *A* does not belong to some *B*, we may infer in the same way. The supposition is that *A* belongs to every *B*, and it was assumed that *A* belongs to no *C*, and *C* belongs to some *B*; for thus we get the first figure.

Again suppose it has been proved in the third figure that *A* belongs to every *B*. Then the supposition must have been that *A* belongs not to every *B*, and it was assumed that *C* belongs to every *B*, and *A* belongs to every *C*; for thus we shall get what is impossible. And this is the first figure. Similarly if the demonstration establishes a particular proposition: the supposition then must have been that *A* belongs to no *B*, and it was assumed that *C* belongs to some *B*, and *A* to every *C*. If the deduction is negative, the supposition must have been that *A* belongs to some *B*, and it was assumed that *C* belongs to no *A* and to every *B*; and this is the middle figure. Similarly if the demonstration is not universal. The supposition will then be that *A* belongs to every *B*, and it was assumed that *C* belongs to no *A* and to some *B*; and this is the middle figure.

It is clear then that it is possible through the same terms to prove each of the problems probatively as well. Similarly it will be possible if the deductions are probative to reduce them *ad impossibile* in the terms which have been taken, whenever the opposite of the conclusion is taken as a premiss. For the deductions become identical with those which are obtained by means of conversion, so that we obtain immediately the figures through which each problem will be solved. It is clear then that every problem can be proved in both ways, i.e. *per impossibile* and probatively, and it is not possible to separate one method from the other.

15 · In what figure it is possible to draw a conclusion from propositions which are opposed, and in what figure this is not possible, will be made clear in this way. Verbally four kinds of opposition are possible, viz. 'to every'–'to no', 'to every'–'not to every', 'to some'–'to no', 'to some'–'not to some'; but in reality there are only three, for 'to some' is only verbally opposed to 'not to some'. Of these I call those which are universal contraries ('to every'–'to no', e.g. 'every science is good', 'no science is good'); the others I call opposites.

In the first figure no deduction whether affirmative or negative can be made out of opposed propositions: no affirmative deduction is possible because both propositions must be affirmative, but opposites are the one affirmative, the other negative; no negative deduction is possible because opposites affirm and deny the same predicate of the same subject, and the middle term in the first figure is not predicated of both extremes, but one thing is denied of it, and it is affirmed of something else and such propositions are not opposed.

In the middle figure a deduction can be made both of opposites and of contraries. Let *A* stand for good, let *B* and *C* stand for science. If then one assumes that every science is good, and no science is good, *A* belongs to every *B* and to no *C*, so that *B* belongs to no *C*; no science, then, is a science. Similarly if after assuming that every science is good one assumed that the science of medicine is not good; for *A* belongs to every *B* but to no *C*, so that a particular science will not be a science. Again, if *A* belongs to every *C* but to no *B*, and *B* is science, *C* medicine, and *A* supposition; for after assuming that no science is supposition, one has assumed that a particular science is supposition. This differs from the preceding deduction because the relations between the terms are converted: before, the affirmative concerned *B*, now it concerns *C*. Similarly if one proposition is not universal; for the middle term is always that which is said negatively of one extreme, and affirmatively of the other. Consequently it is possible that opposites may lead to a conclusion, though not always or in every mood, but only if the terms subordinate to the middle are such that they are either identical or related as whole to part. Otherwise it is impossible; for the propositions cannot anyhow be either contraries or opposites.

In the third figure an affirmative deduction can never be made out of opposite propositions, for the reason given in reference to the first figure; but a negative deduction is possible whether the terms are universal or not. Let *B* and *C* stand for science, *A* for medicine. If then one should assume that all medicine is science and that no medicine is science, he has assumed that *B* belongs to every *A* and *C* to no *A*, so that some science will not be a science. Similarly if the proposition *BA* is not assumed universally; for if some medicine is science and again no medicine is science, it results that some science is not science. The propositions are contrary if the terms are taken universally; if one is particular, they are opposite.

We must recognize that it is possible to take opposites in the way we said, viz. 'all science is good' and 'no science is good' or 'some science is not good'. This does not usually escape notice. But it is possible to establish one of the opposites by way of other questions, or to assume it in the way suggested in the *Topics*.[21] Since there are three oppositions to affirmations, it follows that opposites may be assumed in six ways—either to all and to no, or to all and not to all, or to some and to no; and the relations between the terms may be converted; e.g. *A* may belong to every *B* and to no *C*, or to every *C* and to no *B*, or to every of the one, not to every of the other; here too the relation between the terms may be converted. Similarly in the third figure. So it is clear in how many ways and in what figures a deduction can be made by means of propositions which are opposed.

It is clear too that from false premisses it is possible to draw a true conclusion, as has been said before, but it is not possible if the premisses are opposed. For the deduction is always contrary to the fact, e.g. if a thing is good, it is deduced that it is not good, if an animal, that it is not an animal, because the deduction springs out of a contradiction and the terms presupposed are either identical or related as whole and part. It is evident also that in fallacious reasonings nothing prevents a contradiction to the supposition from resulting, e.g. if something is odd, that it is not odd. For the deduction owed its contrariety to its opposite premisses: if we assume

[21] See *Topics* VIII 1.

such premisses we shall get a result that contradicts our supposition. But we must recognize that contraries cannot be inferred from a single deduction in such a way that we conclude that what is not good is good, or anything of that sort, unless a proposition of that form is at once assumed (e.g. every animal is white and not white, and man is an animal). Either we must introduce the contradiction by an additional assumption, assuming, e.g., that every science is supposition, and then assuming that medicine is a science, but none of it is supposition (which is the mode in which refutations are made); or we must argue from two deductions. In no other way than this, as was said before, is it possible that the assumptions should be really contrary.

16 · To beg and assume the point at issue is a species of failure to demonstrate the problem proposed; but this happens in many ways. A man may not deduce at all, or he may argue from premisses which are more unknown or equally unknown, or he may establish what is prior by means of what is posterior; for demonstration proceeds from what is more convincing and prior. Now begging the point at issue is none of these; but since some things are naturally known through themselves, and other things by means of something else (the first principles through themselves, what is subordinate to them through something else), whenever a man tries to prove by means of itself what is not known by means of itself, then he begs the point at issue. This may be done by claiming what is at issue at once; it is also possible to make a transition to other things which would naturally be proved through the point at issue, and demonstrate it through them, e.g. if A should be proved through B, and B through C, though it was natural that C should be proved through A; for it turns out that those who reason thus are proving A by means of itself. This is what those persons do who suppose that they are constructing parallel lines; for they fail to see that they are assuming facts which it is impossible to demonstrate unless the parallels exist. So it turns out that those who reason thus merely say a particular thing is, if it is: in this way everything will be known by means of itself. But that is impossible.

If then it is uncertain whether A belongs to C, and also whether A belongs to B, and if one should assume that A does belong to B, it is not yet clear whether he begs the point at issue, but it is evident that he is not demonstrating; for what is as uncertain as the question to be answered cannot be a principle of a demonstration. If however B is so related to C that they are identical, or if they are plainly convertible, or the one inheres in the other, the point at issue is begged. For one might equally well prove that A belongs to B through those terms if they are convertible. (As it is, things prevent such a demonstration, but the method does not.) But if one were to make the conversion, then he would be doing what we have described and effecting a reciprocal proof with three propositions.

Similarly if he should assume that B belongs to C, this being as uncertain as the question whether A belongs to C, the point at issue is not yet begged, but no demonstration is made. If however A and B are identical either because they are convertible or because A follows B, then the point at issue is begged for the same reason as before. For we have explained the meaning of begging the point at issue, viz. proving by means of itself that which is not clear by means of itself.

If then begging the point at issue is proving by means of itself what is not clear by means of itself, in other words failing to prove when the failure is due to the thesis to be proved and that through which it is proved being equally uncertain, either because predicates which are identical belong to the same subject, or because the same predicate belongs to subjects which are identical, the point at issue may be begged in the middle and third figures in both ways, though, if the deduction is affirmative, only in the third and first figures. If the deduction is negative, it occurs when identical predicates are denied of the same subject; and both propositions do not beg the point at issue in the same way (similarly in the middle figure), because the terms in negative deductions are not convertible. In demonstrations the point at issue is begged when the terms are really related in the manner described, in dialectical arguments when they are believed to be so related.

17 · The objection that this is not the reason why the result is false, which we frequently make in argument, arises first in the case of a *reductio ad impossibile,* when it is used to contradict that which was being proved by the reduction. For unless a man has contradicted this proposition he will not say, 'That is not the reason', but urge that something false has been assumed in the earlier parts of the argument; nor will he use the formula in the case of a probative demonstration; for here what one contradicts is not posited. Further when anything is refuted probatively by *ABC*, it cannot be objected that the deduction does not depend on the assumption laid down. For we say that something comes about not for that reason, when the deduction is concluded in spite of the refutation of this; but that is not possible in probative cases; since if an assumption is refuted, a deduction can no longer be drawn in reference to it. It is clear then that 'Not for that reason' can only be used in the case of a *reductio ad impossibile,* and when the original supposition is so related to the impossible conclusion, that the conclusion results indifferently whether the supposition is made or not.

The most obvious case in which the falsity does not come about by reason of the supposition is when a deduction drawn from middle terms to an impossible conclusion is independent of the supposition, as we have explained in the *Topics.*[22] For to put that which is not the cause as the cause, is just this: e.g. if a man, wishing to prove that the diagonal of the square is incommensurate with the side, should try to prove Zeno's theorem that motion is impossible, and so establish a *reductio ad impossibile;* for the falsity has no connexion at all with the original assumption. Another case is where the impossible conclusion is connected with the supposition, but does not result from it. This may happen whether one traces the connexion upwards or downwards, e.g. if it is laid down that *A* belongs to *B*, *B* to *C*, and *C* to *D*, and it is false that *B* belongs to *D*; for if we eliminated *A* and assumed all the same that *B* belongs to *C* and *C* to *D*, the false conclusion would not depend on the original supposition. Or again trace the connexion upwards; e.g. suppose that *A*

[22]See *Sophistical Refutations* $167^{b}21$–36.

belongs to B, E to A, and F to E, it being false that F belongs to A. In this way too the impossible conclusion would result, though the original supposition were eliminated. But the impossible conclusion ought to be connected with the original terms: in this way it will depend on the supposition, e.g. when one traces the connexion downwards, the impossible conclusion must be connected with the term which is predicate; for if it is impossible that A should belong to D, the false conclusion will no longer result after A has been eliminated. If one traces the connexion upwards, the impossible conclusion must be connected with the term which is subject; for if it is impossible that F should belong to B, the impossible conclusion will disappear if B is eliminated. Similarly when the deductions are negative.

It is clear then that when the impossibility is not related to the original terms, the falsity does not result by reason of the supposition. Or perhaps even so it may sometimes be independent. For if it were laid down that A belongs not to B but to K, and that K belongs to C and C to D, the impossible conclusion would still stand (similarly if one takes the terms in an ascending series); consequently since the impossibility results whether the first assumption is suppressed or not, it does not hold by reason of the supposition. Or perhaps we ought not to understand the statement that the false conclusion results even if the assumption does not hold, in the sense that if something else were supposed the impossibility would result; but rather in the sense that when it is eliminated, the same impossibility results through the remaining propositions; since it is not perhaps absurd that the same false result should follow from several suppositions, e.g. that parallels meet, both on the assumption that the interior angle is greater than the exterior and on the assumption that a triangle contains more than two right angles.

18 · A false argument comes about by reason of the first falsity in it. Every deduction is made out of two or more propositions. If then it is drawn from two, one or both of them must be false; for (as was proved) a false deduction cannot be drawn from true premisses. But if from more than two, e.g. if C is established through A and B, and these through D, E, F, and G, one of these higher propositions must be false, and the argument fails by reason of this; for A and B are inferred by means of them. Therefore the conclusion and the falsity come about by reason of one of them.

19 · In order to avoid being argued down, we must take care, whenever an opponent sets up an argument without disclosing the conclusions, not to grant him the same term twice over in his propositions, since we know that a deduction cannot be drawn without a middle term, and that term which is stated more than once is the middle. How we ought to watch out for the middle in reference to each conclusion, is evident from our knowing what kind of thesis is proved in each figure. This will not escape us since we know how we are maintaining the argument.

That which we urge men to beware of in their admissions, they ought in attack to try to conceal. This will be possible first, if, instead of drawing the conclusions of preliminary deductions, they make the necessary assumptions and leave the conclusions in the dark; secondly if instead of inviting assent to propositions which are closely connected they take as far as possible those that are not connected by middle terms. For example suppose that *A* is to be inferred to be true of *F*; *B*, *C*, *D*, and *E* being middle terms. One ought then to ask whether *A* belongs to *B*, and next whether *D* belongs to *E*, instead of asking whether *B* belongs to *C*; after that he may ask whether *B* belongs to *C*, and so on. If the deduction is drawn through one middle term, he ought to begin with that: in this way he will most likely deceive his opponent.

20 · Since we know when a deduction can be formed and how its terms must be related, it is clear when refutation will be possible and when impossible. A refutation is possible whether everything is conceded, or the answers alternate (one, I mean, being affirmative, the other negative). For, as has been shown, a deduction is possible both in the former and in the latter case: consequently, if what is laid down is contrary to the conclusion, a refutation must take place; for a refutation is a deduction which establishes the contradictory. But if nothing is conceded, a refutation is impossible; for no deduction is possible (as we saw) when all the terms are negative; therefore no refutation is possible. For if a refutation were possible, a deduction must be possible; although if a deduction is possible it does not follow that a refutation is possible. Similarly refutation is not possible if nothing is conceded universally; since refutation and deduction are defined in the same way.

21 · It sometimes happens that just as we are deceived in the arrangement of the terms, so error may arise in our thought about them, e.g. if it is possible that the same predicate should belong to more than one subject primarily, but although knowing the one, a man may forget the other and think the predicate belongs to none of it. Suppose that *A* belongs to *B* and to *C* in virtue of themselves, and that *B* and *C* belong to every *D* in the same way. If then a man thinks that *A* belongs to every *B*, and *B* to *D*, but *A* to no *C*, and *C* to every *D*, he will have knowledge and ignorance of the same thing in respect of the same thing. Again if a man were to make a mistake about the members of a single series; e.g. suppose *A* belongs to *B*, *B* to *C*, and *C* to *D*, but someone thinks that *A* belongs to every *B*, but to no *C*: he will both know that *A* belongs to *C*, and believe that it does not. Does he then actually maintain after this that what he knows, he does not believe? For he knows in a way that *A* belongs to *C* through *B*, knowing the particular by virtue of his universal knowledge; so that what he knows in a way, this he maintains he does not believe at all; but that is impossible.

In the former case, where the middle term does not belong to the same series, it is not possible to believe both the propositions with reference to each of the two middle terms: e.g. that *A* belongs to every *B*, but to no *C*, and both *B* and *C* belong to every *D*. For it turns out that the first proposition is either wholly or partially contrary. For if he believes that *A* belongs to everything to which *B* belongs, and he knows that *B* belongs to *D*, then he knows that *A* belongs to *D*. Consequently if again he thinks that A belongs to nothing to which C belongs, he does not think that A belongs to some of that to which B belongs; but if he thinks that A belongs to everything to which B belongs, and again does not think that A belongs to some of that to which B belongs, these beliefs are wholly or partially contrary.

In this way then it is not possible to believe; but nothing prevents a man believing one proposition of each deduction or both of one: e.g. A belongs to every B, and B to D, and again A belongs to no C. An error of this kind is similar to the error into which we fall concerning particulars: e.g. if A belongs to everything to which B belongs, and B to every C, A will belong to every C. If then a man knows that A belongs to everything to which B belongs, he knows also that A belongs to C. But nothing prevents his being ignorant that C exists; e.g. let A stand for two right angles, B for triangle, C for a sensible triangle. A man might believe that C did not exist, though he knew that every triangle contains two right angles; consequently he will know and not know the same thing at the same time. For knowing that every triangle has its angles equal to two right angles is not simple—it may obtain either by having universal knowledge or by particular. Thus by universal knowledge he knows that C contains two right angles, but not by particular; consequently his knowledge will not be contrary to his ignorance. The argument in the *Meno*[23] that learning is recollection may be criticized in a similar way. For it never happens that a man has foreknowledge of the particular, but in the process of induction he receives a knowledge of the particulars, as though by an act of recognition. For we know some things directly; e.g. that the angles are equal to two right angles, if we see that the figure is a triangle. Similarly in all other cases.

By universal knowledge then we see the particulars, but we do not know them by the kind of knowledge which is proper to them; consequently it is possible that we may make mistakes about them, but not that we should have the knowledge and error that are contrary to one another: rather we have universal knowledge but make a mistake in regard to the particular. Similarly in the cases stated above. The error in respect of the middle term is not contrary to the knowledge obtained through the deduction, nor is the belief in respect of the middle terms. Nothing prevents a man who knows both that A belongs to the whole of B, and that B again belongs to C, thinking that A does not belong to C, e.g. knowing that every mule is sterile and that this is a mule, and thinking that this animal is with foal; for he does not know that A belongs to C, unless he considers the two things together. So it is evident that if he knows the one and does not know the other, he will fall into error. And this is the relation of universal knowledge to particular. For we know no sensible thing, once it has passed beyond the range of our senses, even if we happen 67b1
to have perceived it, except by means of the universal and by possessing (but not actualising) particular. For knowing is spoken of in three ways: it may be either universal knowledge or knowledge proper to the matter in hand or actualising such knowledge; consequently three kinds of error also are possible. Nothing then prevents a man both knowing and being mistaken about the same thing, provided that his knowledge and his error are not contrary. And this happens also to the man

[23]See Plato, *Meno* 81B-86B.

who knows each proposition separately and who has not previously considered the particular question. For when he believes that the mule is with foal he does not have knowledge actualised, nor on the other hand has his belief caused an error contrary to his knowledge; for the error contrary to the universal knowledge would be a deduction.

But he who believes the essence of good is the essence of bad will believe the same thing to be the essence of good and the essence of bad. Let *A* stand for the essence of good and *B* for the essence of bad, and again *C* for the essence of good. Since then he believes *B* and *C* identical, he will believe that *C* is *B*, and similarly that *B* is *A*; consequently that *C* is *A*. For just as we saw that if *B* is true of all of which *C* is true, and *A* is true of all of which *B* is true, and *A* is true of all of which *B* is true, *A* is true of *C*, similarly with believing. Similarly also with being; for we saw that if *C* is the same as *B*, and *B* as *A*, *C* is the same as *A*. Similarly therefore with opining. Perhaps then this is necessary if a man will grant the first point. But presumably that is false, that any one could think the essence of good to be the essence of bad (save accidentally—for it is possible to believe this in many different ways). But we must consider this matter better.

22 · Whenever the extremes are convertible it is necessary that the middle should be convertible with both. For if *A* belongs to *C* through *B*, then if *A* and *C* are convertible and *C* belongs to everything to which *A* belongs, *B* is convertible with *A*, and *B* belongs to everything to which *A* belongs, through *C* as middle; and *C* is convertible with *B* through *A* as middle. Similarly in the negative case, e.g. if *B* belongs to *C*, but *A* does not belong to *B*, neither will *A* belong to *C*. If then *B* is convertible with *A*, *C* will be convertible with *A*. Suppose *B* does not belong to *A*; neither then will *C*; for *ex hypothesi* *B* belonged to every *C*. And if *C* is convertible with *B*, *A* is convertible with it too; for *C* is said of that of all of which *B* is said. And if *C* is convertible in relation to *A* as well, *B* also will be convertible. For *C* belongs to that to which *B* belongs; but *C* does not belong to that to which *A* belongs. And this alone starts from the conclusion: the others differ here from the affirmative deduction.

Again if *A* and *B* are convertible, and similarly *C* and *D*, and if *A* or *C* must belong to anything whatever, then *B* and *D* will be such that one or other belongs to anything whatever. For since *B* belongs to that to which *A* belongs, and *D* belongs to that to which *C* belongs, and since *A* or *C* belongs to everything, but not together, it is clear that *B* or *D* belongs to everything, but not together. For two deductions have been put together. Again if *A* or *B* belongs to everything and if *C* or *D* belongs to everything, but they do not belong together, then when *A* and *C* are convertible *B* and *D* are convertible. For if *B* does not belong to something to which *D* belongs, it is clear that *A* belongs to it. But if *A* then *C*; for they are convertible. Therefore *C* and *D* belong together. But this is impossible. For example if that which is uncreated is incorruptible and that which is incorruptible is uncreated, it is necessary that what is created should be corruptible and what is corruptible should have been created.[24]

[24]In the manuscripts, this sentence appears after 'not together', line 8: it was transposed by Pacius.

When A belongs to the whole of B and to C and is affirmed of nothing else, and B also belongs to every C, it is necessary that A and B should be convertible; for since A is said of B and C only, and B is affirmed both of itself and of C, it is clear that B will be said of everything of which A is said, except A itself. Again when A and B belong to the whole of C, and C is convertible with B, it is necessary that A should belong to every B; for since A belongs to every C, and C to B by conversion, A will belong to every B.

When, of two opposites A and B, A is preferable to B, and similarly D is preferable to C, then if A and C together are preferable to B and D together, A is preferable to D. For A is as much to be pursued as B is to be avoided, since they are opposites; and C is similarly related to D, since they also are opposites. If then A is as desirable as D, B is as much to be avoided as C (since each is to the same extent as each—the one an object of aversion, the other an object of desire). Therefore A and C together will be as much to be desired or avoided as B and D together. But since A and C are preferable to B and D, A cannot be as desirable as D; for then B along with D would be as desirable as A along with C. But if D is preferable to A, then B must be less to be avoided than C; for the less is opposed to the less. But the greater good and lesser evil are preferable to the lesser good and greater evil: the whole BD, then, is preferable to the whole AC. But *ex hypothesi* this is not so. A then is preferable to D, and C consequently is less to be avoided than B. If then every lover in virtue of his love would prefer A, viz. that the beloved should be such as to grant a favour, and yet should not grant it (for which C stands), to the beloved's granting the favour (represented by D) without being such as to grant it (represented by B), it is clear that A (being of such a nature) is preferable to granting the favour. To receive affection then is preferable in love to sexual intercourse. Love then aims at affection rather than at intercourse. And if it aims most at affection, then this is its end. Intercourse then either is not an end at all or is an end relative to the receiving of affection. And indeed the same is true of the other desires and arts.

23

· It is clear then how the terms are related in conversion, and in respect of being preferable or more to be avoided. We must now state that not only dialectical and demonstrative deductions are formed by means of the aforesaid figures, but also rhetorical deductions and in general any form of persuasion, however it may be presented. For every belief comes either through deduction or from induction.

Now induction, or rather the deduction which springs out of induction, consists in deducing a relation between one extreme and the middle by means of the other extreme, e.g. if B is the middle term between A and C, it consists in proving through C that A belongs to B. For this is the manner in which we make inductions. For example, let A stand for long-liver, B for bileless, and C for the particular long-lived animals, e.g. man, horse, mule. A then belongs to the whole of C; [for whatever is bileless is long-lived].[25] But B also (not possessing bile) belongs to every C. If then C is convertible with B, and the middle term is not wider in extension, it is necessary that A should belong to B. For it has already been proved that if two things belong to

[25]Tredennick suggests this excision: Ross changes 'whatever is bileless' to 'C'.

the same thing, and the extreme is convertible with one of them, then the other predicate will belong to one that is converted. But we must apprehend *C* as made up of all the particulars. For induction proceeds through an enumeration of all the cases.

Such is the deduction which establishes primary and immediate propositions; for where there is a middle term the deduction proceeds through the middle term; when there is no middle term, through induction. And in a way induction is opposed to deduction; for the latter proves the extreme to belong to the third term by means of the middle, the former proves the extreme to belong to the middle by means of the third. In the order of nature, deduction through the middle term is prior and more familiar, but deduction through induction is clearer to *us*.

24 · We have an example when the extreme is proved to belong to the middle by means of a term which resembles the third. It must be familiar both that the middle belongs to the third term, and that the first belongs to that which resembles the third. For example let *A* be evil, *B* making war against neighbours, *C* Athenians against Thebans, *D* Thebans against Phocians. If then we wish to prove that to fight with the Thebans is an evil, we must assume that to fight against neighbours is an evil. Conviction of this is obtained from similar cases, e.g. that the war against the Phocians was an evil to the Thebans. Since then to fight against neighbours is an evil, and to fight against the Thebans is to fight against neighbours, it is clear that to fight against the Thebans is an evil. Now it is clear that *B* belongs to *C* and to *D* (for both are cases of making war upon one's neighbours) and that *A* belongs to *D* (for the war against the Phocians did not turn out well for the Thebans); but that *A* belongs to *B* will be proved through *D*. Similarly if the conviction in the relation of the middle term to the extreme should be produced by several similar cases. Clearly then an example stands neither as part to whole, nor as whole to part, but rather as part to part, when both are subordinate to the same term, and one of them is familiar. It differs from induction, because induction starting from all the particular cases proves (as we saw) that the extreme belongs to the middle, and does not connect the deduction to the extreme, whereas argument by example does make this connexion and does not draw its proof from all the particular cases.

25 · By reduction we mean an argument in which the first term clearly belongs to the middle, but the relation of the middle to the last term is uncertain though equally or more convincing than the conclusion; or again an argument in which the terms intermediate between the last term and the middle are few. For in any of these cases it turns out that we approach more nearly to knowledge. For example let *A* stand for what can be taught, *B* for knowledge, *C* for justice. Now it is clear that knowledge can be taught; but it is uncertain whether virtue is knowledge. If now *BC* is equally or more convincing than *AC*, we have a reduction; for we are nearer to knowledge, since we have made an extra assumption, being before without

knowledge that A belongs to C.[26] Or again suppose that the terms intermediate between B and C are few; for thus too we are nearer knowledge. For example let D stand for squaring, E for rectilinear figure, F for circle. If there were only one term intermediate between E and F (viz. that the circle is made equal to a rectilinear figure by the help of lunules), we should be near to knowledge. But when BC is not more convincing than AC, and the intermediate terms are not few, I do not call this reduction; nor again when BC is immediate—for such a statement is knowledge.

26 · An objection is a proposition contrary to a proposition. It differs from a proposition, because it may be particular, but a proposition either cannot be particular at all or not in universal deductions. An objection is brought in two ways and through two figures; in two ways because every objection is either universal or particular, by two figures because objections are brought in opposition to the proposition, and opposites can be proved only in the first and third figures. When a man claims that something belongs to all of a given subject, we object either that it belongs to none or that it does not belong to some; and of these, the former is proved from the first figure, the latter from the third. For example let A stand for there being a single science, B for contraries. If a man proposes that contraries are subjects of a single science, the objection may be either that opposites are never subjects of a single science, and contraries are opposites, so that we get the first figure; or that the knowable and the unknowable are not subjects of a single science—this is the third figure; for it is true of C (the knowable and the unknowable) that they are contraries, and it is false that they are the subjects of a single science.

Similarly if the proposition is negative. For if a man claims that contraries are not subjects of a single science, we reply either that all opposites or that certain contraries, e.g. what is healthy and what is sickly, are subjects of the same science: the former argument issues from the first, the latter from the third figure.

In general, in all cases if a man urges a universal objection he must frame his contradiction with reference to the universal of the terms proposed, e.g. if a man claims that contraries are not subjects of the same science, his opponent must reply that there is a single science of all opposites. Thus we must have the first figure; for the term which is universal relative to the original subject becomes the middle term.

If the objection is particular, the objector must frame his contradiction with reference to a term relatively to which the subject of the proposition is universal, e.g. he will point out that the knowable and the unknowable are not subjects of the same science; for contraries are universal relatively to these. And we have the third figure; for the particular term assumed is middle, e.g. the knowable and the unknowable. Premisses from which it is possible to draw the contrary conclusion are what we start from when we try to make objections. Consequently we bring objections in these figures only; for in them only are opposite deductions possible, since the second figure cannot produce an affirmative conclusion.

[26] Reading προσειληφέναι, τὴν ΑΓ.

Besides, an objection in the middle figure would require a fuller argument, e.g. if it should not be granted that *A* belongs to *B*, because *C* does not follow *B*. This can be made clear only by other propositions. But an objection ought not to turn off into other things, but have its other proposition quite clear immediately. [For this reason also this is the only figure from which proof by signs cannot be obtained.][27]

We must consider too the other kinds of objection, namely the objection from contraries, from similars, and from common opinion, and inquire whether a particular objection cannot be elicited from the first figure or a negative objection from the second.[28]

27 · A probability and a sign are not identical, but a probability is a reputable proposition: what men know to happen or not to happen, to be or not to be, for the most part thus and thus, is a probability, e.g. envious men hate, those who are loved show affection. A sign is meant to be a demonstrative proposition either necessary or reputable; for anything such that when it is another thing is, or when it has come into being the other has come into being before or after, is a sign of the other's being or having come into being. An enthymeme is a deduction starting from probabilities or signs,[29] and a sign may be taken in three ways, corresponding to the position of the middle term in the figures. For it may be taken as in the first figure or the second or the third. For example the proof that a woman is with child because she has milk is in the first figure: for to have milk is the middle term. Let *A* represent to be with child, *B* to have milk, *C* woman. The proof that wise men are good, since Pittacus is good, comes through the last figure. Let *A* stand for good, *B* for wise men, *C* for Pittacus. It is true then to predicate both *A* and *B* of *C*—only men do not say the latter, because they know it, though they state the former. The proof that a woman is with child because she is pale is meant to come through the middle figure; for since paleness follows women with child and is a concomitant of this woman, people suppose it has been proved that she is with child. Let *A* stand for paleness, *B* for being with child, *C* for woman.

Now if the one proposition is stated, we have only a sign, but if the other is stated as well, a deduction, e.g. Pittacus is generous; for ambitious men are generous and Pittacus is ambitious. Or again: Wise men are good; for Pittacus is not only good but wise. In this way then deductions are formed, only that which proceeds through the first figure is irrefutable if it is true (for it is universal), that which proceeds through the last figure is refutable even if the conclusion is true, since the deduction is not universal nor relevant to the matter in question; for though Pittacus is good, it is not therefore necessary that all other wise men should be good. But the deduction which proceeds through the middle figure is always refutable in any case; for a deduction can never be formed when the terms are related in this way; for though a woman with child is pale, and this woman also is pale, it is not necessary that she should be with child. Truth then may be found in signs whatever their kind, but they have the differences we have stated.

[27]Excised by Ross.

[28]Some of these matters are considered in *Rhetoric* II 25.

[29]This sentence is transposed to the start of the chapter by Ross.

We must either divide signs in the way stated, and among them designate the middle term as the evidence (for people call that the evidence which makes us know, and the middle term above all has this character), or else we must call the arguments derived from the extremes signs, that derived from the middle term the evidence; for that which is proved through the first figure is most reputable and most true.

It is possible to infer character from physical features, if it is granted that the body and the soul are changed together by the natural affections (No doubt by learning music a man has made some change in his soul, but this is not one of those affections which are natural to us; but rather such natural motions as anger and desire.) If then this were granted and also that there is one sign for one affection, and if we could state the affection and sign proper to each kind of animal, we shall be able to infer character from physical features. For if there is an affection which belongs properly to an individual genus, e.g. courage to lions, it is necessary that there should be a sign of it; for *ex hypothesi* body and soul are affected together. Suppose this sign is the possession of large extremities: this may belong to other genera also though not universally. For the sign is proper in the sense that it is proper to the whole genus, though not proper to it alone, according to our usual manner of speaking. This then will be found in other genera too, and man may be brave, and some other genera of animal as well. They will then have the sign; for *ex hypothesi* there is one sign for one affection. If then this is so, and we can collect signs of this sort in these animals which have only one affection proper to them, and each affection has its sign, since it is necessary that it should have a single sign, we shall then be able to infer character from physical features. But if the genus as a whole has two properties, e.g. if the lion is both brave and generous, how shall we know which of the signs which are its proper concomitants is the sign of which affection? Perhaps if both belong to some other genus though not to the whole of it, and if, in those genera in which each is found though not in the whole of their members, some members possess one of the affections and not the other: e.g. if a man is brave but not generous, but possesses, of the two signs, *this* one, it is clear that this is the sign of courage in the lion also.

To judge character from physical features, then, is possible in the first figure if the middle term is convertible with the first extreme, but is wider than the third term and not convertible with it: e.g. let A stand for courage, B for large extremities, and C for lion. B then belongs to everything to which C belongs, but also to others. But A belongs to everything to which B belongs, and to nothing besides, but is convertible with B: otherwise, there would not be one sign for one affection.

POSTERIOR ANALYTICS

Jonathan Barnes

BOOK I

71a1 1 · All teaching and all intellectual learning come about from already existing knowledge. This is evident if we consider it in every case; for the mathematical sciences are acquired in this fashion, and so is each of the other arts. And similarly too with arguments—both deductive and inductive arguments proceed in this way; for both produce their teaching through what we are already aware of, the former getting their premisses as from men who grasp them, the latter proving the universal through the particular's being clear. (And rhetorical arguments too persuade in the same way; for they do so either through examples, which is induction, or through enthymemes, which is deduction.)

It is necessary to be already aware of things in two ways: of some things it is necessary to believe already that they are, of some one must grasp what the thing said is, and of others both—e.g. of the fact that everything is either affirmed or denied truly, one must believe that it is; of the triangle, that it signifies *this*; and of the unit both (both what it signifies and that it is). For each of these is not equally clear to us.

But you can become familiar by being familiar earlier with some things but getting knowledge of the others at the very same time—i.e. of whatever happens to be under the universal of which you have knowledge. For that every triangle has angles equal to two right angles was already known; but that there is a triangle in the semicircle here became familiar at the same time as the induction. (For in some cases learning occurs in this way, and the last term does not become familiar through the middle—in cases dealing with what are in fact particulars and not said of any underlying subject.)

Before the induction, or before getting a deduction, you should perhaps be said to understand in a way—but in another way not. For if you did not know if it is *simpliciter*, how did you know that it has two right angles *simpliciter*? But it is clear that you understand it in *this* sense—that you understand it universally—but you do not understand it *simpliciter*. (Otherwise the puzzle in the *Meno*[1] will result; for you will learn either nothing or what you know.)

TEXT: W. D. Ross, OCT, Oxford, 1964

[1]See Plato, *Meno* 80D.

For one should not argue in the way in which some people attempt to solve it: Do you or don't you know of every pair that it is even? And when you said Yes, they brought forward some pair of which you did not think that it was, nor therefore that it was even. For they solve it by denying that people know of every pair that it is even, but only of anything of which they know that it is a pair.—Yet they know it of 71b1
that which they have the demonstration about and which they got their premisses about; and they got them not about everything of which they know that it is a triangle or that it is a number, but of every number and triangle *simpliciter*. For no proposition of such a type is assumed (that *what you know to be a number* . . . or *what you know to be rectilineal* . . .), but they are assumed as holding of every case.

But nothing, I think, prevents one from in a sense understanding and in a sense being ignorant of what one is learning; for what is absurd is not that you should know in some sense what you are learning, but that you should know it in *this* sense, i.e. in the way and sense in which you are learning it.

2 · We think we understand a thing *simpliciter* (and not in the sophistic fashion accidentally) whenever we think we are aware both that the explanation because of which the object is is its explanation, and that it is not possible for this to be otherwise. It is clear, then, that to understand is something of this sort; for both those who do not understand and those who do understand—the former think they are themselves in such a state, and those who do understand actually are. Hence that of which there is understanding *simpliciter* cannot be otherwise.

Now whether there is also another type of understanding we shall say later; but we say now that we do know through demonstration. By demonstration I mean a scientific deduction; and by scientific I mean one in virtue of which, by having it, we understand something.

If, then, understanding is as we posited, it is necessary for demonstrative understanding in particular to depend on things which are true and primitive and immediate and more familiar than and prior to and explanatory of the conclusion (for in this way the principles will also be appropriate to what is being proved). For there will be deduction even without these conditions, but there will not be demonstration; for it will not produce understanding.

Now they must be true because one cannot understand what is not the case—e.g. that the diagonal is commensurate. And they must depend on what is primitive and non-demonstrable because otherwise you will not understand if you do not have a demonstration of them; for to understand that of which there is a demonstration non-accidentally is to have a demonstration. They must be both explanatory and more familiar and prior—explanatory because we only understand when we know the explanation; and prior, if they are explanatory, and we are already aware of them not only in the sense of grasping them but also of knowing that they are.

Things are prior and more familiar in two ways; for it is not the same to be prior by nature and prior in relation to us, nor to be more familiar and more familiar 72a1 to us. I call prior and more familiar in relation to us what is nearer to perception, prior and more familiar *simpliciter* what is further away. What is most universal is furthest away, and the particulars are nearest; and these are opposite to each other.

Depending on things that are primitive is depending on appropriate principles; for I call the same thing primitive and a principle. A principle of a demonstration is an immediate proposition, and an immediate proposition is one to which there is no other prior. A proposition is the one part of a contradiction,[2] one thing said of one; it is dialectical if it assumes indifferently either part, demonstrative if it determinately assumes the one that is true.[3] [A statement is either part of a contradiction.][4] A contradiction is an opposition of which of itself excludes any intermediate; and the part of a contradiction saying something *of* something is an affirmation, the one saying something *from* something is a denial.

An immediate deductive principle I call a posit if one cannot prove it but it is not necessary for anyone who is to learn anything to grasp it; and one which it is necessary for anyone who is going to learn anything whatever to grasp, I call an axiom (for there are some such things); for we are accustomed to use this name especially of such things. A posit which assumes either of the parts of a contradiction—i.e., I mean, that something is or that something is not—I call a supposition; one without this, a definition. For a definition is a posit (for the arithmetician posits that a unit is what is quantitatively indivisible) but not a supposition (for what a unit is and that a unit is are not the same).

Since one should both be convinced of and know the object by having a deduction of the sort we call a demonstration, and since this is the case when *these* things on which the deduction depends are the case, it is necessary not only to be already aware of the primitives (either all or some of them) but actually to be better aware of them. For a thing always belongs better to that thing because of which it belongs—e.g. that because of which we love is better loved. Hence if we know and are convinced because of the primitives, we both know and are convinced of them better, since it is because of them that we know and are convinced of what is posterior.

It is not possible to be better convinced than one is of what one knows, of what one in fact neither knows nor is more happily disposed toward than if one in fact knew. But this will result if someone who is convinced because of a demonstration is not already aware of the primitives, for it is necessary to be better convinced of the principles (either all or some of them) than of the conclusion.

Anyone who is going to have understanding through demonstration must not only be familiar with the principles and better convinced of them than of what is
72b1 being proved, but also there must be no other thing more convincing to him or more familiar among the opposites of the principles on which a deduction of the contrary error may depend—if anyone who understands *simpliciter* must be unpersuadable.

[2]Reading *ἀντιφάσεως* for the MSS *ἀποφάνσεως*.
[3]Reading *ὅ τι* for *ὅτι*.
[4]I excise this sentence.

3 · Now some think that because one must understand the primitives there is no understanding at all; others that there is, but that there are demonstrations of everything. Neither of these views is either true or necessary.

For the one party, supposing that one cannot understand in another way,[5] claim that we are led back *ad infinitum* on the grounds that we would not understand what is posterior because of what is prior if there are no primitives; and they argue correctly, for it is impossible to go through infinitely many things. And if it comes to a stop and there are principles, they say that these are unknowable since there is no *demonstration* of them, which alone they say is understanding; but if one cannot know the primitives, neither can what depends on them be understood *simpliciter* or properly, but only on the supposition that they are the case.

The other party agrees about understanding; for it, they say, occurs only through demonstration. But they argue that nothing prevents there being demonstration of everything; for it is possible for the demonstration to come about in a circle and reciprocally.

But *we* say that neither is all understanding demonstrative, but in the case of the immediates it is non-demonstrable—and that this is necessary is evident; for if it is necessary to understand the things which are prior and on which the demonstration depends, and it comes to a stop at some time, it is necessary for these immediates to be non-demonstrable. So as to that we argue thus; and we also say that there is not only understanding but also some principle of understanding by which we become familiar with the definitions.

And that it is impossible to demonstrate *simpliciter* in a circle is clear, if demonstration must depend on what is prior and more familiar; for it is impossible for the same things at the same time to be prior and posterior to the same things—unless one is so in another way (i.e. one in relation to us, the other *simpliciter*), which induction makes familiar. But if so, knowing *simpliciter* will not have been properly defined, but will be twofold. Or is the other demonstration not demonstration *simpliciter* in that it comes from about what is more familiar *to us*?

There results for those who say that demonstration is circular not only what has just been described, but also that they say nothing other than that this is the case if this is the case—and it is easy to prove everything in this way. It is clear that this results if we posit three terms. (For it makes no difference to say that it bends back through many terms or through few, or through few or two.) For whenever if A is the case, of necessity B is, and if this then C, then if A is the case C will be the case. Thus given that if A is the case it is necessary that B is, and if this is that A is (for that is what being circular is)—let A be C: so to say that if B is the case A is, is to say that C is, and this implies that if A is the case C is. But C is the same as A. Hence it results that those who assert that demonstration is circular say nothing but that if A is the case A is the case. And it is easy to prove everything in this way.

Moreover, not even this is possible except in the case of things which follow one another, as properties do. Now if a single thing is laid down, it has been proved[6] that

[5]Reading ἄλλως for ὅλως.
[6]*Prior Analytics* I 25, 41b36–42a40.

it is never necessary that anything else should be the case (by a single thing I mean that neither if one term nor if one posit is posited . . .), but two posits are the first and fewest from which it is possible, if at all, actually to deduce something. Now if *A* follows *B* and *C*, and these follow one another and *A*, in this way it is possible to prove all the postulates reciprocally in the first figure, as was proved in the account of deduction.[7] (And it was also proved that in the other figures either no deduction comes about or none about what was assumed.) But one cannot in any way prove circularly things which are not counterpredicated; hence, since there are few such things in demonstrations, it is evident that it is both empty and impossible to say that demonstration is reciprocal and that because of this there can be demonstration of everything.

4 · Since it is impossible for that of which there is understanding *simpliciter* to be otherwise, what is understandable in virtue of demonstrative understanding will be necessary (it is demonstrative if we have it by having a demonstration). Demonstration, therefore, is deduction from what is necessary. We must therefore grasp on what things and what sort of things demonstrations depend. And first let us define what we mean by holding of every case and what by in itself and what by universally.

Now I say that something holds of every case if it does not hold in some cases and not others, nor at some times and not at others; e.g. if animal holds of every man, then if it is true to call this a man, it is true to call him an animal too; and if he is now the one, he is the other too; and the same goes if there is a point in every line. Evidence: when asked if something holds of every case, we bring our objections in this way—either if in some cases it does not hold or if at some time it does not.

One thing belongs to another in itself both if it belongs to it in what it is—e.g. line to triangle and point to line (for their substance depends on these and they belong in the account which says what they are)—and also if the things it belongs to themselves belong in the account which makes clear what it is—e.g. straight belongs to line and so does curved, and odd and even to number, and prime and composite, and equilateral and oblong; and for all these there belongs in the account which says what they are in the one case line, and in the others number. And similarly in other cases too it is such things that I say belong to something in itself; and what belongs in neither way I call accidental, e.g. musical or white to animal.

Again, what is not said of some other underlying subject—as what is walking is something different walking (and white),[8] while a substance, and whatever signifies some 'this,' is just what it is without being something else. Thus things which are not said of an underlying subject I call things in themselves, and those which are said of an underlying subject I call accidentals.

Again, in another way what belongs to something because of itself belongs to it in itself, and what does not belong because of itself is accidental—e.g. if it lightened when he was walking, that was accidental; for it was not because of his walking that

[7] *Prior Analytics* II 5–7.
[8] Reading λευκόν with most MSS., for Ross's τὸ λευκὸν ⟨λευκόν⟩.

it lightened, but that, we say, was accidental. But if because of itself, then in itself—e.g. if something died while being sacrificed, it died *in* the sacrifice since it died because of being sacrificed, and it was not accidental that it died while being sacrificed.

Whatever, therefore, in the case of what is understandable *simpliciter*, is said to belong to things in themselves in the sense of inhering in the predicates or of being inhered in, holds both because of themselves and from necessity. For it is not possible for them not to belong, either *simpliciter* or as regards the opposites—e.g. straight or crooked to line, and odd or even to number. For the contrary is either a privation or a contradiction in the same genus—e.g. even is what is not odd among numbers, in so far as it follows. Hence if it is necessary to affirm or deny, it is necessary too for what belongs in itself to belong.

Now let holding of every case and in itself be defined in this fashion; I call universal whatever belongs to something both of every case and in itself and as such. It is evident, therefore, that whatever is universal belongs from necessity to its objects. (To belong in itself and as such are the same thing—e.g. point and straight belong to line in itself (for they belong to it as line), and two right angles belong to triangle as triangle (for the triangle is in itself equal to two right angles).)

Something holds universally whenever it is proved of a chance case and primitively; e.g. having two right angles neither holds universally of figure (yet one may prove of a figure that it has two right angles—but not of a chance figure, nor does one use a chance figure in proving it; for the quadrangle is a figure but it does not have angles equal to two right angles)—and a chance isosceles does have angles equal to two right angles, but not primitively—the triangle is prior. If, then, a chance case is proved primitively to have two right angles or whatever else, it belongs universally to this primitively, and of this the demonstration holds universally in itself; but of the others it holds in some fashion not in itself, nor does it hold of the isosceles universally, but with a wider extension.

5 · It must not escape our notice that it often happens that we make mistakes and that what is being proved does not belong primitively and universally in the way in which it seems to be being proved universally and primitively. We make this error when either we cannot grasp anything higher apart from the particular, or we can but it is nameless for objects different in sort, or that of which it is proved is in fact a whole which is a part of something else. (For the demonstration will hold for the parts and it will hold of every case, but nevertheless the demonstration will not hold of this primitively and universally—I say a demonstration is of this primitively and as such when it is of it primitively and universally.)

Now if someone were to prove that right angles do not meet, the demonstration would seem to hold of this because of its holding of all right angles. But that is not so, if it comes about not because they are equal in *this* way but in so far as they are equal in any way at all.

And if there were no triangles other than the isosceles, having two right angles would seem to belong to it as isosceles.

And it might seem that proportion alternates for things as numbers and as lines and as solids and as times—as once it used to be proved separately, though it is possible for it to be proved of all cases by a single demonstration. But because all these things—numbers, lengths, times, solids—do not constitute a single named item and differ in sort from one another, it used to be taken separately. But now it is proved universally; for it did not belong to things as lines or as numbers, but as *this* which they suppose to belong universally.

For this reason, even if you prove of each triangle either by one or by different demonstrations that each has two right angles—separately of the equilateral and the scalene and the isosceles—you do not yet know of the triangle that it has two right angles, except in the sophistic fashion, nor do you know it of triangle universally,[9] not even if there is no other triangle apart from these. For you do not know it of the triangle as triangle, nor even of every triangle (except in respect of number; but not of every one in respect of sort, even if there is none of which you do not know it.)

So when do you not know universally, and when do you know *simpliciter*? Well, clearly you would know *simpliciter* if it were the same thing to be a triangle and to be equilateral (either for each or for all). But if it is not the same but different, and it belongs as triangle, you do not know. Does it belong as triangle or as isosceles? And when does it belong in virtue of this as primitive? And of what does the demonstration hold universally? Clearly whenever after abstraction it belongs primitively—e.g. two right angles will belong to bronze isosceles triangle, but also when being bronze and being isosceles have been abstracted. But not when figure or limit have been. But they are not the first. Then what is first? If triangle, it is in virtue of this that it also belongs to the others, and it is of this that the demonstration holds universally.

6 · Now if demonstrative understanding depends on necessary principles (for what one understands cannot be otherwise), and what belongs to the objects in themselves is necessary (for in the one case it belongs in what they are; and in the other they belong in what they are to what is predicated of them, one of which opposites necessarily belongs), it is evident that demonstrative deduction will depend on things of this sort; for everything belongs either in this way or accidentally, and what is accidental is not necessary.

Thus we must either argue like this, or, positing as a principle that demonstration is necessary[10] and that if something has been demonstrated it cannot be otherwise—the deduction, therefore, must depend on necessities. For from truths one can deduce *without* demonstrating, but from necessities one cannot deduce without demonstrating; for this is precisely the mark of demonstration.

There is evidence that demonstration depends on necessities in the fact that this is how we bring our objections against those who think they are demonstrating—saying that it is not necessary, if we think either that it is absolutely possible for it to be otherwise, or at least for the sake of argument.

[9]Reading καθόλου τρίγωνον with most MSS., for Ross's καθ' ὅλου τριγώνου.
[10]Retaining ἀναγκαῖον with the MSS., for Ross's ἀναγκαίου.

From this it is clear too that those people are silly who think they get their principles correctly if the proposition is reputable and true (e.g. the sophists who assume that to understand is to have understanding). For it is not what is reputable or not[11] that is a principle, but what is primitive in the genus about which the proof is; and not every truth is appropriate.

That the deduction must depend on necessities is evident from this too: if, when there is a demonstration, a man who has not got an account of the reason why does not have understanding, and if it might be that *A* belongs to *C* from necessity but that *B*, the middle term through which it was demonstrated, does not hold from necessity, then he does not know the reason why. For this is not so because of the middle term; for it is possible for that not to be the case, whereas the conclusion is necessary.

Again, if someone does not know now, though he has got the account and is preserved, and the object is preserved, and he has not forgotten, then he did not know earlier either. But the middle term might perish if it is not necessary; so that though, being himself preserved and the object preserved, he will have the account, yet he does not know. Therefore, he did not know earlier either. And if it has not perished but it is possible for it to perish, the result would be capable of occurring and possible; but it is impossible to know when in such a state.

Now when the conclusion is from necessity, nothing prevents the middle term through which it was proved from being non-necessary; for one can deduce a necessity from a non-necessity, just as one can deduce a truth from non-truths. But when the middle term is from necessity, the conclusion too is from necessity, just as from truths it is always true; for let *A* be said of *B* from necessity, and this of *C*—then that *A* belongs to *C* is also necessary. But when the conclusion is not necessary, the middle term cannot be necessary either; for let *A* belong to *C* not from necessity, but to *B* and this to *C* from necessity—therefore *A* will belong to *C* from necessity too; but it was supposed not to.

Since, then, if a man understands demonstratively, it must belong from necessity, it is clear that he must have his demonstration through a middle term that is necessary too; or else he will not understand either why or that it is necessary for that to be the case, but either he will think but not know it (if he believes to be necessary what is not necessary) or he will not even think it (equally whether he knows the fact through middle terms or the reason why actually through immediates).

Of accidentals which do not belong to things in themselves in the way in which things belonging in themselves were defined, there is no demonstrative understanding. For one cannot prove the conclusion from necessity; for it is possible for what is accidental not to belong—for that is the sort of accidental I am talking about. Yet one might perhaps puzzle about what aim we should have in asking these questions about them, if it is not necessary for the conclusion to be the case; for it makes no difference if one asks chance questions and then says the conclusion. But we must ask not as though the conclusion were necessary because of what was asked, but

[11] Reading ἢ μή, with most MSS., for Ross's ἡμῖν.

because it is necessary for anyone who says them to say it, and to say it truly if they truly hold.

Since in each kind what belongs to something in itself and as such belongs to it from necessity, it is evident that scientific demonstrations are about what belongs to things in themselves, and depend on such things. For what is accidental is not necessary, so that you do not necessarily know why the conclusion holds—not even if it should always be the case but not in itself (e.g. deductions through signs). For you will not understand in itself something that holds in itself; nor will you understand why it holds. (To understand why is to understand through the explanation.) Therefore the middle term must belong to the third, and the first to the middle, because of itself.

7 · One cannot, therefore, prove anything by crossing from another genus—e.g. something geometrical by arithmetic. For there are three things in demonstrations: one, what is being demonstrated, the conclusion (this is what belongs to some genus in itself); one, the axioms (axioms are the things on which the demonstration depends); third, the underlying genus of which the demonstration makes clear the attributes and what is accidental to it in itself.

Now the things on which the demonstration depends may be the same; but of things whose genus is different—as arithmetic and geometry, one cannot apply arithmetical demonstrations to the accidentals of magnitudes, unless magnitudes are numbers. (How this is possible in some cases will be said later.)[12]

Arithmetical demonstrations always include the genus about which the demonstration is, and so also do the others; hence it is necessary for the genus to be the same, either *simpliciter* or in some respect, if the demonstration is going to cross. That it is impossible otherwise is clear; for it is necessary for the extreme and the middle terms to come from the same genus. For if they do not belong in themselves, they will be accidentals.

For this reason one cannot prove by geometry that there is a single science of opposites, nor even that two cubes make a cube; nor can one prove by any other science the theorems of a different one, except such as are so related to one another that the one is under the other—e.g. optics to geometry and harmonics to arithmetic. Nor can one prove by geometry anything that belongs to lines not as lines and as from their proper principles—e.g. whether the straight line is the most beautiful of lines or whether it is contrarily related to the circumference; for that belongs to them not as their proper genus but as something common.

8 · It is evident too that, if the propositions on which the deduction depends are universal, it is necessary for the conclusion of such a demonstration and of a demonstration *simpliciter* to be eternal too. There is therefore no demonstration of perishable things, nor understanding of them *simpliciter* but only accidentally, because it does not hold of it universally, but at some time and in some way.

[12] See esp. $78^{b}34$–$79^{a}16$.

And when there is such a demonstration it is necessary for the one proposition to be non-universal and perishable—perishable because when it is the case the conclusion too will be the case, and non-universal because its subjects will sometimes be and sometimes not be[13]—so that one cannot deduce universally, but only that it holds now.

The same goes for definitions too, since a definition is either a principle of demonstration or a demonstration differing in position or a sort of conclusion of a demonstration.

Demonstrations and sciences of things that come about often—e.g. eclipses of the moon—clearly hold always in so far as they are of such-and-such a thing, but are particular in so far as they do not hold always. As with the eclipse, so in the other cases.

9 · Since it is evident that one cannot demonstrate anything except from its own principles if what is being proved belongs to it as that thing, understanding is not this—if a thing is proved from what is true and non-demonstrable and immediate. (For one can conduct a proof in this way—as Bryson proved the squaring of the circle.) For such arguments prove in virtue of a common feature which will also belong to something else; that is why the arguments also apply to other things not of the same kind. So you do not understand it as that thing but accidentally; for otherwise the demonstration would not apply to another genus too.

We understand a thing non-accidentally when we know it in virtue of that in virtue of which it belongs, from the principles of that thing as that thing—e.g. we understand having angles equal to two right angles when we know it in virtue of that to which what has been said belongs in itself, from the principles of that thing. Hence if that too belongs in itself to what it belongs to, it is necessary for the middle to be in the same genus.

If this is not so, then the theorems are proved as harmonical theorems are proved through arithmetic. Such things are proved in the same way, but they differ; for the fact falls under a different science (for the underlying genus is different), but the reason under the higher science under which fall the attributes that belong in themselves. Hence from this too it is evident that one cannot demonstrate anything *simpliciter* except from its own principles. But the principles of these sciences have the common feature.

If this is evident, it is evident too that one cannot demonstrate the proper principles of anything; for those will be principles of everything, and understanding of them will be sovereign over everything. For you understand better if you know from the higher explanations; for you know from what is prior when you know from unexplainable explanations. Hence if you know better and best, that understanding too will be better and best. But demonstration does not apply to another genus—except, as has been said, geometrical demonstrations apply to mechanical or optical demonstrations, and arithmetical to harmonical.

[13]Reading ὅτε μὲν ἔσται ὅτε δ'οὐκ ἔσται τὰ ἐφ' ὧν.

It is difficult to be aware of whether one knows or not. For it is difficult to be aware of whether we know from the principles of a thing or not—and that is what knowing is. We think we understand if we have a deduction from some true and primitive propositions. But that is not so, but it must be of the same genus as the primitives.

10 · I call principles in each genus those which it is not possible to prove to be. Now both what the primitives and what the things dependent on them signify is assumed; but that they are must be assumed for the principles and proved for the rest—e.g. we must assume what a unit or what straight and triangle signify, and that the unit and magnitude are; but we must prove that the others are.

Of the things they use in the demonstrative sciences some are proper to each science and others common—but common by analogy, since things are *useful* in so far as they bear on the genus under the science. Proper: e.g. that a line is *such and such*, and straight so and so; common: e.g. that if equals are taken from equals, the remainders are equal. But each of these is sufficient in so far as it bears on the genus; for it will produce the same result even if it is not assumed as holding of everything but only for the case of magnitudes—or, for the arithmetician, for numbers.

Proper too are the things which are assumed to be, about which the science considers what belongs to them in themselves—as e.g. arithmetic is about units, and geometry is about points and lines. For they assume these to be and to be *this*. As to what are attributes of these in themselves, they assume what each signifies—e.g. arithmetic assumes what odd or even or quadrangle or cube signifies, and geometry what irrational or inflection or verging signifies and they prove that they are, through the common items and from what has been demonstrated. And astronomy proceeds in the same way.

For every demonstrative science has to do with three things: what it posits to be (these form the genus of what it considers the attributes that belong to it in itself); and what are called the common axioms, the primitives from which it demonstrates. and thirdly the attributes, of which it assumes what each signifies. Nothing, however, prevents some sciences from overlooking some of these—e.g. from not supposing that its genus is, if it is evident that it is (for it is not equally clear that number is and that hot and cold are), and from not assuming what the attributes signify, if they are clear—just as in the case of the common items it does not assume what to take equals from equals signifies, because it is familiar. But none the less there are by nature these three things, that about which the science proves, what it proves, and the things from which it proves.

What necessarily is the case because of itself and necessarily seems to be the case is not a supposition or a postulate. For demonstration is not addressed to external argument—but to argument in the soul—since deduction is not either. For one can always object to external argument, but not always to internal argument.

Whatever a man assumes without proving it himself although it is provable—if he assumes something that seems to be the case to the learner, he supposes it (and it is a supposition not *simpliciter* but only in relation to the learner); but if he assumes the same thing when there is either no opinion present in the learner or actually a contrary one present, he postulates it. And it is in this that suppositions and postulates differ; for a postulate is what is contrary to the opinion of the learner, which[14] though it is demonstrable is assumed and used without being proved.

Now terms are not suppositions (for they are not said to be or not be anything),[15] but suppositions are among the propositions, whereas one need only grasp the terms; and suppositions are not that (unless someone will say that hearing is a supposition), but rather propositions such that, if they are the case, then by their being the case the conclusion comes about.

Nor does the geometer suppose falsehoods, as some have said, stating that one should not use a falsehood but that the geometer speaks falsely when he says that the line which is not a foot long is a foot long or that the drawn line which is not straight is straight. But the geometer does not conclude anything from there being this line which he himself has described, but from what is made clear through them.

Again, every postulate and supposition is either universal or particular; but terms are neither of these.

11 · For there to be forms or some one thing apart from the many is not necessary if there is to be demonstration; however, for it to be true to say that one thing holds of many is necessary. For there will be no universal if this is not the case; and if there is no universal, there will be no middle term, and so no demonstration either. There must, therefore, be some one and the same thing, non-homonymous, holding of several cases.

That it is not possible to affirm and deny at the same time is assumed by no demonstration—unless the conclusion too is to be proved in this form. It is proved by assuming that the first term is true of the middle and that it is not true to deny it. It makes no difference if one assumes that the middle term is and is not; and the same holds of the third term too. For if it is granted that that of which it is true to say man, even if not-man is also true of it—but provided only that it is true to say that a[16] man is an animal and not not an animal—for[17] it will be true to say that Callias, even if not Callias, is nevertheless an animal and not not an animal. The explanation is that the first term is said not only of the middle but also of something else, because it holds of several cases; so that even if the middle both is it and is not it, that makes no difference with regard to the conclusion.

That everything is affirmed or denied truly is assumed by demonstration *per impossibile*, and that not always universally but as far as is sufficient in so far as it bears on the genus (I say on the genus—i.e. the genus about which one is bringing the demonstrations), as has been said earlier too.

[14]Omitting ἤ.
[15]Reading λέγονται with the MSS., for Ross's λέγεται.
[16]Omitting πᾶν.
[17]Retaining γάρ.

All the sciences associate with one another in respect of the common items (I call common those which they use as demonstrating from them—not those about which they prove nor what they prove); and dialectic associates with them all, and so would any science that attempted to prove universally the common items—e.g. that everything is affirmed or denied, or that equals from equals leave equals, or any things of the sort. But dialectic is not in this way concerned with any determined set of things, nor with any one genus. For then it would not ask questions; for one cannot ask questions when demonstrating because when opposites are the case the same thing is not proved. This has been proved in the account of dedication.[18]

12 · If a deductive question and a proposition of a contradiction are the same thing, and there are propositions in each science on which the deductions in each depend, then there will be a sort of scientific question from which the deduction appropriate to each science comes about. It is clear, therefore, that not every question will be geometrical (or medical—and similarly in the other cases too), but only those from which either there is proved one of the things about which
77b1 geometry is concerned, or[19] something which is proved from the same things as geometry, such as optical matters. And similarly in the other cases too.

And for those one should indeed supply an argument from the principles and conclusions of geometry; but for the principles, the geometer as geometer should not supply an argument; and similarly for the other sciences too. We should not, therefore, ask each scientist every question, nor should he answer everything he is asked about anything, but only those determined by the scope of this science. If one argues in this way with a geometer as geometer it is evident that one will do so correctly, if one proves something from these things; but otherwise, not correctly. And it is clear that one does not refute the geometer either, except incidentally; so that one should not argue about geometry among non-geometers—for the man who argues badly will escape notice. And the same goes for the other sciences too.

Since there are geometrical questions, are there also nongeometrical ones? And in each science which sort of ignorance is it in regard to which they are, say, geometrical? And is a deduction of ignorance a deduction from the opposites (or a paralogism, though a geometrical one)? Or is it a deduction from another art? e.g. a musical question is non-geometrical about geometry, but thinking that parallels meet is geometrical in a sense and non-geometrical in another way. For this is twofold (like being non-rhythmical), and one way of being non-geometrical is by not having geometrical skill (like being non-rhythmical) and the other by having it badly; and it is *this* ignorance and ignorance depending on such principles that is contrary to understanding.

In mathematics paralogism does not occur in the same way, because the twofold term is always the middle term; for something is said of all this, and this again is said of all something else (of what is predicated one does not say all), and one can as it were see these by thought, though they escape notice in arguments. Is

[18] *Prior Analytics* II 15.
[19] Reading ὧν ἢ δείκνυται . . . ἢ ἐκ τῶν . . . for ὧν δείκνυται . . . ἢ ἃ ἐκ τῶν . . .

every circle a shape? If you draw one it is clear. Well, is the epic a circle? It is evident that it is not.

One should not bring an objection against it if the proposition is inductive. For just as there is no proposition which does not hold of several cases (for otherwise it will not hold of all cases; but deduction depends on universals), it is clear that there is no objection either. For propositions and objectives are the same thing; for what one brings as an objection might become a proposition, either demonstrative or dialectical.

It happens that some people argue non-deductively because they assume what follows both terms—e.g. Caeneus does when he says that fire consists in multiple analogy,[20] for fire, he says, is generated quickly, and so is this analogy. In this way there is no deduction; but there is if multiple analogy follows fastest analogy and the fastest changing analogy follows fire.

Now sometimes it is not possible to make a deduction from the assumptions; and sometimes it is possible, but it is not seen.

If it were impossible to prove truth from falsehood, it would be easy to make an analysis; for they would convert from necessity. For let *A* be something that is the case; and if this is the case,then *these* are the case (things which I know to be the case, call them *B*). From these, therefore, I shall prove that the former is the case. (In mathematics things convert more because they assume nothing accidental—and in this too they differ from argumentations—but only definitions.)

A science increases not through the middle terms but by additional assumption—e.g. *A* of *B*, this of *C*, this again of *D*, and so on *ad infinitum;* and laterally—e.g. *A* both of *C* and of *E* (e.g. *A* is definite—or even indefinite—number; *B* is definite odd number; *C* odd number; therefore *A* holds of *C*. And *D* is definite even number; *E* is even number: therefore *A* holds of *E*).

13 · Understanding the fact and the reason why differ, first in the same science—and in that in two ways: in one way, if the deduction does not come about through immediates (for the primitive explanation is not assumed, but understanding of the reason why occurs in virtue of the primitive explanation); in another, if it is through immediates but not through the explanation but through the more familiar of the converting terms. For nothing prevents the nonexplanatory one of the counterpredicated terms from sometimes being more familiar, so that the demonstration will occur through this.

E.g. that the planets are near, through their not twinkling: let *C* be the planets, *B* not twinkling, *A* being near. Thus it is true to say *B* of *C*; for the planets do not twinkle. But also to say *A* of *B*; for what does not twinkle is near (let this be got through induction or through perception). So it is necessary that *A* belongs to *C*; so that it has been demonstrated that the planets are near. Now this deduction is not of the reason why but of the fact; for it is not because they do not twinkle that they are near, but because they are near they do not twinkle.

[20]The reference may be to Antiphanes' comedy: see *Poetics* 1457b21.

But it is also possible for the latter to be proved through the former, and the demonstration will be of the reason why—e.g. let C be the planets, B being near, A not twinkling. Thus B belongs to C and A to B; so that A belongs to C. And the deduction is of the reason why; for the primitive explanation has been assumed.

Again, take the way they prove that the moon is spherical through its increases—for if what increases in this way is spherical and the moon increases, it is evident that it is spherical. Now in this way the deduction of the fact comes about; but if the middle term is posited the other way about, we get the deduction of the reason why; for it is not because of the increases that it is spherical, but because it is spherical it gets increases of this sort. Moon, C; spherical, B; increases, A.

But in cases in which the middle terms do not convert and the non-explanatory term is more familiar, the fact is proved but the reason why is not.

Again, in cases in which the middle is positioned outside—for in these too the demonstration is of the fact and not of the reason why; for the explanation is not mentioned. E.g. why does the wall not breathe? Because it is not an animal. For if this were explanatory of breathing—i.e. if the denial is explanatory of something's not belonging, the affirmation is explanatory of its belonging (e.g. if imbalance in the hot and cold elements is explanatory of not being healthy, their balance is explanatory of being healthy), and similarly too if the affirmation is explanatory of something's belonging, the denial is of its not belonging. But when things are set out in this way what we have said does not result; for not every animal breathes. The deduction of such an explanation comes about in the middle figure. E.g. let A be animal, B breathing, C wall: then A belongs to every B (for everything breathing is an animal), but to no C, so that B too belongs to no C—therefore the wall does not breathe.

Explanations of this sort resemble those which are extravagantly stated (that consists in arguing by setting the middle term too far away)—e.g. Anacharsis' argument that there are no flute-girls among the Scyths, for there are no vines.

Thus with regard to the same science (and with regard to the position of the middle terms) there are these differences between the deduction of the fact and that of the reason why.

The reason why differs from the fact in another fashion, when each is considered by means of a different science. And such are those which are related to each other in such a way that the one is under the other, e.g. optics to geometry, and mechanics to solid geometry, and harmonics to arithmetic, and star-gazing to astronomy. Some of these sciences bear almost the same name—e.g. mathematical and nautical astronomy, and mathematical and acoustical harmonics. For here it is for the empirical scientists to know the fact and for the mathematical to know the reason why; for the latter have the demonstrations of the explanations, and often they do not know the fact, just as those who consider the universal often do not know some of the particulars through lack of observation.

These are those which, being something different in substance, make use of forms. For mathematics is about forms, for its objects are not said of any underlying subject—for even if geometrical objects are said of some underlying subject, still it is not *as* being said of an underlying subject that they are studied.

Related to optics as this is related to geometry, there is another science related to it—viz. the study of the rainbow; for it is for the natural scientist to know that fact, and for the student of optics—either *simpliciter* or mathematical—to know the reason why. And many even of those sciences which are not under one another are related like this—e.g. medicine to geometry; for it is for the doctor to know the fact that circular wounds heal more slowly, and for the geometer to know the reason why.

14 · Of the figures the first is especially scientific. For the mathematical sciences carry out their demonstrations through it—e.g. arithmetic and geometry and optics—and so do almost all those which make inquiry after the reason why; for the deduction of the reason why occurs, either in general or for the most part and in most cases, through this figure. Hence for this reason too it will be especially scientific; for consideration of the reason why has most importance for knowledge.

Next, it is possible to hunt for understanding of what a thing is through this figure alone. For in the middle figure no affirmative deduction comes about; but understanding what a thing is is understanding an affirmation. And in the last figure an affirmative deduction does come about, but it is not universal; but what a thing is is something universal—for it is not in a certain respect that man is a two-footed animal.

Again, this figure has no need of the others, but they are thickened and increased through it until they come to the immediates.

So it is evident that the first figure is most important for understanding.

15 · Just as it was possible for *A* to belong to *B* atomically, so it is also possible for it to not belong in this way. By belonging or not belonging atomically I mean that there is no middle term for them; for in this way their belonging or not belonging will no longer be in virtue of something else.

Now when either *A* or *B* is in some whole or both are, it is not possible for *A* to belong to *B* primitively. For let *A* be in the whole *C*. Now if *B* is not in the whole *C* (for it is possible that *A* is in some whole and *B* is not in it), there will be a deduction that *A* does not belong to *B*; for if *C* belongs to every *A* and to no *B*, *A* belongs to not *B*. And similarly too, if *B* is in some whole, e.g. in *D*; for *D* belongs to every *B* and *A* to no *D*, so that *A* will belong to no *B* through a deduction. And it will be proved in the same way again if both are in some whole.

That it is possible for *B* not to be in a whole that *A* is in, or again for *A* not to be in a whole that *B* is in, is evident from those chains of predicates which do not overlap one another. For if nothing in the chain *A,C,D* is predicated of anything in the chain *B,E,F*, and *A* is in the whole *H* (which is in the same chain as it), it is evident that *B* will not be in *H*; for otherwise the chains will overlap. And similarly too if *B* is in some whole.

If neither is in any whole and *A* does not belong to *B*, it is necessary for it to not belong atomically. For if there is to be a middle term, it is necessary for one of them to be in some whole. For the deduction will be either in the first or in the middle figure. Now if it is in the first, *B* will be in some whole (for the proposition with it as subject must be affirmative); and if it is in the middle, one or other of them will be in some whole (for a deduction comes about if the negative is assumed with either as subject—but with both negative there will not be one).

So it is evident that it is possible for one thing to not belong to another atomically, and we have said when it is possible, and how.

16 · Ignorance—what is called ignorance not in virtue of a negation but in virtue of a disposition—is error coming about through deduction. In the case of what belongs or does not belong primitively this comes about in two ways: either when one believes *simpliciter* that something belongs or does not belong, or when one gets the belief through deduction. Now for simple belief the error is simple, but when it is through deduction there are several ways of erring.

For let *A* belong to no *B* atomically: now if you deduce that *A* belongs to *B*, assuming *C* as a middle term, you will have erred through deduction. Now it is possible for both the propositions to be false, and it is possible for only one to be. For if neither *A* belongs to any of the *C*'s nor *C* to any of the *B*'s, and each has been assumed the other way about, both will be false. And it is possible that *C* is so related to *A* and *B* that it neither is under *A* nor holds universally of *B*. For it is impossible for *B* to be in any whole (for *A* was said to not belong to it primitively), and it is not necessary that *A* holds universally of everything there is; hence both will be false.

But it is also possible to assume one truly—not, however, whichever you like, but only *AC*; for the proposition *CB* with always be false because *B* is not in anything, but *AC* may be true—e.g. if *A* belongs atomically both to *C* and to *B* (for when the same thing is predicated primitively of several things neither will be in the other). But it makes no difference even if it belongs non-atomically.

Now error about belonging comes about by these means and in this way only; for in no other figure was there a deduction of belonging. But error about not belonging comes about both in first and in the middle figure.

Now first let us say in how many ways and under what characterization of the propositions it comes about in the first figure. Now it is possible when both premisses are false, e.g. if *A* belongs atomically both to *C* and to *B*; for if *A* is assumed to belong to no *C* and *C* to every *B*, the propositions are false. It is also possible when one is false, and that whichever you like. For it is possible for *AC* to be true and *CB* false—*AC* true because *A* does not belong to everything there is; *CB* false because it is impossible for *C*, to none of which *A* belongs, to belong to *B* (for the proposition *AC* will no longer be true, and at the same time if they are *both* true the conclusion too will be true). But it is also possible for *CB* to be true while the other is false, i.e. if *B* is both in *C* and in *A*; for it is necessary for the one to be under the other, so that if you assume that *A* belongs to no *C*, the proposition will be false.

So it is evident that both when one proposition is false and when both are the deduction will be false.

In the middle figure it is not possible for both propositions to be false as wholes; for when *A* belongs to every *B*, one cannot assume anything which will belong to all the one and none of the other; but it is necessary to assume the propositions in such a way that something belongs to one and does not belong to the other if there is to be a deduction. So if when assumed in such a way they are false, clearly they will be the other way about when assumed in the contrary way; but this is impossible.

But nothing prevents each being partially false i.e. if *C* were to belong both to some *A* and to some *B*. For if it is assumed to belong to every *A* and to no *B*, both propositions will be false—not, however, as wholes but partially. And if the negative is posited the other way about, the same holds.

It is possible for one of them to be false, and that whichever you like. For what belongs to every *A* also belongs to *B*; so if *C* is assumed to belong to the whole of *A* and to not belong to the whole of *B*, *CA* will be true and *CB* false. Again, what belongs to no *B* will not belong to every *A*; for if to *A*, then to *B* too—but it did not belong to *B*. So if *C* is assumed to belong to the whole of *A* and to no *B*, the proposition *CB* is true and the other false.

Similarly too if the negative is transposed. For what belongs to no *A* will not belong to any *B* either; so if *C* is assumed to not belong to the whole of *A* and to belong to the whole of *B*, the proposition *AC*[21] will be true and the other false. And again, what belongs to every *B* it is false to assume belongs to no *A*. For it is necessary, if it belongs to every *B*, for it also to belong to some *A*; so if *C* is assumed to belong to every *B* and to no *A*, *CB* will be true and *CA* false.

So it is evident that both when both are false and when only one is there will be an erroneous deduction in the case of atomic propositions.

17 · In the case of what belongs non-atomically, when the deduction of the falsehood comes about through the appropriate middle term, it is not possible for both propositions to be false but only the one relating to the major extreme. (I call appropriate a middle term through which the deduction of the contradictory comes about.) For let *A* belong to *B* through a middle term *C*. Now since it is necessary for *CB* to be assumed as an affirmative if a deduction comes about, it is clear that this will always be true; for it does not convert. And *AC* is false; for if this converted the contrary deduction comes about.

Similarly too if the middle term is taken from another chain—e.g. *D*, if it is both in the whole of *A* and predicated of every *B*; for it is necessary for the proposition *DB* to stand and for the other to be converted, so that the one is always true and the other always false. And *this* sort of error is much the same as that through the appropriate middle.

But if the deduction comes about not through the appropriate middle, then when the middle term is under *A* and belongs to no *B*, it is necessary for both to be false. For the propositions must be assumed with the contrary character to that which they actually have if there is going to be a deduction; and so assumed both come out false. I.e. if *A* belongs to the whole of *D* and *D* to none of the *B*'s; for when these are converted there will be a deduction and the propositions will both be false.

[21]Retaining ΑΓ.

But when the middle term, i.e. *D*, is not under *A*, *AD* will be true and *DB* false. For *AD* is true because *D* was not in *A*; and *DB* false because if it were true the conclusion too would be true, but it was false.

When the error comes about through the middle figure, it is not possible for both propositions to be false as wholes; for when *B* is under *A* it is not possible for anything to belong to all the one and none of the other, as was said earlier. But it is possible for one to be false as a whole, and that whichever you like.

For if *C* belongs both to *A* and to *B*, if it is assumed to belong to *A* and not to belong to *B*, then *AC*[22] will be true and the other false. And again, if *C* were assumed to belong to *B* and to no *A*, *CB* will be true and the other false.

Now if the deduction of the error is negative, we have said when and by what means the error will occur. If it is affirmative, then when it is through the appropriate middle term it is impossible for both to be false; for it is necessary for *CB* to stand if there is to be a deduction, as was said earlier. Hence *CA*[23] will always be false; for this is the proposition that converts.

Similarly too if the middle term were taken from another chain, as was said in the case of negative error too; for it is necessary for *DB* to stand and *AD* to convert. And the error is the same as the earlier one.

When it is not through the appropriate middle term, then if *D* is under *A*, this will be true and the other false; for it is possible for *A* to belong to several things which are not under one another. And if *D* is not under *A*, this clearly will always be false (for it is assumed as an affirmative), but it is possible for *DB* both to be true and false. For nothing prevents *A* from belonging to no *D* and *D* to every *B*, e.g. animal to knowledge, knowledge to music; nor again *A* from belonging to none of the *D*'s and *D* to none of the *B*'s.

So it is evident that if the middle term is not under *A* it is possible both for both propositions to be false and for whichever you like to be.[24]

So it is evident in how many ways and by what means errors in virtue of deduction may come about, both in the case of the immediates and in the case of what is established through demonstration.

18 · It is evident too that if some perception is wanting, it is necessary for some understanding to be wanting too—which it is impossible to get if we learn either by induction or by demonstration, and demonstration depends on universals and induction on particulars, and it is impossible to consider universals except through induction (since even in the case of what are called abstractions one will be able to make familiar through induction that some things belong to each genus, even if they are not separable, in so far as each thing is *such and such*), and it is impossible to get an induction without perception—for of particulars there is perception; for it is not possible to get understanding of them; for it can be got neither from universals without induction nor through induction without perception.

[22] Retaining ΑΓ.
[23] Retaining ΓΑ.
[24] Ross excises this sentence.

19 · Every deduction is through three terms; and the one type is capable of proving that *A* belongs to *C* because it belongs to *B* and that to *C*, while the other is negative, having one proposition to the effect that one thing belongs to another and the other to the effect that something does not belong. So it is evident that the principles and what are called the suppositions are these; for it is necessary to assume these and prove in this way—e.g. that *A* belongs to *C* through *B*, and again that *A* belongs to *B* through another middle term, and that *B* belongs to *C* in the same way.

Now those who are deducing with regard to opinion and only dialectically clearly need only inquire whether their deduction comes about from the most reputable propositions possible; so that even if there is not in truth any middle term for *AB* but there seems to be, anyone who deduces through this has deduced dialectically. But with regard to truth one must inquire on the basis of what actually holds. It is like this: since there is something which itself is predicated of something else nonaccidentally (I mean by accidentally—e.g. we sometimes say that that white thing is a man, not speaking in the same way as when we say that the man is a white thing;[25] for it is not the case that, being something different, he is a white thing, whereas the white thing is a man because the man was accidentally white)—now there are some things such as to be predicated in themselves.

Well, let *C* be such that it itself no longer belongs to anything else and *B* belongs to it primitively and there is nothing else between. And again let *E* belong to *F* in the same way and this to *B*. Now is it necessary for this to come to a stop, or is it possible for it to go on *ad infinitum?*

And again, if nothing is predicated of *A* in itself and *A* belongs to *H* primitively and to nothing prior in between, and *H* belongs to *G* and this to *B*, is it necessary for *this* to come to a stop or is it possible for *this* to go on *ad infinitum?* This differs from the earlier question to this extent, that the one is: Is it possible, beginning from something such that it belongs to nothing else and something else belongs to it, to go upwards *ad infinitum*? while the other has us begin from something such that it is predicated of something else and nothing is predicated of it and consider if it is possible to go downwards *ad infinitum*.

Again, is it possible for the terms in between to be indefinitely many if the extremes are determined? I mean, e.g., if *A* belong to *C*, and *B* is a middle term for them, and for *B* and *A* there are other middle terms, and for these others, is it possible for *these* to go on *ad infinitum*, or impossible?

This is the same as to inquire whether demonstrations go on *ad infinitum* and whether there is demonstration of everything, or whether some terms are bounded by one another.

I say the same in the case of negative deductions and propositions too; i.e. if *A* does not belong to any *B*, either it will not belong to *B* primitively, or there will be something prior in between to which it does not belong (e.g. *G*, which belongs to all *B*), and again another still prior to this (e.g. *H*, which belongs to every *G*). For in these cases too either the prior terms it belongs to are indefinitely many or they come to a stop.

[25] Retaining λευκόν.

(The same does not go for terms that convert. For among counterpredicated terms there is none of which any is predicated primitively or finally (for in this respect at least every term is related to every other in a similar way), and if[26] its predicates are indefinitely many, then the things we are puzzling over are indefinitely many in both directions—unless it is possible that they convert not similarly but the one as an accidental, the other as a predicate.)

20 · Now it is clear that it is not possible for the terms in between to be indefinitely many if the predications come to a stop downwards and upwards—I mean by upwards, towards the more universal; and by downwards, towards the particular. For if when *A* is predicated of *F* the terms in between—the *B*'s—are indefinitely many, it is clear that it would be possible both that from *A* downwards one thing should be predicated of another *ad infinitum* (for before *F* is reached the terms in between are indefinitely many) and that from *F* upwards there are indefinitely many before *A* is reached. Hence if these things are impossible, it is also impossible for there to be indefinitely many terms between *A* and *F*.

For if someone were to say that some of *A*,*B*,*F* are next to one another so that there are none between them, and that the others cannot be grasped, that makes no difference; for whichever of the *B*'s I take, the terms in between in the direction of *A* or in the direction of *F* will either be indefinitely many or not. Well, it makes no difference which is the first term from which they are indefinitely many—whether at once or not at once—for the terms after these are indefinitely many.

21 · It is evident too that in the case of negative demonstration it will come to a stop if it comes to a stop in both directions in the affirmative case. For let it be possible neither to go upwards from the last term *ad infinitum* (I call last that which
82b1 itself belongs to nothing else while something else belongs to it, e.g. *F*), nor from the first to the last (I call first that which itself holds of another while nothing holds of it). Well, if this is so, it will come to a stop in the case of negation too.

For a thing is proved not to belong in three ways. For either *B* belongs to everything to which *C* does and *A* to nothing to which *B* does—in the case of *BC*, then and in general of the second premiss it is necessary to come to immediates; for this premiss is affirmative. And clearly if the other term does not belong to something else that is prior, e.g. to *D*, this will have to belong to every *B*; and if again it does not belong to something else prior to *D*, that will have to belong to every *D*. Hence since the way upwards comes to a stop, the way to *A* will come to a stop too, and there will be some first thing to which it does not belong.

Again, if *B* belongs to every *A* and to no *C*, *A* belongs to none of the *C*'s. Again, if one has to prove this, clearly it will be proved either in the above fashion, or in this or the third. Now the first has been described, and the second will now be proved.

You might prove it in this way—e.g. that *D* belongs to every *B* and to no *C*—if it is necessary for something to belong to *B*. And again, if this is not to belong to *C*,

[26] Reading εἴ τ' . . . ἐπ' . . . for εἶτ' . . . εἶτ' . . .

something else belongs to *D* which does not belong to *C*. So since belonging to ever higher terms comes to a stop, not belonging will come to a stop too.

The third way was: if *A* belongs to every *B* and *C* does not belong to it, *C* does not belong to everything to which *A* does. Again, this will be proved either in the ways described above or similarly. Well, if the former, it comes to a stop; and if the latter, one will again assume that *B* belongs to *E*, to not all of which *C* belongs. And this again similarly. Since it is supposed that it comes to a stop in the downward direction too, it is clear that *C*'s not belonging will also come to a stop.

It is evident that even if it is proved not in one way but in all—sometimes from the first figure, sometimes from the second or third—that it will come to a stop even so; for the ways are finite, and necessarily anything finite taken a finite number of times is finite.

So it is clear that it comes to a stop in the case of negation if it does in the case of belonging. That it comes to a stop in the latter case is evident if we consider it generally, as follows.

22 · Now in the case of things predicated in what something is, it is clear; for if it is possible to define, or if what it is to be something is knowable, but one cannot go through indefinitely many things, it is necessary that the things predicated in what something is are finite.

We argue universally, as follows: one can say truly that the white thing is walking, and that that large thing is a log, and again that the log is large and that the man is walking. Well, speaking in the latter and in the former ways are different. For when I say that the white thing is a log, then I say that that which is accidentally white is a log; and not that the white thing is the underlying subject for the log; for it is not the case that, being white or just what is some white, it came to be a log, so that it is not a log except accidentally. But when I say that the log is white, I do not say that something else is white and that that is accidentally a log, as when I say that the musical thing is white (for then I say that the man, who is accidentally musical, is white); but the log is the underlying subject which *did* come to be white without being something other than just what is a log or a particular log.

Well, if we must legislate, let speaking in the latter way be predicating, and in the former way either no predicating at all, or else not predicating *simpliciter* but predicating accidentally. (What is predicated is like the white, and that of which it is predicated is like the log.) Thus let it be supposed that what is predicated is always predicated *simpliciter* of what it is predicated of, and not accidentally; for this is the way in which demonstrations demonstrate. Hence when one thing is predicated of one, either it is predicated in what a thing is or it says that it has some quality or quantity or relation or is doing something or undergoing something or is at some place of time.

Again, the things signifying a substance signify of what they are predicated of just what is that thing or just what is a particular sort of it; but the things which do not signify a substance but are said of some other underlying subject which is neither just what is that thing nor just what is a particular sort of it, are accidental, e.g. white of the man. For the man is neither just what is white nor just what is some white—but presumably animal; for a man is just what is an animal. But the things that do not signify a substance must be predicated of some underlying subject, and there cannot be anything white which is not white through being something different. (For we can say goodbye to the forms; for they are nonny-noes, and if there are any they are nothing to the argument; for demonstrations are about things of this type.)

Again, if it cannot be the case that this is a quality of that and the latter of the former—a quality of a quality—it is impossible for them to be counterpredicated of one another in this way—it is possible to say it truly, but it is not possible to counterpredicate truly. Now either it will be predicated as a substance, i.e. either being the genus or the difference of what is predicated—but it has been proved that these will not be infinitely many, either downwards or upwards (e.g. man is two-footed, that is animal, that is something else; nor animal of man, that of Callias, and that of another thing in what it is); for one can define every substance of that kind, but one cannot go through infinitely many things in thought. Hence they are not infinitely many either upwards or downwards; for one cannot define that of which infinitely many things are predicated. Thus they will not be counterpredicated of one another as genera; for a thing will itself be just what is some of itself.

But neither will any case of quality or the other kinds of predication be counterpredicated unless it is predicated accidentally; for all these are accidental and are predicated of substances.

But it is clear that they will not be infinitely many upwards either; for of each is predicated whatever signifies either a quality or a quantity or one of those things, or what is in its substance; but these are finite, and the genera of predications are finite—for they are either quality or relation or doing or undergoing or place or time.

It is supposed that one thing is predicated of one thing, and that things which are not what something is are not predicated of themselves. For they are all accidental (though some in themselves and some in another fashion) and we say that all of them are predicated of some underlying subject, and that what is accidental is not an underlying subject; for we posit nothing of this type which is not called what it is called through being something different, and itself belongs to other things.[27]

Neither upwards, therefore, nor downwards will one thing be said to belong to one thing. For the things of which the accidentals are said are whatever is in the substance of each thing; and these are not infinitely many. And upwards there are both these and their accidentals, and neither are infinitely many. It is necessary, therefore, for there to be something of which something is predicated primitively, and something else of that; and for this to come to a stop, and for there to be something which is no longer predicated of anything prior and of which nothing else prior is predicated.

[27]Reading ἀλλ' αὐτὸ ἄλλοις for ἀλλ' αὐτὸ ἄλλου καὶ τοῦτο καθ' ἑτέρου.

Now this is one way of demonstration; but there is still another, if there is demonstration of that of which some prior things are predicated, and it is not possible either to be more happily related to the things of which there is demonstration than by knowing them or to know them without demonstration, and if this is familiar through these and we neither know these nor are more happily related to them than by knowing them, we shall not understand what is familiar through them either.

So if one can know something through demonstration—*simpliciter*, and not dependent on something, nor on a supposition—it is necessary for the predications in between to come to a stop. For if they do not come to a stop but there is always something above what has been taken, there will be demonstration of everything; hence if it is not possible to go through infinitely many things, we shall not know through demonstration the things of which there is demonstration. So if we are not more happily related to them than by knowing them, we will be able to understand nothing through demonstration *simpliciter* but only on a supposition.

Now generally, one might be convinced of what we said by this; but analytically, it is evident more concisely from the following facts that neither upwards nor downwards can the terms predicated be infinitely many in the demonstrative sciences with which our inquiry is concerned.

For demonstration is of what belongs to the objects in themselves—in themselves in two ways: both what belongs in them in what they are, and the things which have what they themselves belong to belonging in what they are (e.g. odd to number—odd belongs to number and number itself inheres in its account; and again plurality or divisibility inheres in the account of number). And it is not possible for either of these sorts of term to be infinitely many—either as odd of number (for then there would again be something else belonging to odd in which odd inhered; and if this is prime, number will inhere in what belongs to it; so if it is not possible for infinitely many such things to belong in the one thing, they will not be infinitely many in the upward direction; but it is necessary that everything belongs to the primitive term, i.e. to number, and number to them, so that they will be convertible and will not exceed it). Nor yet can the terms inhering in what something is be infinitely many; for then it would not be possible to define.

Hence if all the terms predicated are said in themselves, and there are not infinitely many, then the terms leading upward will come to a stop. Hence they will come to a stop in the downward direction too. And if this is so, the terms in between two terms will also always be finite.

And if this is the case, it is now clear too that of necessity there are principles of demonstrations and there is not demonstration of everything (which, as we said at the beginning, some men assert). For if there are principles, neither is everything demonstrable, nor is it possible to go on *ad infinitum*; for for either of these to be the case is nothing other than for there to be no immediate and indivisible proposition but for all to be divisible. For it is by interpolating a term inside and not by taking an additional one that what is demonstrated is demonstrated; hence if it is possible for this to go on *ad infinitum*, it would be possible for there to be infinitely many middle terms in between two terms. But this is impossible if the predications come to a stop

84b1 upwards and downwards. And that they do come to a stop has been proved generally before and analytically now.

23 · Now that this has been proved, it is evident that if one and the same thing belongs to two things—e.g. *A* both to *C* and to *D*—which are not predicated one of the other (either not at all or not in every case), that it will not always belong in virtue of something common. E.g. having angles equal to two right angles belongs to isosceles and to scalene in virtue of something common (for it belongs to them as figures of a certain sort and not as different things); but this is not always so.

For let *B* be that in virtue of which *A* belongs to *C*, *D*. It is clear, then, that *B* too will belong to *C* and *D* in virtue of some other common feature, and that in virtue of another; so that infinitely many terms would fall between two terms. But that is impossible.

It is not necessary, then, that when one and the same thing belongs to several things it should always do so in virtue of something common, since there are immediate propositions. Yet it is necessary for the terms to be in the same genus and dependent on the same atoms, if the common feature is to be something belonging in itself; for it turned out impossible that what is proved should cross from one genus to another.

It is evident too that when *A* belongs to *B*, then if there is some middle term you can prove that *A* belongs to *B*, and the elements of this are[28] as many as the middle terms (for the immediate propositions are the elements, either all of them or the universal ones); but if there is no middle term, there is no longer a demonstration, but this is the path to the principles.

Similarly, too, if *A* does not belong to *B*, then if there is either a middle or a prior term to which it does not belong, there is a demonstration; and if not, there is not, but it is a principle. And there are as many elements as terms; for the propositions containing these are principles of the demonstration. And just as there are some non-demonstrable principles to the effect that this is *this* and this belongs to *this*, so too there are some to the effect that this is *not this* and this does *not* belong to *this*; so that there will be principles some to the effect that something is, and others to the effect that something is not.

When you have to prove something, you should assume what is predicated primitively of *B*. Let it be *C*; and let *D* be predicated similarly of this. And if you always proceed in this way no proposition and nothing belonging outside *A* will ever be assumed in the proof, but the middle term will always be thickened, until they become indivisible and single. It is single when it becomes immediate; and a single proposition *simpliciter* is an immediate one. And just as in other cases the principle is simple, though it is not the same everywhere—but in weight it is the ounce, in song the semitone, and in other cases other things—so in deduction it is the unit[29]
85a1 and in demonstration and understanding it is comprehension.

[28]Omitting ταῦτα καί.
[29]Omitting πρότασις ἄμεσος.

So, in deductions proving something to belong, nothing falls outside; but in deductions, in one case nothing falls outside the term which must belong—i.e. if *A* does not belong to *B* through *C* (if *C* belongs to every *B*, and *A* to no *C*), then if again you have to prove that *A* belongs to no *C*, you should assume a middle term for *A* and *C*; and it will always proceed in this way.

If you have to prove that *D* does not belong to *E* by the fact that *C* belongs to every *D* and to no *E* it will never fall outside *E* (this is the term to which it must belong).

In the case of the third way, it will never pass outside either the term of which it must be denied or that which must be denied of it.

24 · Some demonstrations are universal, others particular, and some are affirmative, others negative; and it is disputed which are better. And similarly too for those which are said to demonstrate and those which lead to the impossible. Now first let us inquire about universal and particular demonstrations; and when we have made this clear, let us speak about those which are said to prove and those which lead to the impossible

Now it might perhaps seem to some, inquiring as follows, that particular demonstration is better: if a demonstration in virtue of which we understand better is a better demonstration (for this is the excellence of demonstration), and we understand a thing better when we know it in itself than when we know it in virtue of something else (e.g. we know musical Coriscus better when we know that Coriscus is musical than when we know that a man is musical; and similarly in the other cases too), and the universal demonstration shows that something else and not that the thing itself is in fact so and so (e.g. of the isosceles,[30] it shows not that the isosceles but that the triangle has two right angles), while the particular demonstration shows that the thing itself has in fact two right angles—well, if a demonstration of something in itself is better, and the particular rather than the universal is of that type, then the particular demonstration will be better.

Again, if the universal is not a thing apart from the particulars, and demonstration instils an opinion that that in virtue of which it demonstrates is some thing, and that this belongs as a sort of natural object among the things there are (e.g. a triangle apart from the individual triangles, and a figure apart from the individual figures and a number apart from the individual numbers), and a demonstration about something there is is better than one about something that is not, and one by which we will not be led into error is better than one by which we will be, and universal demonstration is of this type (for as they go on they prove as in the case of proportion, e.g. that whatever is of such a type—neither line nor number nor solid nor plane but something apart from these—will be proportional)—so, if 85b1
this is more universal and is less about something there is than the particular demonstration, and instils a false opinion, then the universal will be worse than the particular.

[30]Omitting ὅτι.

Or, first, is the other argument any better fitted to the universal than to the particular case? For if two right angles belong not as isosceles but as triangle, one who knows that the isosceles has two right angles will know it less well as such than one who knows that a triangle has two right angles.

And in general, if it does not hold as triangle and yet someone proves it, this will not be a demonstration; and if it does, it is the man who knows a thing as it belongs who knows it better. Thus if triangle extends further, and there is the same account and triangles are not so called in virtue of a homonymy, and two right angles belong to every triangle, it will not be that the triangle has two right angles as isosceles but that the isosceles has such angles as triangle. Hence one who knows universally knows it better as it belongs than one who knows it particularly. Therefore the universal demonstration is better than the particular.

Again, if there is some single account and the universal is not a homonymy, it will be some thing no less than some of the particulars, but actually more so, inasmuch as what is imperishable is among the former and it is rather the particulars that are perishable. And again, there is no necessity to believe that this is a thing apart from the particulars on the grounds that it makes one thing clear, any more than in the case of the other things which do not signify an individual but either quality or quantity or relation or doing. If, therefore, this is believed, it is not the demonstration but the audience which is responsible.

Again, if demonstration is a probative deduction of an explanation and the reason why, and the universal is more explanatory (for that to which something belongs in itself, is itself explanatory for itself; and the universal is primitive: therefore the universal is explanatory); hence the universal demonstration is better; for it is more a demonstration of the explanation and the reason why it is the case.

Again, we seek the reason why up to this point, and it is then we think we know, when it is not the case that this either comes about or is because something else does; for the last term is in this way an end and a limit. E.g. with what aim did he come? So as to get the money—and that so as to give back what he owed; and that so as not to be dishonest. And going on in this way, when it is no longer because of something else or with some other aim, we say it is because of this as an end that he came (and that it is and that it came about) and that then we best know why he came. Thus if the same goes for all explanations and reasons why, and in the case of explanations in terms of aim we know best in this way—in the other cases too, therefore, we then know best when this no longer belongs to it because it is something else. So when we are aware that the external angles are equal to four right angles because it is isosceles, it still remains to ask why the isosceles is so because it is a triangle, and that because it is a rectilineal figure. And if this is no longer the case because it is something else, it is then we know best. And it is then too that it is universal; therefore the universal demonstration is better.

Again, the more particular a demonstration is, the more it falls into what is indefinite, while the universal tends to the simple and the limit. And as indefinite, things are not understandable; but as finite they are understandable. Therefore they are more understandable as universal than as particular. Therefore universals are more demonstrable. And of more demonstrable things there is more of a demonstration; for correlatives vary in degree together. Therefore the universal demonstration is better, since it is more of a demonstration.

Again, if a demonstration in virtue of which one knows this and something else is preferable to one in virtue of which one knows this alone; and one who has the universal demonstration knows the particular fact too, but the latter does not know the universal fact[31]—hence in this way too it will be preferable.

Again, as follows: to prove more universally is to prove through a middle term that is nearer to the principle. The immediate is nearest, and this is a principle. So if a demonstration depending on a principle is more precise than one not depending on a principle, a demonstration more dependent on a principle is more precise than one less so; and the more universal demonstration is of such a type; therefore the universal will be superior. E.g. if you had to demonstrate *A* of *D*; the middle terms are *B*, *C*: well, *B* is higher, so that the demonstration through it is more universal.

But some of the things we have said are general. It is most clear that universal demonstration is more important from the fact that grasping the prior of the propositions we have in a sense the posterior one too and we grasp it potentially. E.g. if someone knows that every triangle has two right angles, he knows in a sense of the isosceles too that it has two right angles—potentially—even if he does not know of the isosceles that it is a triangle. But one who grasps the latter proposition does not know the universal in any sense, neither potentially nor actually.

And the universal proposition is comprehensible, while the particular terminates in perceptions.

25 · So much, then, for the view that universal demonstration is better than particular; that probative is better than negative is clear from what follows.

Let that demonstration be better which, other things being equal, depends on fewer postulates or suppositions or propositions. For if they are equally familiar, knowing will come about more quickly in this way; and that is preferable.

The argument for the proposition that the one depending on fewer things is better is, put universally, this: if it is the case that the middle terms are equally familiar, and the prior terms are more familiar, let the one demonstration show that *A* belongs to *E* through middle terms *B*, *C*, *D*, and the other that *A* belongs to *E* through *F*, *G*. Thus that *A* belongs to *D* and that *A* belongs to *E* are similar. But that 86b1
A belongs to *D* is prior to and more familiar than the proposition that *A* belongs to *E*; for the latter is demonstrated through the former, and that through which a thing is demonstrated is more convincing. Therefore the demonstration through the fewer items is better, other things being equal.

Now both are proved through three terms and two propositions, but the one assumes that something is the case and the other both that something is and that something is not the case; therefore it is through more items, so that it is worse.

[31] Reading τό for τήν.

Again, since it has been proved that it is impossible for a deduction to come about when both propositions are negative, but that one must be so and the other to the effect that something belongs, in addition to that one must assume this: the affirmative propositions, as the demonstration increases, necessarily become more numerous, whereas it is impossible for the negatives to be more than one in any deduction.

For let *A* belong to none of the *B*'s and *B* belong to every *C*. Well, if we must again increase both propositions, a middle term must be interpolated. Let it be *D* for *A B*, and *E* for *B C*. Well, it is evident that *E* is affirmative, and that *D* is affirmative of *B* but lies as negative towards *A*. For *D* holds of every *B*, and *A* must belong to none of the *D*'s. So a single negative proposition, *A D*, comes about.

The same holds of the other deductions too. For the middle for the affirmative terms is always affirmative both ways; but for the negative it is necessarily negative in one way, so that this comes to be the single such proposition and the others are affirmative.

Thus if that through which something is proved is more familiar and more convincing, and the negative demonstration is proved through the affirmative while the latter is not proved through the former, then, being prior and more familiar and more convincing, the affirmative will be better.

Again, if the universal immediate proposition is a principle of deduction, and the universal proposition is affirmative in the probative demonstration and negative in the negative, and the affirmative is prior to and more familiar than the negative (for the negation is familiar because of the affirmation, and the affirmation is prior, just as being the case is prior to not being the case)—hence the principle of the probative is better than that of the negative; and the one which uses better principles is better.

Again, it is more principle-like; for without the probative there is no negative.

87a1 **26** · Since affirmative demonstration is better than negative, it is clear that it is also better than demonstration leading to the impossible. But we must know what is the difference between them.

Well, let *A* belong to no *B* and *B* to every *C*; thus it is necessary for *A* to belong to no *C*. Now if things are assumed in this way, the negative demonstration that *A* does not belong to *C* will be probative. The demonstration leading to the impossible goes thus: if we should have to prove that *A* does not belong to *B*, we must assume that it does belong and that *B* belongs to *C*, so that it results that *A* belongs to *C*. Let it be familiar and agreed that this is impossible. Therefore it is not impossible for *A* to belong to *B*. So if *B* is agreed to belong to *C*, it is impossible for *A* to belong to *B*.

So the terms are similarly arranged, and the difference is a matter of which negative proposition is the more familiar—that *A* does not belong to *B* or that *A* does not belong to *C*. Now when the conclusion (that it is not the case) is more familiar, demonstration to the impossible comes about; but when the proposition in the deduction is more familiar, we have demonstrative demonstration. By nature the proposition *A B* is prior to *A C*. For that on which the conclusion depends is prior to the conclusion; and that *A* does not belong to *C* is a conclusion, whereas that *A* does not belong to *B* is something on which the conclusion depends. For it is not the case that if it happens that something is disproved, then this is a conclusion and those are what it depends on; but what a deduction depends on is whatever is so related as to be related as whole to part or part to whole—and the propositions *B C* and *A B*[32] are not so related to one another.

So if the demonstration depending on what is more familiar and prior is superior, and in both cases conviction depends on something's not being the case, but in the one on something prior and in the other on something posterior, then the negative demonstration will be better *simpliciter* than the one to the impossible; hence the affirmative, which is better than this, is clearly also better than the one to the impossible.

27 · One science is more precise than another and prior to it both if it is at the same time of the fact and of the reason why and not of the fact separately from the science of the reason why; and if it is not said of an underlying subject and the other is said of an underlying subject (e.g. arithmetic and harmonics); and if it depends on fewer items and the other on an additional posit (e.g. arithmetic and geometry). (I mean by on an additional posit, e.g. a unit is a positionless substance, and a point a substance having position—the latter depends on an additional posit.)

28 · A science is one if it is of one genus—of whatever things are composed from the primitives and are parts or attributes of these in themselves. One science is different from another if their principles depend neither on the same thing nor the ones on the others. There is evidence for this when one comes to the non-demonstrables; for these must be in the same genus as the things demonstrated. And there is evidence for *this* when the things that are proved through them are in the same genus and of a kind.

29 · It is possible for there to be several demonstrations of the same thing not only if one takes a non-continuous middle term from the same chain—e.g. *C* and *D* and *F* for *A B*—but also if one takes a middle term from a different chain. E.g. let *A* be altering, *D* changing, *B* enjoying, and again *G* coming to rest. Now it is true to predicate both *D* of *B* and *A* of *D*; for the man who is enjoying himself is changing, and what is changing is altering. Again, it is true to predicate *A* of *G* and *G* of *B*; for everyone who is enjoying himself is coming to rest, and one who is coming to rest is altering. Hence the deduction is through middle terms that are different and not from the same chain—yet not in such a way that neither of the middle terms is said of the other; for it is necessary for them both to belong to some one thing. Inquire in how many ways it is possible for a deduction of the same thing to come about through the *other* figures.

[32]Reading ΒΓ καὶ ΑΒ.

30 · There is no understanding through demonstration of what holds by chance. For what holds by chance is neither necessary nor for the most part, but what comes about apart from these; and demonstration is of one or other of these. For every deduction is either through necessary or through for the most part propositions; and if the propositions are necessary, the conclusion is necessary too; and if for the most part, the conclusion too is such. Hence if what happens by chance is neither for the most part nor necessary, there will not be demonstration of it.

31 · Nor can one understand through perception. For even if perception is of what is such and such, and not of individuals, still one necessarily perceives an individual and at a place and at a time, and it is impossible to perceive what is universal and holds in every case; for that is not an individual not at a time; for then it would not be universal—for it is what is always and everywhere that we call universal.

So, since demonstrations are universal, and it is not possible to perceive these, it is evident that it is not possible to understand through perception either; but it is clear that even if one could perceive of the triangle that it has its angles equal to two right angles, we would seek a demonstration and would not, as some say, understand it; for one necessarily perceives particulars, whereas understanding comes by becoming familiar with the universal.

That is also why if we were on the moon and saw the earth screening it we would not know the explanation of the eclipse. For we would perceive that it is eclipsed and not why at all; for there turned out to be no perception of the universal. Nevertheless, if, from considering this often happening, we hunted the universal, we would have a demonstration; for from several particulars the universal is clear.

The universal is valuable because it makes clear the explanation; hence universal demonstration is more valuable than perception and comprehension[33]—with regard to those things whose explanation is something different; but for the primitives there is a different account.

So it is evident that it is impossible by perceiving to understand anything demonstrable—unless someone calls this perceiving: having understanding through demonstration.

Yet some of our problems are referred to want of perception; for in some cases if we saw we should not seek—not on the grounds that we knew by seeing, but that we grasped the universal from seeing. E.g. if we saw the glass to be perforated and the light coming through it, it would also be clear why it does, even if seeing[34] occurs separately for each piece of glass while comprehending grasps at one time that it is thus in every case.

32 · It is impossible for all deductions to have the same principles. First, let us consider it in general terms.

[33]'Comprehension' here translates *νόησις*; later it is also used to translate *νοῦς*.

[34]Reading *καὶ εἰ τό* for *καίει τῷ*.

Some deductions are true and some false. For even if it is possible to reduce a truth from falsehoods, yet this only comes about once. E.g. if *A* is true of *C*, and the middle, *B*, is false (for *A* does not belong to *B* nor *B* to *C*); but if middle terms are assumed for these propositions they will be false, because every false conclusion depends on falsehoods, while true conclusions depend on truths, and the truths and the falsehoods are different.

Next, not even falsehoods depend on the same things as one another; for there are falsehoods which are actually contrary to one another and cannot be the case together—e.g. that justice is injustice or cowardice, and that the man is a horse or a cow, and that what is equal is greater or less.

From what we have laid down we argue as follows: not even all truths have the same principles. For the principles of many of them are different in genus and do not apply—e.g. units do not apply to points, for the former do not have the position while the latter do. But it is necessary for them to apply either as middle terms or from above or from below, or for some of the terms to be inside and some outside.

Nor is it possible for there to be some of the common principles from which everything will be proved. (I call common e.g. that everything is affirmed or denied.) For the genera of the things there are are different, and some predicates belong to quantities and some to qualities alone, with the help of which proofs are conducted through the common items.

Again, the principles are not much fewer than the conclusions; for the propositions are principles, and the propositions are formed either by taking an additional term or by interpolating one.

Again, the conclusions are infinite, the terms finite.

Again, some principles are necessary and others possible.

Now if we inquire in this way, it is impossible for them to be the same and finite if the conclusions are infinite. If anyone means it in some other way, e.g. that *these* are the principles of geometry, *these* of calculations, *these* of medicine, what else will he be saying other than that the sciences have principles? It is ridiculous to say they are the same because they are the same as themselves—for in this way everything comes to be the same.

Nor yet is the contention that anything is proved from everything the same as seeking the same principles for everything; for that is too silly. For neither does this come about in the evident parts of mathematics, nor is it possible on analysis; for the immediate propositions are principles, and a different conclusion comes about if an additional immediate proposition is taken. And if someone were to say that it is the *primitive* immediate propositions that are principles, then there is one in each genus.

If it is claimed neither that anything must be proved from all of them, nor that they are different in the sense of being different for each science, it remains to consider whether the principles of everything are of the same kind, but *this* depends on *these* and *this* on *these*. It is evident that this too is not possible; for it has been proved that the principles of things different in genus are different in genus. For the principles are twofold, those from which and those about which; now while those from which are common, those about which are proper—e.g. number, magnitude.

33 · What is understandable, and understanding, differ from what is opinable, and opinion, because understanding is universal and through necessities, and what is necessary cannot be otherwise. But there are some things which are true and are the case, but which can also be otherwise. So it is clear that understanding is not about these things; for then what can be otherwise could not be otherwise. But nor is comprehension concerned with them—for by comprehension I mean a principle of understanding—nor is non-demonstrative understanding (this is belief in an immediate proposition). But it is comprehension and understanding and opinion and what is named from these that are true; hence it remains that opinion is about what is true or false but can also be otherwise. This is belief in a proposition which is immediate and not necessary.

And this agrees with the appearances; for opinion is unstable, and so too is the nature of the things in question. In addition, no one thinks that he opines when he thinks that it is impossible for it to be otherwise, but that he understands; but when he thinks that it is so but that nothing prevents if from being otherwise, then he thinks he opines, supposing opinion to be about that sort of thing and understanding about what is necessary.

So how can one opine and understand the same thing? and why will not opinion be understanding if one posits that it is possible to opine everything that one knows? For the knower and the opiner will follow one another through the middle terms until they come to the immediates; so that since the former knows, the opiner too knows. For just as one can opine the fact, so too one can opine the reason why; and that is the middle term.

Or if he believes what cannot be otherwise in the way in which he does the definitions through which the demonstrations come about, will he not opine but understand? While if he believes that they are true but not that *they* belong to them in virtue of their substance and in virtue of their form, he will opine and not truly understand—both the fact and the reason why if he opines through the immediates, but if not through immediates, he will opine only the fact.

There is not opinion and understanding of the same thing in every sense; but just as there is in a way both false and true opinion of the same thing, so there is both understanding and opinion of the same thing. For if there is true and false opinion of the same thing in the way some say, it results that one is committed to absurdities, and in particular to the absurdity that a man does not opine what he opines falsely. But since things are called the same in several ways, in a sense it is possible and in a sense it is not. For to opine truly that the diagonal is commensurate is absurd; but because the diagonal about which the opinions are is the same, in this way they are of the same thing—but what it is to be each of them in respect of its account is not the same.

Similarly, there is both knowledge and opinion of the same thing. For the one is of animal in such a way that it cannot not be an animal, and the other in such a way that it can be—e.g. if the one is of just what is man, and the other of man but not of just what is man. For it is the same because man is the same, but the manner is not the same.

It is also evident from this that it is not possible to opine and to understand the same thing at the same time. For one would at the same time hold the belief that the same thing can be otherwise and cannot be otherwise, which is not possible. For in different men it is possible for there to be each of these attitudes with regard to the same thing, as has been said; but in the same man it is not possible even in this way; for he will at the same time hold a belief, e.g. that a man is just what is an animal (for this is what it was for it not to be possible for something not to be an animal), and that man is not just what is an animal (for let that be what it is for it to be possible).

As for how the rest should be distributed among thought and comprehension and understanding and skill and prudence and wisdom—that is rather the task partly of nature and partly of moral theory.

34 · Acumen is a talent for hitting upon the middle term in an imperceptible time; e.g. if someone sees that the moon always holds its bright side toward the sun and quickly grasps why this is—because it gets light from the sun; or he is aware that someone is talking to a rich man because he is borrowing from him; or why they are friends—because they are enemies of the same man. For seeing the extremes he becomes familiar with all the explanatory middle terms.

The bright side's being toward the sun, *A*: getting light from the sun, *B*; the moon, *C*. Well, *B*, getting light from the sun, belongs to *C*, the moon; and *A*, the bright side's being toward that from which it gets light, to *B*; hence *A* belongs to *C*, through *B*.

BOOK II

1 · The things we seek are equal in number to those we understand. We seek four things: the fact, the reason why, if it is, what it is.

For when we seek whether it is this or this, putting it into a number (e.g. whether the sun is eclipsed or not), we seek the fact. Evidence for this: on finding that it is eclipsed we stop; and if from the start we know that it is eclipsed, we do not seek whether it is. When we know the fact we seek the reason why (e.g. knowing that it is eclipsed and that the earth moves, we seek the reason why it is eclipsed or why it moves).

Now while we seek these things in this way, we seek some things in another fashion—e.g. if a centaur or a god is or is not (I mean if one is or not *simpliciter* and not if one is white or not). And knowing that it is, we seek what it is (e.g. so what is a god? or what is a man?).

2 · Now what we seek and what on finding we know are these and thus many. We seek, whenever we seek the fact or if it is *simpliciter,* whether there is or is not a middle term for it; and whenever we become aware of either the fact or if it is—either partially or *simpliciter*—and again seek the reason why or what it is, then we seek what the middle term is. (I mean by the fact that it is partially and *simpliciter*—partially: Is the moon eclipsed? or is it increasing? (for in such cases we seek if it is something or is not something); *simpliciter:* if the moon or night is or is not.) It results, therefore, that in all our searches we seek either if there is a middle term or what the middle term is.

For the middle term is the explanation, and in all cases that is sought. Is it eclipsed?—Is there some explanation or not? After that, aware that there is one, we seek what this is. For the explanation of a substance being not this or that but *simpliciter,* or of its being not *simpliciter* but one of the things which belong to it in itself or accidentally—that is the middle term. I mean by *simpliciter* the underlying subject (e.g. moon or earth or sun or triangle) and by one of the things eclipse, equality, inequality, whether it is in the middle or not.

For in all these cases it is evident that what it is and why it is are the same. What is an eclipse? Privation of light from the moon by the earth's screening. Why is there an eclipse? or Why is the moon eclipsed? Because the light leaves it when the earth screens it. What is a harmony? An arithmetical ratio between high and low. Why does the high harmonize with the low? Because an arithmetical ratio holds between the high and the low. Can the high and the low harmonize?—Is there an arithmetical ratio between them? Assuming that there is, what then is the ratio?

That the search is for the middle term is made clear by the cases in which the middle is perceptible. For if we have not perceived it, we seek, e.g. for the eclipse, if there is one or not. But if we were on the moon we would seek neither if it comes about nor why, but it would be clear at the same time. For from perceiving, it would come about that we knew the universal too. For perception tells us that it is now screening it (for it is clear that it is now eclipsed); and from this the universal would come about.

So, as we say, to know what it is is the same as to know why it is—and that either *simpliciter* and not one of the things that belong to it, or one of the things that belong to it, e.g. that it has two right angles, or that it is greater or less.

3 · Now, that everything we seek is a search for a middle term is clear; let us now say how one proves what a thing is, and what is the fashion of the reduction, and what definition is and of what, first going through the puzzles about them. Let the start of what we are about to say be whatever is most appropriate to the neighbouring arguments.

A man might puzzle over whether one can know the same thing in the same respect by definition and by demonstration, or whether that is impossible.

For definition seems to be of what a thing is, and what a thing is is in every case universal and affirmative, but deductions are some of them negative and some not universal—e.g. those in the second figure are all negative and those in the third not universal.

Next, there is not definition even of all the affirmatives in the first figure—e.g. that every triangle has angles equal to two right angles. The argument for this is that to understand what is demonstrable is to have a demonstration; so that since there is demonstration of such things, clearly there will not also be definition of them—for someone might understand them in virtue of the definition without having the demonstration; for nothing prevents him from not having them together.

An induction, too, is sufficiently convincing; for we have never yet become aware of anything by giving a definition—neither of anything belonging in itself nor of any accidental.

Again, if definition is becoming familiar with some substance, it is evident that *such* things are not substances.

So it is clear that there is not definition of everything of which there is demonstration.

Well then, is there demonstration of everything of which there is definition, or not?

Well, one argument is the same in this case too. For of one thing, as one, there is one mode of understanding. Hence, if to understand what is demonstrable is to have a demonstration, something impossible will result; for anyone who has the definition without the demonstration will understand.

Again, the principles of demonstrations are definitions, and it has been proved earlier that there will not be demonstrations of these—either the principles will be demonstrable and there will be principles of the principles, and this will go on *ad infinitum*, or the primitives will be non-demonstrable definitions.

But if the objects of definition and demonstration are not all the same, are some of them the same? or is this impossible? For there is no demonstration of that of which there is definition. For definition is of what a thing is and of substance; but all demonstrations evidently suppose and assume what a thing is—e.g. mathematical demonstrations assume what a unit is and what odd, and the others similarly.

Again, every demonstration proves something of something, i.e. that it is or is not; but in a definition one thing is not predicated of another—e.g. neither animal of two-footed nor this of animal, nor indeed figure of plane (for plane is not figure nor is figure plane).

Again, proving what a thing is and that it is are different. So the definition makes clear what it is, and the demonstration that this is or is not true of that. And of different things there are different demonstrations—unless they are related as a part to the whole (I mean by this that the isosceles has been proved to have two right angles if every triangle has been proved to be so; for one is a part and the other a whole). But these things—that it is and what it is—are not related to one another in this way; for neither is part of the other.

It is evident, therefore, that neither is there demonstration of everything of which there is definition, nor is there definition of everything of which there is demonstration, nor in general is it possible to have both of the same thing. Hence it is clear that definition and demonstration are neither identical nor the one included in the other; for then their underlying subjects would be similarly related.

4 · Now so much for these puzzles; but is there deduction and demonstration of what a thing is, or is there not, as the argument just now supposed?

For deduction proves something of something through the middle term. But what a thing is both is proper to it and is predicated in what it is. And these necessarily convert; for if *A* is proper to *C* it is clear that it is also proper to *B* and this to *C*; so that all are proper to one another. And if *A* belongs to every *B* in what it is, and *B* is said universally of every *C* in what it is, necessarily *A* is said of *C* in what it is. But if you do not assume them in this double way, it will not be necessary for *A* to be predicated of *C* in what it is (if *A* holds of *B* in what it is, but of what *B* is said of *B* does not hold in what it is). But both these will contain what it is; therefore *B* too will hold of *C* in what it is.

Thus if both contain what a thing is and what it is to be it, what it is to be it will be prior in the case of the middle term. And in general if one can prove what a man is, let *C* be man, and *A* what man is—whether two-footed animal or something else. If, then, it is deduced, it is necessary for *A* to be predicated of every *B*, and there will be an intermediate account other than this,[35] so that this too will be what man is. So you assume what you have to prove; for *B* is what man is.

We must inquire in the case of two propositions and of what is primitive and immediate; for there what we are saying becomes especially evident.

Now those who prove through conversion what soul is, or what man is, or anything else that there is, postulate the point at issue—e.g. if someone were to claim that soul is what is explanatory of its own being alive, and that this is a number that moves itself; for it is necessary to postulate that soul is just what is a number that moves itself, in the sense of its being the same thing.

For it is not the case that if *A* follows *B* and this *C*, *A* will be what it is to be *C*, but it is true[36] to say only *A* will be *C*—even if *A* is just what is some *B* and is predicated of every *B*. For what it is to be an animal is predicated of what it is to be a man (for it is true that every case of what it is to be a man is what it is to be an animal, just as every man is an animal), but not in the sense of their being one thing.

If, then, you do not assume in this way, you will not deduce that *A* is what it is to be *C* and its substance; and if you do assume in this way, you will already have assumed what is what it is to be *C*, viz. *B*. Hence it has not been demonstrated; for you have assumed the point of issue.

5 · But neither does the method of division deduce, as we said in our analysis of the figures.[37] For it nowhere becomes necessary for the object to be *that* if *these*

[35]Reading τούτου, with the MSS., for Ross's τοῦτο.
[36]Reading ἀληθὲς ἦν for ἀληθές.
[37]See *Prior Analytics* I 31.

are the case—just as someone who is giving an induction does not demonstrate. For one must not ask the conclusion, nor must it be the case by being granted; but it is necessary for it to be the case if *those* are the case, even if the answerer denies it.

Is man an animal or inanimate? If[38] he assumed animal, he has not deduced it. Again, every animal is either terrestrial or aquatic: he assumed terrestrial. And that man is the whole—a terrestrial animal—is not necessary from what he has said, but he assumes this too. It makes no difference whether he does this in many steps or in few; for it is the same. (Indeed those who proceed in this way actually make non-deductive use even of what can be deduced.) For what prevents all this from being true of man yet not making clear what a man is or what it is to be a man? Again, what prevents you from positing something additional, or from abstracting something, or from passing over something in its substance?

Now these points are ignored; but it is possible to solve them if one assumes everything in what the thing is, and makes the division consecutive by postulating what is primitive, and leaves nothing out. [This is necessary if everything falls into the division and nothing is omitted; and this is necessary, for it must already by atomic.][39]

But nevertheless there is no deduction in it; but it makes us familiar with what the thing is, if at all, in some other fashion. And this is nothing absurd; for neither, presumably, does someone who gives an induction demonstrate, but he nevertheless makes something clear. And someone who states the definition as a result of the division does not state a deduction. For just as in the case of conclusions without middle terms if someone says that if these are the case it is necessary that *this* is the case, it is possible to ask why; so too this is possible in the case of divisional definitions. What is man? An animal, mortal, footed, two-footed, wingless. Why (at each additional posit)? For he will say, and prove by the division as he thinks, that everything is either mortal or immortal. But a whole argument of this sort is not a definition, so that even if it were demonstrated by the division, that does not make *the definition* a deduction.

6 · But can one actually demonstrate what a thing is in respect of substance, but do so on a supposition, by assuming that what it is to be something is the property composed from the things in what it is, and that *these* alone are in what it is, and that the whole is proper to it? For this is what it is to be that thing.

Or do you again assume what it is to be the thing in this case too? For it is necessary to prove it through the middle term.

Again, just as in a deduction you do not assume what being deduced is (for the proposition on which the deduction depends is always whole or part), so too what it is to be something must not be in the deduction, but this must be separate from what is laid down. And if anyone disputes whether something has been deduced or not, we meet him by saying that "that is what a deduction is"; and if anyone says that what it is to be it has not been deduced we can say that "Yes it has; for that is what we

[38]Reading εἴτ' for εἶτ'.

[39]The text of the bracketed passage is intelligible as it stands, but it does not fit the context.

supposed what it is to be something is." Hence it is necessary for something to have been deduced *without* assuming what deduction is or what it is to be something.

And even if you prove it from a supposition—e.g. if being bad is being divisible, and for things which have a contrary being their contrary is being contrary to what they are,[40] and the good is contrary to the bad, and the indivisible to the divisible—therefore being good is being indivisible.

For here too you prove by assuming what it is to be something, and you assume it in order to prove what it is to be it.—Yet something different.—Granted; for in demonstrations too one assumes that this is true of this—but not itself, and not something that has the same account and converts.

And in both cases—if you prove in virtue of a division and if you produce a deduction in this way—there is the same puzzle: why will man be a two-footed terrestrial animal and not animal and terrestrial? For from the assumption there is no necessity for what is predicated to become a unity, but it might be as if the same man were musical and literate.

7 · Well now, how will a definer prove a thing's substance or what it is?

For neither, as in demonstration, will he make it clear from what is agreed to be the case because necessarily if these are the case something else is (for this is demonstration); nor, as in induction, will he show through the particulars, which are clear, that everything is thus since nothing is otherwise (for in induction you do not prove what a thing is, but that either it is or it is not).

Now what other way is left? For you will hardly prove it by perception or by pointing with your finger.

Again, how will you prove what a thing is? For it is necessary for anyone who knows what a man or anything else is to know too *that* it is (for of that which is not, no one knows what it is—you may know what the account or the name signifies when I say goatstag, but it is impossible to know what a goatstag is). But if you are to prove what it is and that it is, how will you prove them by the same argument? For both the definition and the demonstration make one thing clear; but what a man is and that a man is are different.

Next, we say it is necessary that everything that a thing is should be proved through demonstration, unless it is its substance. But being is not the substance of anything; for what is is not a genus. Therefore there will be a demonstration that it is. And that is what the sciences as a matter of fact do; for the geometer assumes what triangle signifies and proves that it is. So when you define what it is, what will you prove? Triangle?[41] Then you will know by definition what it is, but you will not know if it is. But that is impossible.

It is evident too from the present fashions of definition that definers do not prove that a thing is. For if it is in fact what is[42] equidistant from the middle, why should what has been defined be? and why is this a circle? For one might say that it

[40]Reading *τῷ δ' ἐναντίῳ τὸ τῷ ἐναντίῳ* with the MSS., for Ross's *τὸ δ' ἐναντίῳ τὸ τῷ ἐναντίῳ ἐναντίῳ*.
[41]Reading *τί ἐστιν; ἤ* . . . for Ross's *ἢ τί ἔστι* . . . .
[42]Reading *τό* for *τι*.

was a definition of mountain-copper. For definitions do not in addition make clear either that what is said is possible, or that it is that of which they say they are definitions, but it is always possible to say "Why?"

If, therefore, the definer proves either what a thing is or what its name signifies, then if a definition has nothing at all to do with what a thing is, it will be an account signifying the same as a name. But that is absurd.

For, first, there would be definitions even of non-substances, and of things that are not—for one can signify even things that are not.

Again, all accounts would be definitions; for one could posit a name for any account whatever, so that we would all talk definitions and the *Iliad* would be a definition.

Again, no demonstration would demonstrate that this name makes *this* clear; nor then do definitions make this clear in addition.

From this, then, it is evident that definition and deduction are not the same, and that deduction and definition are not of the same thing; and in addition, that definition neither demonstrates nor proves anything, and that you can become aware of what a thing is neither by definition nor by demonstration.

8 · We must inquire again which of these points is correctly argued and which not correctly; and what a definition is; and whether there is in some way demonstration and definition of what a thing is, or in no way at all.

Since, as we said, to know what something is and to know the explanation of the fact that it is are the same—the argument for this is that there is some explanation, and this is either the same thing or something else, and if it is something else it is either demonstrable or non-demonstrable—if, then, it is something else and it is possible to demonstrate it, it is necessary for the explanation to be a middle term and to be proved in the first figure; for what is being proved is both universal and affirmative.

Well, one way would be the one just examined—proving what a thing is through another definition. For in the case of what a thing is, it is necessary for the middle term to state what the thing is (and in the case of what is proper it must be proper). Hence you will prove the one but you will not prove the other instance of what it is to be the same object. Now that this way will not be a demonstration was said earlier (but it is a general deduction of what the thing is).

But let us say in what way a demonstration *is* possible, speaking again from the beginning. Just as we seek the reason why when we grasp the fact—sometimes they actually become clear together, but it is not possible to become familiar with the reason why *before* the fact—it is clear that similarly we cannot grasp what it is to be something without grasping the fact that it is; for it is impossible to know what a thing is if we are ignorant of whether it is. But as to whether it is, sometimes we grasp this accidentally, and sometimes when grasping something of the object itself—e.g. of thunder, that it is a sort of noise of the clouds; and of eclipse, that it is a sort of privation of light; and of man, that he is a sort of animal; and of soul, that it is something moving itself.

Now in cases in which we know accidentally that a thing is, necessarily we have no hold on what it is; for we do not even know that it is, and to seek what it is without grasping that it is, is to seek nothing. But in the cases in which we grasp something, it is easier. Hence in so far as we grasp that it is, to that extent we also have some hold on what it is.

So in cases in which we grasp something of what the thing is, let it be first like this:—eclipse *A*, moon *C*, screening by the earth *B*. So to ask whether it is eclipsed or not is to seek whether *B* is or not. And this is no different from seeking whether there is an account of it; and if this is, we say that that is too. (Or: of which of the contradictory pair does the account hold—of its having two right angles or of its not having them?)

When we discover it, we know at the same time the fact and the reason why, if it is through immediates; if not, we know the fact but not the reason why. Moon, *C*; eclipse, *A*; not being able to produce a shadow during full moon though there is nothing evident between us, *B*. Then if *B*—not being able to produce a shadow though there is nothing evident between us—belongs to *C*, and *A*—being eclipsed—to this, then it is clear *that* it is eclipsed but not yet *why;* and we know *that* an eclipse is but we do not know *what* it is.

When it is clear that *A* belongs to *C*, then to seek why it belongs is to seek what *B* is—whether screening or rotation of the moon or extinction. And this is the account of the one extreme, i.e. in this case of *A*. For an eclipse is a screening by the earth.

What is thunder? Extinction of fire in cloud. Why does it thunder? Because the fire in the cloud is extinguished. Cloud *C*, thunder *A*, extinction of fire *B*. Thus *B* belongs to *C*, the cloud (for the fire is extinguished in it); and *A*, noise, to this; and *B* is indeed an account of *A*, the first extreme. And if again there is another middle term for this, it will be from among the remaining accounts.

We have said, then, how what a thing is is grasped and becomes familiar, hence no deduction and no demonstration of what a thing is comes about—yet it is clear through deduction and through demonstration. Hence without a demonstration you cannot become aware of what a thing is (in cases where the explanation is something else), yet there is no demonstration of it (as we said when we went through the puzzles).

9 · Of some things there is something else that is their explanation, of others there is not. Hence it is clear that in some cases what a thing is is immediate and a principle; and here one must suppose, or make apparent in some other way, both that they are and what they are (which the arithmetician does; for he supposes both what the unit is and that it is); but in those cases which have a middle term and for which something else is explanatory of their substance, one can, as we said, make them clear through a demonstration, but not by demonstrating what they are.

10 · Since a definition is said to be an account of what a thing is, it is evident that one type will be an account of what the name, or a different name-like account, signifies—e.g. what triangle signifies. And when we grasp that this is, we seek why

it is; but it is difficult to grasp in this way why a thing is if we do not know that it is. The explanation of the difficulty has been stated already—that we do not even know whether it is or not, except accidentally. (An account is a unity in two ways—either by connection, like the *Iliad*, or by making one thing clear of one thing non-accidentally.)

Thus one definition of definition is the one stated; another definition is an account which makes clear why a thing is. Hence the former type of definition signifies but does not prove, whereas the latter evidently will be a sort of demonstration of what a thing is, differing in position from the demonstration. For there is a difference between saying why it thunders and what thunder is; for in the one case you will say: Because the fire is extinguished in the clouds. What is thunder?—A noise of fire being extinguished in the clouds. Hence the same account is put in a different way, and in *this* way it is a continuous demonstration, in *this* way a definition.

Again, a definition of thunder is noise in the clouds; and this is a conclusion of the demonstration of what it is.

The definition of immediates is an undemonstrable positing of what they are.

One definition, therefore, is an undemonstrable account of what a thing is; one is a deduction of what it is, differing in aspect from the demonstration; a third is a conclusion of the demonstration of what it is.

So it is evident from what has been said, both in what way there is a demonstration of what a thing is, and in what way there is not; and in what cases there is and in what cases there is not; and again in how many ways something is called a definition, and in what way it proves what a thing is and in what way it does not, and in what cases it does and in what cases it does not; and again how it is related to demonstration and in what way it is possible for them to be of the same thing and in what way it is not possible.

11 · Since we think we understand when we know the explanation, and there are four types of explanation (one, what it is to be a thing; one, that if certain things hold it is necessary that this does; another, what initiated the change; and fourth, the aim), all these are proved through the middle term.

The case in which if something holds it is necessary that this does, does not occur if one proposition is assumed, but only if at least two are; and this occurs when they have one middle term. So when this one thing is assumed it is necessary for the conclusion to hold. It is clear too as follows: Why is the angle in the semicircle right? It is right if *what* holds? Well, let right be *A*; half of two rights *B*; the angle in the semicircle *C*. Thus *B* is the explanation of why *A*, right, belongs to *C*, the angle in the semicircle. For this is equal to *A* and *C* to *B*; for it is half of two rights. So if *B*, half of two rights, holds, then *A* belongs to *C* (that is, the angle in the semicircle is right). And what it is to be it is the same as this, since this is what its account signifies.

And the middle term has also been proved to be explanatory of what it is to be something.[43]

[43]Reading τοῦ τί ἦν εἶναι for τὸ τί ἦν εἶναι, and omitting Ross's ὄν.

And why did the Persian war come upon the Athenians? What is the explanation of the Athenians' being warred upon? Because they attacked Sardis with the Eretrians; for that initiated the change. War, *A*; being the first to attack, *B*; Athenians, *C*. Thus *B* belongs to *C* (being the first to attack to the Athenians), and *A* to *B* (for men make war on those who have first done them wrong). Therefore *A* belongs to *B* (being warred upon to those who first began), and this—*B*—to the Athenians (for they first began). Therefore here too the explanation, what initiated the change, is a middle term.

In cases in which the aim is explanatory—e.g. why does he walk about? In order to be healthy. Why is there a house? In order that his belongings may be preserved—in the one case with the aim of being healthy, in the other with the aim of their being preserved. (Why must he walk about after dinner? and With what aim must he? do not differ.) Walk after dinner, *C*; the foodstuffs' not remaining on the surface, *B*; being healthy, *A*. Well, let there belong to walking about after dinner, making the foodstuffs not to remain on the surface at the mouth of the stomach; and let this be healthy. For *B*, the foodstuffs' not remaining on the surface, seems to belong to walking about, *C*; and *A*, healthy, to this. So what is explanatory—the aim—for *C* of *A*'s belonging to it?—*B*, their not remaining on the surface. And this is as it were an account of it; for *A* will be set out in this way. Why is *B* explanatory for *C*? Because this, being in such a state, is what being healthy is. (One must transpose the accounts, and in this way everything will be more evident.)

Here the events are the other way about from those in the case of explanations in respect of change; for there the middle term must come about first, but here *C*, the last term, comes about first, and the final term to come about is the aim.

It is possible for the same thing to be the case both with some aim and from necessity—e.g. the light through the lantern; for the finer body passes through the larger pores both from necessity (if light comes about by passing through), and with some aim (in order that we shan't stumble).

Now if it is possible for something to be the case in this way, is it also possible for something to come about thus? E.g. if it thunders: when the fire is extinguished, it is necessary for it to sizzle and make a noise, and also (if things are as the Pythagoreans say) it has the aim of threatening those in Hell in order to make them afraid.

There are very many things of this sort, especially among things which are constituted by nature or are being so constituted; for one nature makes them with some aim and another from necessity. (Necessity is twofold: one, in accordance with nature and impulse; the other, by force and[44] contrary to impulse—e.g. a stone travels both upwards and downwards from necessity, but not because of the same necessity.) Among the products of thought, some never occur spontaneously—e.g. a house or a statute—nor from necessity either, but with some aim; but others occur by chance too—e.g. health and preservation. But it is especially among things

[44]Reading καί for ἤ.

which can be both thus and otherwise, when their coming about, not being by chance, is such that the end is good, that things come about with some aim, and then either by nature or by skill. but by change nothing comes about with any aim.

12 · The same thing is explanatory for what is coming about and what has come about and what will be as for what is the case (for the middle term is explanatory)—except that for what is the case, it is the case; for what is coming about, it is coming about; for what has come about, it has come about; and for what will be, it will be.

E.g. why has an eclipse come about? Because the earth has come to be in the middle. And it *is* coming about because it *is* coming to be there; and it will be because it will be in the middle; and it is because it is.

What is ice? Well, assume that it is solidified water. Water, *C*; solidified, *A*; the explanatory middle term *B*—utter lack of heat. Thus *B* belongs to *C*, and being solidified, *A*, to this. And ice is coming about if *B* is coming about; and it has come about if it has come about; and it will be if it will be.

Now what is explanatory in this way and what is explanatory of come about together when they come about, and are the case together when they are; and similarly for having come about and going to be. But what of things that do not go together—can it be that in continuous time, as it seems to us, one should be explanatory of another? something else that has come about of the fact that this has come about, and something else that will be of the fact that this will be, and of the fact that this is coming about something that came to be before?

Well, the deduction proceeds from what has come about later (but the principle of these things is actually what has come about—and similarly in the case of what is coming about), and it does not proceed from what is earlier (e.g. since this has come about, that this has come about later). And similarly for what will be the case. For whether the time is indeterminate or determined it will not be the case that since it is true to say that this has come about it is true to say that this, the later thing, has come about. For in between it will be false to say this, when the one has already come about. And the same account also goes for what will be the case.

Neither can one deduce that since this has come about this will be. For the middle term must be coeval—something that came about for what came about, something that will be for what will be, something that is coming about for what is coming about, something that is for what is; but it is not possible for anything to be coeval with "it has come about" and "it will be".

Again, the time in between can be neither determinate or determined; for it will be false to say it in between.

We must inquire what it is that holds things together so that after what *has* come about there are objects that *are* coming about. Or is it clear that what is coming about is *not* next to what has come about? For neither is what came about next to what came about; for they are limits and atomic. So just as points are not next to one another, neither are things that came about; for both are indivisible. Thus neither is what is coming about next to what has come about, for the same reason; for what is coming about is divisible, but what has come about is indivisible. So just as a line is related to a point, in the same way what is coming about is related to what has come about; for infinitely many things that have come about inhere in what is coming about.

But we must speak more clearly about this in our general account of change.

Now as to the character of the explanatory middle term when events occur consecutively, let this much be assumed. For here too it is necessary for the middle and the first term to be immediate.

E.g. *A* has come about since *C* has come about (*C* has come about later, *A* before; but *C* is the principle since it is nearer to the present, which is the principle of time); and *C* has come about if *D* has come about. Thus if *D* has come about it is necessary that *A* has come about; and *C* is the explanation—for if *D* came about it is necessary that *C* has come about, and if *C* has come about it is necessary that *A* has come about earlier.

If we take things in this way, will the middle term come to a stop anywhere at an immediate, or will there always be something falling in between because of the infinite nature of the past? For what has come about is not next to what has come about, as has been said. But nevertheless it is necessary to *begin* from something that is immediate and first from the present.

The same goes too for "it will be". For if it is true to say that *D* will be, then necessarily it was earlier true to say that *A* will be. And *C* is explanatory of this; for if *D* will be, *C* will be earlier; and if *C* will be, *A* will be earlier. And similarly the division is infinite in these cases too; for things that will be are not next to one another. But in these cases too an immediate principle must be got.

And it is like this in actual cases—if a house has come about it is necessary for stones to have been cut and to have come about. Why is this? Because it is necessary for a foundation to have come about if a house has come about; and if a foundation has come about, it is necessary for stones to have come about earlier.

Again, if there is going to be a house, in the same way there will be stones earlier. It is proved similarly through the middle term; for there will be a foundation earlier.

Since we see that among the things that come about there is a sort of circular coming about, it is possible for this to be the case if the middle term and the extremes follow one another; for in these cases there is conversion (this has been
96a1 proved in our first chapters[45] because the conclusions convert; and this is what being circular is.

In actual cases it appears as follows: if the earth is soaked, necessarily steam came about; and if that came about, cloud; and if that came about, water: and if that came about, it is necessary for the earth to be soaked. But this was what we started from; so that it has come round in a circle—for if any whatever of them is the case, another is; and if that, another; and if that, the first.

Some things come about universally (for always and in every case either it

[45] See I 3, 73a6–20.

holds or it comes about in this way), others not always but for the most part—e.g. not every male man has hair on his chin, but for the most part they do. Well, in such cases it is necessary for the middle term also to hold for the most part. For if A is predicated universally of B and this universally of C, it is necessary for A to be predicated of C always and in every case; for that is what the universal is—what holds in every case and always. But it was supposed to hold for the most part. Therefore it is necessary for the middle term, B, also to hold for the most part. There will be immediate principles, then, also in the case of what is for the most part, which hold or come about in this way for the most part.

13 · Now we have already said how what a thing is is set out in the terms, and in what way there is or is not demonstration or definition of it; let us now say how one should hunt out what is predicated in what a thing is.

Well, of the things which belong always to something, some extend further—yet not outside its genus. (I say they belong further if they belong to the thing universally but also belong to something else.) E.g. there is something which belongs to every triplet but also to non-triplets—as being belongs to the triplet but also to non-numbers, but odd both belongs to every triplet and belongs further (for it also belongs to the quintuplet), but not outside its genus; for the quintuplet is a number, and nothing outside number is odd.

Well, such things must be taken up to the first point at which just so many are taken that each will belong further but all of them together will not belong further; for necessarily this will be the substance of the object.

E.g. number belongs to every triplet, and so do odd, prime (in both ways—both as not being measured by number and as not being compounded from numbers). This, then, is precisely what a triplet is: a number that is odd, prime, and prime in *this* way. For each of these belongs in some cases to all the odds as well and in the last case to pairs as well—but all of them together belong to nothing other than the 96b1
triplet.

Since we have made clear above[46] that what is predicated in what a thing is is necessary[47] (and what is universal is necessary), and in the case of the triplet (and of anything else for which we take terms in this way) what is taken is in what it is, in this way a triplet will be these things from necessity.

And that they constitute its substance is clear from this: necessarily, if this is not what being a triplet is, it is some sort of genus, either named or nameless. It will, then, belong further than to the triplet—for let it be supposed that a genus is such as potentially to belong further. Then if it belongs to nothing other than the atomic triplets, this will be what being a triplet is—for let this too be supposed, that the substance of a thing is the last such predication to hold of the atoms. Hence in the case of anything else proved in this way, the same will go for what being it is.

When you are dealing with some whole, you should divide the genus into what

[46] See I 4.
[47] Reading ἀναγκαῖα, with the MSS., for Ross's καθόλου.

is atomic in species—the primitives—(e.g. number into triplet and pair); then in this way attempt to get definitions of these (e.g. of straight line and circle and right angle); and after that, grasping what the genus is (e.g. whether it is a quantity or a quality), consider the proper affections through the first common items.

For what holds for what is compounded from the atoms will be clear from the definitions, because definitions and what is simple are principles of everything, and what holds belongs in themselves to the simples alone, and to the other things in virtue of them.

Divisions made according to the differentiae are useful for this sort of pursuit: while the sense in which they prove has been discussed earlier,[48] they will be useful for deducing what a thing is only as follows.

Yet they might seem to be of no use, but to assume everything straight off—just as if one were to assume it from the beginning without the division. But it makes a difference which of the predicates are predicated first and which later—e.g. to say *animal tame two-footed* or *two-footed animal tame.* For if everything depends on two things and *animal tame* is a single thing, and again man (or whatever the single thing in question may be) depends on this and the differentia, then it is necessary to postulate by dividing.

Again, only in this way is it possible to ensure that you leave nothing out in what the thing is. For when the first genus has been taken, if you take one of the lower divisions not everything will fall into it—e.g. not every animal is either whole-winged or split-winged, but every *winged* animal (for it is *this* of which it is a differentia). The first differentia of animal is that into which every animal falls; and similarly of each of the others, both the genera outside it and those under it—e.g. the first differentia of bird is that into which every bird falls, and of fish, that into which every fish.

Now if you proceed in this way you can know that nothing has been left out; but in any other way you will of necessity both leave something out and not know it.

There is no need for one who is defining and dividing to know everything there is. Yet some say that it is impossible to know a thing's differences from something without knowing that thing; but that without the differences one cannot know that thing—for it is the same as that from which it does not differ and different from that from which it does differ.

Now, first, this is false; for a thing is not different in virtue of every difference; for many differences belong to things that are the same species—though not in respect of their substance, nor in themselves.

Next, when you assume the opposites and the differentia and that everything falls here or here, and assume that what you are seeking is in one of them, and are aware of this, it makes no difference whether you know or do not know the other things of which the differentiae are predicated. For it is evident that if, proceeding in this way, you come to things of which there is no longer a differentia, you will have the account of its substance. (And that everything falls into the division—if

[48]See Chapter 5.

they are opposites which have nothing between them—is not a postulate; for it is necessary for everything to be in one of them, if it is a differentia of that thing.)

To establish a definition through divisions, one must aim for three things—grasping what is predicated in what the thing is, ordering these as first or second, and ensuring that these are all there are.

The first one of these is achieved through being able to establish conclusions through the genus, just as in the case of accidentals one can deduce that they belong.[49]

And ordering them as one should will be achieved if you take the first term; and this will be achieved by taking the one which follows all the others but is not followed by them all (for of necessity there will be some such term). And when this is taken the same now goes for the lower terms; for second will be that which is first of the others, and third that which is first of the next; for if the upmost one is abstracted, the next will be first of the others. And similarly in the other cases too.

And that these are all there are is evident; for you assume of the first term in the division that every animal is either this or this, and that this belongs to it, and again you take the differentia of this whole, and you assume that there is no further differentia of the final whole—or that straightaway after the final differentia this no longer differs in species from the complex. For it is clear both that nothing extra has been posited (for all of these terms have been taken in what the thing is) and that nothing is missing (for it would be either a genus or a differentia: now both the first term, and this taken together with the differentiae, constitute the genus; and the differentiae are all grasped—for there is no later one left; for then the final term would differ in species, but it has been said not to differ).

We should look at what are similar and undifferentiated, and seek, first, what they all have that is the same; next, we should do this again for other things which are of the same genus as the first set and of the same species as one another but of a different species from those. And when we have grasped what all these have that is the same, and similarly for the others, then we must again inquire if what we have grasped have anything that is the same—until we come to a single account; for this will be the definition of the object. And if we come not to one but to two or more accounts, it is clear that what we are seeking is not a single thing but several.

I mean, e.g., if we were to seek what pride is we should inquire, in the case of some proud men we know, what one thing they all have as such. E.g. if Alcibiades is proud, and Achilles and Ajax, what one thing do they all have? Intolerance of insults; for one made war, one waxed wroth, and the other killed himself. Again in the case of others, e.g. Lysander and Socrates. Well, if here it is being indifferent to good and bad fortune, I take these two things and inquire what both indifference to fortune and not brooking dishonour have that is the same. And if there is nothing, then there will be two sorts of pride.

Every definition is always universal; for the doctor does not say what is healthy in the case of some individual eye, but either in the case of every eye, or determining some species of eye.

[49]Aristotle alludes to the methods of the *Topics*: on genera see esp. *Topics* IV.

And it is easier to define the particular than the universal—that is why one should cross from the particulars to the universals. For homonymies escape notice in what is universal more than in what is undifferentiated.

Just as in demonstrations a *deduction* must have been made, so in definitions there must be clarity. And this will be achieved if, through the stated[50] particulars, one can define separately for each genus (e.g. if one defines similarity not for every case but for colour and for shape, and sharpness for sound), and can then proceed in this way to what is common, taking care not to fall into homonymy.

And if one should not argue in metaphors, it is clear too that one should not define either by metaphors or what is said in metaphors; for then one will necessarily argue in metaphors.

98a1 **14** · In order to grasp problems, one should excerpt both the anatomies and the divisions; and in this way, laying down the genus common to all the subject-matter, one should excerpt (if e.g. animals are under consideration) whatever belongs to every animal; and having got this, again excerpt whatever follows every case of the first of the remaining terms (e.g. if it is bird, whatever follows every bird), and always excerpt in this way whatever follows the nearest term. For it is clear that we shall now be in a position to state the reason why what follows the items under the common genus belongs to them—e.g. why it belongs to man or to horse. Let *A* be animal, *B* what follows every animal, and *C*, *D*, *E* individual animals. Well, it is clear why *B* belongs to *D*; for it does so because of *A*. Similarly in the other cases too. and the same account will always hold for the others.[51]

Now at present we argue in terms of the common names that have been handed down; but we must not only inquire in these cases, but also if anything else has been seen to belong in common, we must extract that and then inquire what it follows and what follows it—e.g. having a manyplies and not having upper incisors follow having horns; again, we should inquire what having horns follows. For it is clear why what we have mentioned will belong to them; for it will belong because they have horns.

Again, another way is excerpting in virtue of analogy; for you cannot get one identical thing which pounce and spine and bone should be called; but there will be things that follow them too, as though there were some single nature of this sort.

15 · Problems are the same in some cases through having the same middle term, e.g. because they are all cases of reciprocity. And of these some are the same in genus—those which have differences through holding of different things or in different ways: e.g. Why does it echo? or Why is it mirrored? and Why is there a rainbow?—for all these are the same problem in genus (for they are all cases of reflection), but different in species.

Other problems differ in that the middle term of the one is under the other middle term; e.g. Why does the Nile flow more at the end of the month? Because

[50]Reading *εἰρημένων* with the MSS. for Ross's *εἰλημμένων*.
[51]Reading *ἄλλων* for *κάτω*.

the end of the month is more stormy. And why is the end more stormy? Because the moon is waning. For these are related in this way to one another.

16 · About explanations and what they are explanatory of, one might puzzle whether when the explanandum belongs to something the explanation belongs too. E.g. if it sheds its leaves or if it suffers eclipse, will the explanation of the eclipse or the shedding also hold—if this is, e.g. having broad leaves, and (for the eclipse) the earth's being in the middle? For if they do not hold, something else will be explanatory of them. And if the explanation belongs to it, does the explanandum also belong at the same time? e.g. if the earth is in the middle, it suffers eclipse; or if it is broad-leaved, it sheds its leaves.

If this is so, they will hold at the same time and will be proved through one another. For let shedding leaves be *A*, broad-leaved *B*, vine *C*. Well, if *A* belongs to *B* (for everything broad-leaved sheds its leaves) and *B* belongs to *C* (for every vine is broad-leaved), then *A* belongs to *C* and every vine sheds its leaves. *B*, the middle term, is explanatory. But one can also demonstrate that the vine is broad-leaved through the fact that it sheds its leaves. For let *D* be broad-leaved, *E* shedding leaves, *F* vine. Well, *E* belongs to *F* (for every vine sheds its leaves) and *D* to *E* (for everything that sheds its leaves is broad-leaved); therefore vine is broad-leaved. Shedding its leaves is explanatory.

But if it is not possible for things to be explanatory of one another (for the explanation is prior to what it is explanatory of), and the earth's being in the middle is explanatory of the eclipse, but the eclipse is not explanatory of the earth's being in the middle—so if the demonstration through the explanation gives the reason why, and the one not through the explanation gives the fact, you know *that* it is in the middle but not *why*. And that the eclipse is not explanatory of its being in the middle but the latter of the eclipse is evident; for its being in the middle belongs in the account of the eclipse; so that it is clear that the latter becomes familiar through the former and not the former through the latter.

Or is it possible for there to be several explanations of one thing? For if the same thing can be predicated of several things primitively—let *A* belong to *B* primitively and to another term, *C*, primitively; and these to *D*, *E*. Therefore *A* will belong to *D*, *E*; and *B* is explanatory for *D*, and *C* for *E*. Hence when the explanation belongs, it is necessary for the object to belong; but when the object belongs it is not necessary for everything which is explanatory to belong—something, yet not everything, explanatory must belong.

Or if problems are always universal, must the explanation be some whole and what it is explanatory of universal? E.g. shedding leaves is determined to some whole, even if that has species, and it belongs to *these* universally (either plants or plants of such and such a sort); hence in these cases the middle term and what it is explanatory of must be equal and convert. E.g. why do trees shed their leaves? Well, if it is because of solidification of their moisture, then if a tree sheds its leaves solidification must belong to it, and if solidification belongs—not to anything whatever but to a tree—it must shed its leaves.

17 · Is it possible for there not to be the same explanation of the same thing for every case, but a different one? or not? Perhaps if it has been demonstrated in itself and not in virtue of a sign or accidentally it is not possible (for the middle term is the account of the extreme), but if it has not been demonstrated in this way, it is possible? One can inquire accidentally both about what it is explanatory of and about what it is explanatory for—but these do not seem to be problems. Otherwise, the middle term will have a similar character—if they are homonymous, the middle will be homonymous; if they are in a genus, it will have a similar character.

E.g. why do proportionals alternate? For the explanation in the cases of lines and of numbers is different—*and* the same: as lines it is different, as having such and such an increase it is the same. And so in all cases.

The explanation of a colour's being similar to a colour and a figure to a figure is different in the different cases. For what is similar is homonymous in these cases; for here it is presumably having proportionate sides and equal angles, but in the case of colours it is that perception of them is single, or something else of that sort.

And things which are the same by analogy will have their middle term the same by analogy too.

The explanation and what it is explanatory of and what it is explanatory for are interrelated like this: taking them severally, what it is explanatory of extends further (e.g. having external angles equal to four right angles extends further than either triangle or quadrangle), but for all of them together it extends equally (for they comprise everything that has external angles equal to four right angles); and similarly for the middle term. (But the middle term is an account of the first extreme: that is why all the sciences come about through definition.)

E.g. shedding leaves follows together with the vine and exceeds it; and with the fig, and exceeds it—but not all of them, but it is equal.

Thus if you were to take the primitive middle term, it is an account of shedding leaves. For there will be a middle term in the other direction (that all are *such and such*); and then a middle for this (that the sap solidifies or something else of that sort). What is shedding leaves? The solidifying of the sap at the connection of the seed.

Schematically it will come out as follows for anyone seeking the interrelation between the explanation and what it is explanatory of: Let A belong to every B, and B to each of the D's, and further. Thus B will hold universally of the D's (for I call universal that with which they do not convert, and primitive universal that with which severally they do not convert but taken all together they do convert and extend alongside). Thus B is explanatory of A for the D's. Therefore A must extend alongside further than B; for if it does not, why will this be explanatory rather than that?

Well, if A belongs to all the E's, all of them together will be some one thing different from B. For if not, how will one be able to say that A belongs to everything to which E belongs but E does not belong to everything to which A belongs? For why will there not be some explanation, as of its belonging to all the D's? (But *will* the DE's be some one thing? We must inquire into this; let it be C.)

Thus it is possible for there to be several explanations of the same thing, but not for things of the same species—e.g. the explanation of longevity for quadrupeds is their not having bile, but for birds their being dry or something else.

18 · If they do not come at once to what is atomic and there is not only one middle term but several, the explanations too are several. But which of the middle terms is explanatory for the particulars—that which is primitive in the direction of the universal or that which is primitive in the direction of the particular? Well, it is clear that it is the one nearest to what it is explanatory for. For this explains why the primitive term belongs under the universal—i.e. *C* is explanatory for *D* of *B*'s belonging to it. So for *D C* is explanatory of *A*, and for *C B*, and for this itself.

19 · Now as for deduction and demonstration, it is evident both what each is and how it comes about—and at the same time this goes for demonstrative understanding too (for that is the same thing). But as for the principles—how they become familiar and what is the state that becomes familiar with them—that will be clear from what follows, when we have first set down the puzzles.

Now, we have said earlier that it is not possible to understand through demonstration if we are not aware of the primitive, immediate, principles. But as to knowledge of the immediates, one might puzzle both whether it is the same or not the same—whether there is understanding of each, or rather understanding of the one and some other kind of thing of the other—and also whether the states are not present in us but come about in us, or whether they are present in us but escape notice.

Well, if we have them, it is absurd; for it results that we have pieces of knowledge more precise than demonstration and yet this escapes notice. But if we get them without having them earlier, how might we become familiar with them and learn them from no pre-existing knowledge? For that is impossible, as we said in the case of demonstration too. It is evidently impossible, then, both for us to have them and for them to come about in us when we are ignorant and have no such state at all. Necessarily, therefore, we have some capacity, but do not have one of a type which will be more valuable than these in respect of precision.

And *this* evidently belongs to all animals; for they have a connate discriminatory capacity, which is called perception. And if perception is present in them, in some animals retention of the percept comes about, but in others it does not comes about. Now for those in which it does not come about, there is no knowledge outside perceiving (either none at all, or none with regard to that of which there is no retention); but for some[52] perceivers, it is possible to grasp it in their minds. And when many such things come about, then a difference comes about, so that some come to have an account from the retention of such things, and others do not.

So from perception there comes memory, as we call it, and from memory (when it occurs often in connection with the same thing), experience; for memories

[52]Reading ἐνίοις δ' ἔστιν αἰσθανομένοις for ἐν οἷς δ' ἔνεστιν αἰσθομένοις.

that are many in number from a single experience. And from experience, or from the whole universal that has come to rest in the soul (the one apart from the many, whatever is one and the same in all those things), there comes a principle of skill and of understanding—of skill if it deals with how things come about, of understanding if it deals with what is the case.

Thus the states neither belong in us in a determinate form, nor come about from other states that are more cognitive; but they come about from perception—as in a battle when a rout occurs, if one man makes a stand another does and then another, until a position of strength[53] is reached. And the soul is such as to be capable of undergoing this.

What we have just said but not said clearly, let us say again: when one of the undifferentiated things makes a stand, there is a primitive universal in the mind (for though one perceives the particular, perception is of the universal—e.g. of man but not of Callias the man); again a stand is made in these, until what has no parts and is universal stands—e.g. *such and such* an animal stands, until animal does, and in this a stand is made in the same way. Thus it is clear that it is necessary for us to become familiar with the primitives by induction; for perception too[54] instils the universal in this way.

Since of the intellectual states by which we grasp truth some are always true and some admit falsehood (e.g. opinion and reasoning—whereas understanding and comprehension are always true), and no kind other than comprehension is more precise than understanding, and the principles of demonstrations are more familiar, and all understanding involves an account—there will not be understanding of the principles; and since it is not possible for anything to be truer than understanding, except comprehension, there will be comprehension of the principles—both if we inquire from these facts and because demonstration is not a principle of demonstration so that understanding is not a principle of understanding either—so if we have no other true kind apart from understanding, comprehension will be the principle of understanding. And the principle will be of the principle, and understanding as a whole will be similarly related to the whole object.

[53]Reading ἀλκήν for ἀρχήν.
[54]Reading καί for ἤ.

TOPICS

W. A. Pickard-Cambridge

BOOK I

1 · Our treatise proposes to find a line of inquiry whereby we shall be able to reason from reputable opinions about any subject presented to us, and also shall ourselves, when putting forward an argument, avoid saying anything contrary to it. First, then, we must say what deduction is, and what its varieties are, in order to grasp dialectical deduction; for this is the object of our search in the treatise before us.

Now a deduction is an argument in which, certain things being laid down, something other than these necessarily comes about through them. It is a demonstration, when the premisses from which the deduction starts are true and primitive, or are such that our knowledge of them has originally come through premisses which are primitive and true; and it is a dialectical deduction, if it reasons from reputable opinions. Things are true and primitive which are convincing on the strength not of anything else but of themselves; for in regard to the first principles of science it is improper to ask any further for the why and wherefore of them; each of the first principles should command belief in and by itself. On the other hand, those opinions are reputable which are accepted by everyone or by the majority or by the wise—i.e. by all, or by the majority, or by the most notable and reputable of them. Again, a deduction is contentious if it starts from opinions that seem to be reputable, but are not really such, or again if it merely seems to reason from opinions that are or seem to be reputable. For not every opinion that seems to be reputable actually is reputable. For none of the opinions which we call reputable show their character entirely on the surface, as happens in the case of the principles of contentious arguments; for the nature of the falsity in these is obvious immediately, and for the most part even to persons with little power of comprehension. So then, of the contentious deductions mentioned, the former really deserves to be called deduction, but the other should be called contentious deduction, but not deduction, since it appears to deduce, but does not really do so.

Further, besides all the deductions we have mentioned there are the fallacies that start from the premisses peculiar to the special sciences, as happens (for

TEXT: J. Brunschwig, Budé Paris, 1967 (Books I–IV)
W. D. Ross, OCT, Oxford, 1958 (Books V–VIII)

example) in the case of geometry and its sister sciences. For this form of reasoning appears to differ from the deductions mentioned above; the man who draws a false figure reasons from things that are neither true and primitive, nor yet reputable. For he does not fall within the definition: he does not assume opinions that are received either by everyone or by the majority or by the wise—that is to say, by all, or by most, or by the most reputable of them—but he conducts his deduction upon assumptions which, though appropriate to the science in question, are not true; for he effects his fallacy either by describing the semicircles wrongly or by drawing certain lines in a way in which they should not be drawn.

The foregoing must stand for an outline survey of the species of deduction. In general, in regard both to all that we have already discussed and to those which we shall discuss later, we may remark that that amount of distinction between them may serve, because it is not our purpose to give a precise definition of any of them; we merely want to describe them in outline: we consider it quite enough from the point of view of the line of inquiry before us to be able to recognize each of them in some sort of way.

2 · Next in order after the foregoing, we must say for how many and for what purposes the treatise is useful. They are three—intellectual training, casual encounters, and the philosophical sciences. That it is useful as a training is obvious on the face of it. The possession of a plan of inquiry will enable us more easily to argue about the subject proposed. For purposes of casual encounters, it is useful because when we have counted up the opinions held by most people, we shall meet them on the ground not of other people's convictions but of their own, shifting the ground of any argument that they appear to us to state unsoundly. For the study of the philosophical sciences it is useful, because the ability to puzzle on both sides of a subject will make us detect more easily the truth and error about the several points that arise. It has a further use in relation to the principles used in the several sciences. For it is impossible to discuss them at all from the principles proper to the particular science in hand, seeing that the principles are primitive in relation to everything else: it is through reputable opinions about them that these have to be discussed, and this task belongs properly, or most appropriately, to dialectic; for dialectic is a process of criticism wherein lies the path to the principles of all inquiries.

3 · We shall be in perfect possession of the way to proceed when we are in a position like that which we occupy in regard to rhetoric and medicine and faculties of that kind; [this means the doing of that which we choose with the materials that are available.][1] for it is not every method that the rhetorician will employ to persuade, or the doctor to heal: still, if he omits none of the available means, we shall say that his grasp of the science is adequate.

[1]Brunschwig excises this sentence.

4 · First, then, we must see of what parts our inquiry consists. Now if we were to grasp with reference to how many, and what kind of, things arguments take place, and with what materials they start, and how we are to become well supplied with these, we should have sufficiently won our goal. Now the materials with which arguments start are equal in number, and are identical, with the subjects on which deductions take place. For arguments start with propositions, while the subjects on which deductions take place are problems. Now every proposition and every problem indicates either a genus or a property or an accident—for the differentia too, being generic, should be ranked together with the genus. Since, however, of what is proper to anything part signifies its essence, while part does not, let us divide the proper into both the aforesaid parts, and call that part which indicates the essence a definition, while of the remainder let us adopt the terminology which is generally current about these things, and speak of it as a property. What we have said, then, makes it clear that according to our present division, the elements turn out to be four, all told, namely either property or definition or genus or accident. Do not let any one suppose us to mean that each of these enunciated by itself constitutes a proposition or problem, but only that it is from these that both problems and propositions are formed. The difference between a problem and a proposition is a difference in the turn of the phrase. For if it be put in this way, 'Is two-footed terrestrial animal the definition of man?' or 'Is animal the genus of man?' the result is a proposition; but if thus, 'Is two-footed terrestrial animal the definition of man or not?' and 'Is animal the genus of man or not?' the result is a problem. Similarly too in other cases. Naturally, then, problems and propositions are equal in number; for out of every proposition you will make a problem if you change the turn of phrase.

5 · We must now say what are definition, property, genus, and accident. A definition is a phrase signifying a thing's essence. It is rendered in the form either of a phrase in lieu of a name, or of a phrase in lieu of another phrase; for it is sometimes possible to define the meaning of a phrase as well. People whose rendering consists of a term only, try it as they may, clearly do not render the definition of the thing in question, because a definition is always a phrase of a certain kind. One may, however, call definitory such a remark as that the beautiful is the becoming, and likewise also of the question, 'Are perception and knowledge the same or different?'—for argument about definitions is mostly concerned with questions of sameness and difference. In a word we may call definitory everything that falls under the same branch of inquiry as definitions; and that all the above-mentioned examples are of this character is clear on the face of them. For if we are able to argue that two things are the same or are different, we shall be well supplied by the same turn of argument with lines of attack upon their definitions as well; for when we have shown that they are not the same we shall have demolished the definition. But the converse of this last statement does not hold; for to show that they are the same is not enough to establish a definition. To show, however, that they are not the same is enough of itself to overthrow it.

A property is something which does not indicate the essence of a thing, but yet belongs to that thing alone, and is predicated convertibly of it. Thus it is a property of man to be capable of learning grammar; for if he is a man, then he is capable of learning grammar, and if he is capable of learning grammar, he is a man. For no one calls anything a property which may possibly belong to something else, e.g. sleep in the case of man, even though at a certain time it may happen to belong to him alone. That is to say, if any such thing were actually to be called a property, it will be called not a property absolutely, but a temporary or a relative property; for being on the right hand side is a temporary property, while two-footed is a relative property; e.g. it is a property of man relatively to a horse and a dog. That nothing which may belong to anything else is a convertible predicate is clear; for it does not necessarily follow that if something is asleep it is a man.

A genus is what is predicated in what a thing is of a number of things exhibiting differences in kind. We should treat as predicates in what a thing is all such things as it would be appropriate to mention in reply to the question, 'What is the object in question?'; as, for example, in the case of man, if asked that question, it is appropriate to say 'He is an animal'. The question, 'Is one thing in the same genus as another or in a different one?' is also a generic question; for a question of that kind as well falls under the same branch of inquiry as the genus; for having argued that animal is the genus of man, and likewise also of ox, we shall have argued that they are in the same genus; whereas if we show that it is the genus of the one but not of the other, we shall have argued that these things are not in the same genus.

An accident is something which, though it is none of the foregoing—i.e. neither a definition nor a property nor a genus—yet belongs to the thing; and something which may either belong or not belong to any one and the self-same thing, as (e.g.) being seated may belong or not belong to some self-same thing. Likewise also whiteness; for there is nothing to prevent the same thing being at one time white and at another not white. Of the definitions of accident the second is the better; for in the case of the first, any one is bound, if he is to understand it, to know already what definition and genus and property are, whereas the second is sufficient of itself to tell us the essential nature of the thing in question. To accident are to be attached also all comparisons of things together, when expressed in language that is derived in any kind of way from accident; such as, for example, the question, 'Is the honourable or the expedient preferable?' and 'Is the life of virtue or the life of self-indulgence the pleasanter?', and any other problem which may happen to be phrased in terms like these. For in all such cases the question is 'of which of the two is the predicate more properly an accident?' It is clear on the face of it that there is nothing to prevent an accident from becoming a temporary or a relative property. Thus being seated is an accident, but will be a temporary property, whenever a man is the only person sitting, while if he is not the only one sitting, it is still a property relatively to those who are not sitting. So then, there is nothing to prevent an accident from becoming both a relative and a temporary property; but a property absolutely it will never be.

6 · We must not fail to observe that everything applicable to property and genus and accident will be applicable to definition as well. For when we have shown that the content of the definition fails to belong to the subject alone, as we do in the case of a property, or that the genus rendered in the definition is not the true genus, or that any of the things mentioned in the phrase used does not belong, as would be remarked in the case of an accident, we shall have demolished the definition; so that, in the sense previously described, all the points we have enumerated might in a way be called definitory. But we must not on this account expect to find a single line of inquiry which will apply universally to them all; for this is not an easy thing to find, and, even were one found, it would be very obscure indeed, and of little service for the treatise before us. Rather, a special plan of inquiry must be laid down for each of the classes we have distinguished, and then, starting from what is appropriate in each case, it will be easier to make our way right through the task before us. So then, as was said before, we must outline a division of our subject, and other questions we must relegate each to the particular branch to which it most naturally belongs, speaking of them as definitory and generic questions. The questions I mean have practically been already assigned to their several branches.

7 · First of all we must determine the number of ways we talk of sameness. Sameness would be generally regarded as falling, roughly speaking, into three divisions. We generally apply the term numerically or specifically or generically—numerically in cases where there is more than one name but only one thing, e.g. doublet and cloak; specifically, where there is more than one thing, but they present no differences in respect of their species, as one man and another, or one horse and another; for things like this that fall under the same species are said to be specifically the same. Similarly, too, those things are called generically the same which fall under the same genus, such as a horse and a man. It might appear that the sense in which water from the same spring is called the same water is somehow different and unlike the senses mentioned above; but really such a case as this ought to be ranked in the same class with the things that in one way or another are called the same in view of unity of species. For all such things seem to be of one family and to resemble one another. For the reason why all water is said to be specifically the same as all other water is because of a certain likeness it bears to it, and the only difference in the case of water drawn from the same spring is this, that the likeness is more emphatic: that is why we do not distinguish it from the things that in one way or another are called the same in view of unity of species. It seems that things numerically one are called the same by everyone with the greatest degree of agreement. But this too is apt to be rendered in more than one sense; its most literal and primary use is found whenever the sameness is rendered by a name or definition, as when a cloak is said to be the same as a doublet, or a two-footed terrestrial animal is said to be the same as a man; a second sense is when it is rendered by a property, as when what can acquire knowledge is called the same as a man, and what naturally travels upward the same as fire; while a third use is found

when it is rendered in reference to some accident, as when the creature who is sitting, or who is musical, is called the same as Socrates. For all these are meant to signify numerical unity. That what I have just said is true may be best seen where one form of appellation is substituted for another. For often when we give the order to call one of the people who are sitting down, indicating him by name, we change our description, whenever the person to whom we give the order happens not to understand us; he will, we think, understand better from some accidental feature; so we bid him call to us the man who is sitting or who is conversing—clearly supposing ourselves to be indicating the same object by its name and by its accident.

8 · Of sameness then, as has been said, three types are to be distinguished. Now one way to confirm that the elements mentioned above are those out of which and through which and to which arguments proceed, is by induction; for if any one were to survey propositions and problems one by one, it would be seen that each was formed either from the definition of something or from its property or from its genus or from its accident. Another way to confirm it is through deduction. For every predicate of a subject must of necessity be either convertible with its subject or not: and if it is convertible, it would be its definition or property, for if it signifies the essence, it is the definition; if not, it is a property—for this was what a property is, viz. what is predicated convertibly, but does not signify the essence. If, on the other hand, it is not predicated convertibly of the thing, it either is or is not one of the terms contained in the definition of the subject; and if it is one of those terms, then it will be the genus or the differentia, inasmuch as the definition consists of genus and differentiae; whereas, if it is not one of those terms, clearly it would be an accident, for accident was said to be what belongs to a subject without being either its definition or its genus or a property.

9 · Next, then, we must distinguish between the categories of predication in which the four above-mentioned are found. These are ten in number: What a thing is, Quantity, Quality, Relation, Place, Time, Position, State, Activity, Passivity. For the accident and genus and property and definition of anything will always be in one of these predications; for all the propositions found through these signify either what something is or its quality or quantity or some one of the other types of predicate. It is clear, too, on the face of it that the man who signifies what something is signifies sometimes a substance, sometimes a quality, sometimes some one of the other types of predicate. For when a man is set before him and he says that what is set there is a man or an animal, he states what it is and signifies a substance; but when a white colour is set before him and he says that what is set there is white or is a colour, he states what it is and signifies a quality. Likewise, also, if a magnitude of a cubit be set before him and he says that what is set there is a cubit or a magnitude, he will be describing what it is and signifying a quantity. Likewise, also, in the other cases; for each of these kinds of predicate, if either it be asserted of itself, or its genus be asserted of it, signifies what something is; if, on the other hand, one kind of predicate is asserted of another kind, it does not signify what something is, but a quantity or a quality or one of the other kinds of predicate. Such,

then, and so many, are the subjects on which arguments take place, and the materials with which they start. How we are to acquire them, and by what means 104a1
we are to become well supplied with them, falls next to be told.

10 · First, then, a definition must be given of a dialectical proposition and a dialectical problem. For it is not every proposition nor yet every problem that is to be set down as dialectical; for no one in his senses would make a proposition of what no one holds, nor yet make a problem of what is obvious to everybody; for the latter admits of no doubt, while to the former no one would assent.

Now a dialectical proposition consists in asking something that is reputable to all men or to most men or to the wise, i.e. either to all, or to most, or to the most notable of these, provided it is not paradoxical; for a man would probably assent to the view of the wise, if it be not contrary to the opinions of most men. Dialectical propositions also include views which are like those which are reputable; also propositions which contradict the contraries of opinions that are taken to be reputable, and also all opinions that are in accordance with the recognized arts. Thus, supposing it to be reputable that the knowledge of contraries is the same, it might probably pass for reputable also that the perception of contraries is the same; also, supposing it to be a reputable opinion that there is but one single science of grammar, it might pass for a reputable opinion that there is but one science of flute-playing as well—and if more than one science of grammar, more than one science of flute-playing as well; for all these seem to be alike and akin. Likewise, also, propositions contradicting the contraries of reputable opinions will pass as reputable; for if it is a reputable opinion that one ought to do good to one's friends, it will also be a reputable opinion that one ought not to do them harm. Here, that one ought to do harm to one's friends is the contrary, and that one ought not to do them harm is the contradictory of that contrary. Likewise also, if one ought to do good to one's friends, one ought not to do good to one's enemies: this too is the contradictory of the contrary—the contrary being that one ought to do good to one's enemies. Likewise, also, in other cases. Also, on comparison, it will look like a reputable opinion that the contrary predicate belongs to the contrary subject: e.g. if one ought to do good to one's friends, one ought also to do evil to one's enemies. (It might appear as if doing good to one's friends were a contrary to doing evil to one's enemies; but whether this actually is or is not so in reality will be stated in the course of the discussion of contraries.)[2] Clearly also, all opinions that are in accordance with the arts are dialectical propositions; for people are likely to assent to the views held by those who have made a study of these things, e.g. on a question of medicine they will agree with the doctor, and on a question of geometry with the geometrician; and likewise also in other cases.

11 · A dialectical problem is a subject of inquiry that contributes either to 104b1
choice and avoidance, or to truth and knowledge, and does that either by itself, or as a help to the solution of some other such problem. It must, moreover, be something

[2]See II 7.

on which either people hold no opinion either way, or most people hold a contrary opinion to the wise, or the wise to most people, or each of them among themselves. For some problems it is useful to know only with a view to choice or avoidance, e.g. whether pleasure is to be chosen or not, while some it is useful to know merely with a view to knowledge, e.g. whether the universe is eternal or not; others, again, are not useful in themselves for either of these purposes, but yet help us in regard to some such problems; for there are many things which we do not wish to know in themselves, but for the sake of other things, in order that through them we may come to know something else. Problems also include questions in regard to which deductions conflict (the difficulty then being whether so-and-so is so or not, there being convincing arguments for both views); others also in regard to which we have no argument because they are so vast, and we find it difficult to give our reasons, e.g. the question whether the universe is eternal or no; for into questions of that kind too it is possible to inquire.

Problems, then, and propositions are to be defined as aforesaid. A thesis is a paradoxical belief of some eminent philosopher; e.g. the view that contradiction is impossible, as Antisthenes said; or the view of Heraclitus that all things are in motion; or that what exists is one, as Melissus says; for to take notice when any ordinary person expresses views contrary to men's usual opinions would be silly. Or it may be a view contrary to men's usual opinions about which we have an argument, e.g. the view maintained by the sophists that what is need not in every case either have come to be or be eternal; for a musician who is a grammarian is so without ever having come to be so, or being so eternally. For even if some do not accept this view, a man might do so on the ground that it has an argument in its favour.

Now a thesis also is a problem, though a problem is not always a thesis, inasmuch as some problems are such that we have no opinion about them either way. That a thesis is a problem, is clear; for it follows of necessity from what has been said that either the mass of men disagree with the wise about the thesis, or that the one or the other class disagree among themselves, seeing that the thesis is a paradoxical belief. Practically all dialectical problems indeed are now called theses. But it should make no difference whichever description is used; for our object in thus distinguishing them has not been to create a terminology, but to recognize what differences actually exist between them.

Not every problem, nor every thesis, should be examined, but only one which might puzzle one of those who need argument, not punishment or perception. For people who are puzzled to know whether one ought to honour the gods and love one's parents or not need punishment, while those who are puzzled to know whether snow is white or not need perception. The subjects should not border too closely upon the sphere of demonstration, nor yet be too far removed from it; for the former cases admit of no doubt, while the latter involve difficulties too great for the art of the trainer.

12 · Having made these distinctions, we must distinguish how many species there are of dialectical arguments. There are induction and deduction. Now what

deduction is has been said before; induction is a passage from particulars to universals, e.g. the argument that supposing the skilled pilot is the most effective, and likewise the skilled charioteer, then in general the skilled man is the best at his particular task. Induction is more convincing and clear: it is more readily learnt by the use of the senses, and is applicable generally to the mass of men; but deduction is more forcible and more effective against contradictious people.

13 · The classes, then, of things about which, and of things out of which, arguments are constructed, are to be distinguished in the way we have said before. The instruments whereby we are to become well supplied with deductions are four: one, the securing of propositions; second, the power to distinguish in how many ways an expression is used; third, the discovery of the differences of things; fourth, the investigation of likeness. The last three, as well, are in a certain sense propositions; for it is possible to make a proposition corresponding to each of them, e.g. that the desirable is either the honourable or the pleasant or the expedient; and that sensation differs from knowledge in that the latter may be recovered again after it has been lost, while the former cannot; and that the relation of the healthy to health is like that of the vigorous to vigour. The first proposition depends upon the use of one term in several ways, the second upon the differences of things, the third upon their likenesses.

14 · Propositions should be selected in as many ways as we drew distinctions in regard to the proposition: thus one may choose the opinions held by all or by most men or by the wise, i.e. by all, or most, or the most notable of them—if they are not contrary to those that seem to be generally held; and, again, all opinions that are in accordance with the arts. We must make propositions also of the contradictories of opinions contrary to those that seem to be generally held, as was laid down before. It is useful also to make them by selecting not only those opinions that actually are reputable, but also those that are like these, e.g. that the perception of contraries is the same—the knowledge of them being so—and that we see by admission of something into ourselves, not by an emission; for so it is, too, in the case of the other senses; for in hearing we admit something into ourselves; we do not emit; and we taste in the same way. Likewise also in the other cases. Moreover, all statements that seem to be true in all or in most cases, should be taken as a principle or accepted thesis; for they are posited by those who do not also see what exception there may be. We should select also from the written handbooks of argument, and should draw up sketch-lists of them upon each several kind of subject, putting them down under separate headings, e.g. 'On Good', or 'On Life'—and that 'On Good' should deal with every form of good, beginning with the essence. In the margin, too, one should indicate also the opinions of individual thinkers, e.g. that Empedocles said that the elements of bodies were four; for any one might assent to the saying of some reputable authority.

Of propositions and problems there are—to comprehend the matter in outline—three divisions; for some are ethical propositions, some are on natural science, while some are logical. Propositions such as the following are ethical, e.g. 'Ought one rather to obey one's parents or the laws, if they disagree?'; such as this are logical, e.g. 'Is the knowledge of opposites the same or not?'; while such as this are on natural science, e.g. 'Is the universe eternal or not?' Likewise also with problems. The nature of each of the aforesaid kinds of proposition is not easily rendered in a definition, but we have to try to recognize each of them by means of the familiarity attained through induction, examining them in the light of the illustrations given above.

For purposes of philosophy we must treat of these things according to their truth, but for dialectic only with an eye to opinion.

All propositions should be taken in their most universal form; then, the one should be made into many. E.g. 'The knowledge of opposites is the same'; next, 'The knowledge of contraries is the same', and 'of relative terms'. In the same way these should again be divided, as long as division is possible, e.g. the knowledge of good and evil, of white and black, of cold and hot. Likewise also in other cases.

106a1 15 · On the subject of propositions, the above remarks are enough. As regards the number of ways in which a term is used, we must not only treat of those terms which are used in different ways, but we must also try to render their definitions; e.g. we must not merely say that justice and courage are called good in one way, and that what conduces to vigour and what conduces to health are called so in another, but also that the former are so called because of a certain intrinsic quality they themselves have, the latter because they are productive of a certain result and not because of any intrinsic quality in themselves. Similarly also in other cases.

Whether a term is used in many ways or in one only, may be considered by the following means. First, look and see if its contrary is used in many ways, whether the discrepancy between them be one of kind or one of names. For in some cases a difference is at once displayed even in the names; e.g. the contrary of sharp in the case of a sound is flat, while in the case of a body it is dull. Clearly, then, the contrary of sharp is used in many ways, and if so, so also is sharp; for corresponding to each of the former terms the contrary will be different. For sharp will not be the same when contrary to dull and to flat, though sharp is the contrary of each. Again that in the case of a sound has sharp as its contrary, but in the case of a body raised,[3] so that that is used in many ways, inasmuch as its contrary also is so used. Likewise, also, fine as applied to an animal has ugly as its contrary, but, as applied to a house, mean; so that fine is homonymous.

In some cases there is no discrepancy of any sort in the names used, but a difference of kind is at once obvious: e.g. in the case of clear and obscure;[4] for sound is called clear and obscure, just as colour is too. As regards the names, then, there is no discrepancy, but the difference in kind is at once obvious; for colour is not called

[3]Literally not 'raised' but 'light' (κοῦφος): here, as often, Greek and English ambiguities do not march together.

[4]Literally, 'white and black'.

clear in a like way to sound. This is plain also through sensation; for of things that are the same in kind we have the same sense, whereas we do not judge clearness by the same sense in the case of sound and of colour, but in the latter case we judge by sight, in the former by hearing. Likewise also with sharp and dull in regard to flavours and bodies: here in the latter case we judge by touch, but in the former by taste. For here again there is no discrepancy in the names used, in the case either of the original terms or of their contraries; for the contrary of sharp in either case is dull.

Moreover, see if one use of a term has a contrary, while another has absolutely none; e.g. the pleasure of drinking has a contrary in the pain of thirst, whereas the pleasure of seeing that the diagonal is incommensurate with the side has none, so that pleasure is used in more than one way. To love also, used of the frame of mind, has to hate as its contrary, while as used of the physical activity it has none; clearly, therefore, to love is homonymous.

Further, see in regard to their intermediates, if one use has an intermediate, while another has none, or if both have one but not the same one, as e.g. clear and obscure in the case of colours have grey as an intermediate, whereas in the case of sound they have none, or, if they have, it is muffled, as some people say that a muffled sound is intermediate. Clear, then, is homonymous, and likewise also obscure.

See, moreover, if some of them have more than one intermediate, while others have but one, as is the case with clear and obscure; for in the case of colours there are numbers of intermediates, whereas in regard to sound there is but one, viz. muffled.

Again, in the case of the contradictory opposite, look and see if it is used in more than one way. For if it is, then the opposite of it also will be used in more than one way; e.g. to fail to see is used in more than one way, viz. to fail to possess the power of sight, and to fail to put that power to active use. But if this is used in more than one way, it follows necessarily that to see also is used in more than one way; for there will be an opposite to each way of failing to see; e.g. the opposite of failing to possess the power of sight is to possess it, while of failing to put the power of sight to active use, the opposite is to put it to active use.

Moreover, examine the case of terms that are opposed as privation and possession; for if the one term is used in more than one way, then so will the remaining term: e.g. if to perceive is used in more than one way, as applied to the soul and to the body, then to be imperceptive too will be used in more than one way, as applied to the soul and to the body. That the opposition between the terms now in question depends upon privation and possession is clear, since animals naturally possess each kind of perception, both as applied to the soul and as applied to the body.

Moreover, examine the inflected forms. For if 'justly' is used in more than one way, the 'just', also, will be used in more than one way; for there will be a 'just' corresponding to each 'justly'; e.g. if 'justly' is used of judging according to one's own opinion, and also of judging as one ought, then 'just' also will be used in like manner. In the same way also, if 'healthy' is used in more than one way, then 'healthily' also will be used in more than one way: e.g. if healthy is what produces health and what preserves health and what betokens health, then 'healthily' also will be used to mean 'in such a way as to produce' or 'preserve' or 'betoken' health. Likewise also in other cases, whenever the original term is used in more than one way, the inflexion also that is formed from it will be used in more than one way, and vice versa.

Look also at the classes of the predicates signified by the term, and see if they are the same in all cases. For if they are not the same, then clearly the term is homonymous: e.g. good in the case of food is what is productive of pleasure, and in the case of medicine what is productive of health, whereas as applied to the soul it is to be of a certain quality, e.g. temperate or courageous or just; and likewise also, as applied to a man. Sometimes it signifies what happens at a certain time, as (e.g.) what happens at the right time; for what happens at the right time is called good. Often it signifies what is of a certain quantity, e.g. as applied to the proper amount; for the proper amount too is called good. So then good is homonymous. In the same way also clear, as applied to a body, signifies a colour, but in regard to a sound it denotes what is easy to hear. Sharp, too, is in a closely similar case; for the same term does not have the same use in all its applications; for a sharp note is a swift note, as the mathematical theorists of harmony tell us, whereas a sharp angle is one that is less than a right angle, while a sharp dagger is one cut at a sharp angle.

Look also at the genera of the objects denoted by the same name, and see if they are different without the one falling under the other, as (e.g.) donkey is both the animal and the engine. For the account of them that corresponds to the name is different; for the one will be declared to be an animal of a certain kind, and the other to be an engine of a certain kind. If, however, the genera are subordinate one to the other, there is no necessity for the accounts to be different. Thus (e.g.) animal is the genus of raven, and so is bird. Whenever therefore we say that the raven is a bird, we also say that it is a certain kind of animal, so that both the genera are predicated of it. Likewise also whenever we call the raven a winged two-footed animal, we declare it to be a bird; in this way, then, as well, both the genera are predicated of raven. But in the case of genera that are not subordinate one to the other this does not happen; for whenever we call a thing an engine, we do not call it an animal, nor vice versa.

Look also and see not only if the genera of the term before you are different without being subordinate one to the other, but also in the case of its contrary; for if its contrary is used in many ways, clearly the term before you is as well.

It is useful also to look at the definition that arises from the use of the term in combination, e.g. of a clear body and of a clear sound. For then if what is proper to each case be abstracted, the same phrase ought to remain over. This does not happen in the case of homonyms, e.g. in the cases just mentioned. For the former will be a body possessing such and such a colour, while the latter will be a sound easy to hear. Abstract, then, 'a body' and 'a sound', and the remainder in each case is not the same. It should, however, have been, had clear in each case been synonymous.

Often in the actual accounts as well homonymy creeps in without being noticed, and for this reason the accounts also should be examined. If (e.g.) any one describes what betokens and produces health as being in a balanced state, we must not desist but go on to examine in what sense he has used the term 'balanced' in each case, e.g. if in the latter case it means that it is of the right amount to produce health, whereas in the former it means that it is such as to betoken what kind of state prevails.

Moreover, see if the terms cannot be compared as more or less or as in like degree, as is the case (e.g.) with a clear sound and a clear argument,[5] and a sharp flavour and a sharp sound. For neither are these things said to be clear or sharp in a like degree, nor yet is the one said to be clearer or sharper than the other. Clear, then, and sharp are homonymous. For synonyms are always comparable; for they will always hold either in like manner, or else in a greater degree in one case.

Now since of genera that are different without being subordinate one to the other the differentiae also are different in kind, e.g. those of animal and knowledge (for the differentiae of these are different), look and see if the items falling under the same term are differentiae of genera that are different without being subordinate one to the other, as e.g. sharp is of a sound and a body. For being sharp differentiates sound from sound, and likewise also one body from another. Sharp, then, is homonymous; for it forms differentiae of genera that are different without being subordinate one to the other.

Again, see if the items falling under the same term themselves have different differentiae, e.g. colour in bodies and colour in tunes; for the differentiae of colour in bodies are dispersing the eye and compressing the eye, whereas colour in melodies has not the same differentiae. Colour, then, is homonymous; for things that are the same have the same differentiae.

Moreover, since the species is never the differentia of anything, look and see if one of the items falling under the same term is a species and another a differentia, as (e.g.) clear as applied to a body is a species of colour, whereas in the case of a sound it is a differentia; for one sound is differentiated from another by being clear.

16 · Thus when a term is used in many ways, it may be investigated by these and like means. The differences which things present to each other should be examined both in the genera themselves (e.g. 'Wherein does justice differ from courage, and wisdom from temperance?'—for all these belong to the same genus); and also from one genus to another, provided they are not too far apart (e.g. 'Wherein does perception differ from knowledge?'); for in the case of genera that are very far apart, the differences are entirely obvious.

17 · Likeness should be studied, first, in the case of things belonging to different genera, the formula being: as one is to one thing, so is another to another (e.g. as knowledge stands to the object of knowledge, so is perception related to the

[5] Literally 'garment'.

object of perception), or: as one is in one thing, so is another in another (e.g. as sight is in the eye, so is intellect in the soul, and as is a calm in the sea, so is windlessness in the air). Practice is more especially needed in regard to terms that are far apart; for in the case of the rest, we shall be more easily able to see the points of likeness. We should also look at things which belong to the same genus, to see if any identical attribute belongs to them all, e.g. to a man and a horse and a dog; for in so far as they have any identical attribute, in so far they are alike.

18 · It is useful to have examined the number of uses of a term both for clearness' sake (for a man is more likely to know what it is he asserts, if it has been made clear to him how many uses it may have), and also with a view to ensuring that our deductions shall be in accordance with the actual facts and not addressed merely to the word used. For as long as it is not clear in how many ways a term is used, it is possible that the answerer and the questioner are not directing their minds upon the same thing; whereas when once it has been made clear how many uses there are, and also upon which of them the former directs his mind when he makes his assertion, the questioner would then look ridiculous if he failed to address his argument to this. It helps us also both to avoid being misled and to mislead by fallacies; for if we know the number of uses of a term, we shall certainly never be misled by fallacy, but shall know if the questioner fails to address his argument to the same point; and when we ourselves put the questions we shall be able to mislead him, if our answerer happens not to know the number of uses of our terms. This, however, is not possible in all cases, but only when of the many uses some are true and others are false. This manner of argument, however, does not belong properly to dialectic; dialecticians should therefore by all means beware of this kind of verbal discussion, unless any one is absolutely unable to discuss the subject before him in any other way.

The discovery of differences helps us both in deductions about sameness and difference, and also in recognizing what any particular thing is. That it helps us in
108b1 deductions about sameness and difference is clear; for when we have discovered a difference of any kind whatever between the objects before us, we shall already have proved that they are not the same; while it helps us in recognizing what a thing is, because we usually distinguish the account that is proper to the substance of each particular thing by means of the differentiae that are appropriate to it.

The examination of likeness is useful with a view both to inductive arguments and to hypothetical deductions, and also with a view to the rendering of definitions. It is useful for inductive arguments, because it is by means of an induction of particulars in cases that are alike that we claim to induce the universal; for it is not easy to do this if we do not know the points of likeness. It is useful for hypothetical deductions because it is a reputable opinion that among similars what is true of one is true also of the rest. If, then, with regard to any of them we are well supplied with matter for a discussion, we shall secure a preliminary admission that however it is in these cases, so it is also in the case before us; then when we have proved the former we shall have proved, on the strength of the hypothesis, the matter before us as well; for we have first made the hypothesis that however it is in these cases, so it is also in the case before us, and have then produced the demonstration. It is useful for the rendering of definitions because, if we are able to see what is the same in each individual case of it, we shall be at no loss when we define it; for of the common predicates that which is most definitely predicated in what the thing is is likely to be the genus. Likewise, also, in the case of objects widely divergent, the examination of likeness is useful for purposes of definition, e.g. the sameness of a calm at sea, and windlessness in the air (each being a form of rest), and of a point on a line and the unit in number (each being a principle). If, then, we render as the genus what is common to all the cases, we shall get the credit of defining not inappropriately. Definition-mongers too nearly always render them in this way; for they declare the unit to be the principle of number, and the point the principle of a line. It is clear, then, that they place them in that which is common to both as their genus.

The instruments, then, whereby deductions are effected, are these; the commonplace rules, for the observance of which the aforesaid instruments are useful, are as follows.

BOOK II

1 · Of problems some are universal, others particular. Universal problems are such as 'Every pleasure is good' and 'No pleasure is good'; particular problems are such as 'Some pleasure is good' and 'Some pleasure is not good.' The methods of establishing and overthrowing a view universally are common to both kinds of problems; for when we have proved that a predicate belongs in every case, we shall also have proved that it belongs in some cases. Likewise, also, if we prove that it does not belong in any case, we shall also have proved that it does not belong in every case. First, then, we must speak of the methods of overthrowing a view universally, because such are common to both universal and particular problems, and because people more usually introduce theses asserting a predicate than denying it, while those who argue with them overthrow it.

The conversion of an appropriate name which is derived from an accident is an extremely precarious thing; for in the case of accidents and in no other it is possible for something to be true in a certain respect and not universally. Names derived from definition and property and genus are bound to be convertible; e.g. if being a two-footed terrestrial animal belongs to something, then it will be true by conversion to say that it is a two-footed terrestrial animal. Likewise, also, if derived from the genus; for if being an animal belongs to something, then it is an animal. The same is true also in the case of a property; for if being capable of learning grammar belongs to something, then it will be capable of learning grammar. For none of these attributes can possibly belong or not belong in part; they must either belong or not belong absolutely. In the case of accidents, on the other hand, there is nothing to prevent an attribute (e.g. whiteness or justice) belonging in part, so that it is not enough to show that whiteness or justice belongs to a man in order to show that he is white or just; for it is open to dispute it and say that he is white or just in part only. Conversion, then, is not a necessary process in the case of accidents.

We must also define the errors that occur in problems. They are of two kinds, caused either by false statement or by transgression of the established use of language. For those who make false statements, and say that something belongs to a thing which does not belong to it, commit error; and those who call objects by the names of other objects (e.g. calling a plane-tree a man) transgress the established terminology.

2 · Now one commonplace rule is to look and see if a man has ascribed as an accident what belongs in some other way. This mistake is most commonly made in regard to the genera of things, e.g. if one were to say that being a colour is an accident of white—for being a colour does not happen by accident to white, but colour is its genus. The assertor may of course make the mistake in so many words, saying (e.g.) that it is an accident of justice to be a virtue; but often even without such explicitness it is obvious that he has rendered the genus as an accident; e.g. suppose that one were to say that whiteness is coloured or that walking is in motion. For a predicate drawn from the genus is never ascribed to the species in a derived form, but always the genera are predicated of their species synonymously; for the species take on both the name and the account of their genera. A man therefore who says that white is coloured has not rendered it as its genus, seeing that he has used a derived form, nor yet as its property or as its definition; for the definition and property of a thing belong to it and to nothing else, whereas many things besides white are coloured, e.g. a log, a stone, a man, a horse. Clearly then he renders it as an accident.

Another rule is to examine all cases where a predicate has been said to belong to all or none of something. Look at them species by species, and not in their infinite multitude; for then the inquiry will proceed more directly and in fewer steps. You should look and begin with the primitives, and then proceed in order down to those that are not further divisible: e.g. if a man has said that the knowledge of opposites is the same, you should look and see whether it be so of relative opposites and of contraries and of terms opposed as privation and possession, and of contradictory terms. Then, if no clear result is reached so far in these cases, you should again divide these until you come to those that are not further divisible, and see (e.g.) whether it is so of just deeds and unjust, or of the double and the half, or of blindness and sight, or of being and not-being; for if in any case it is proved that the knowledge of them is not the same we shall have demolished the problem. Likewise, also, if the predicate belongs in no case. This rule is convertible for both destructive and constructive purposes; for if, as we proceed with the division, the predicate appears to hold in all or in a large number of cases, we may then claim that the other should actually assert it universally, or else bring an objection to show in what case it is not so; for if he does neither of these things, a refusal to assert it will make him look absurd.

Another rule is to make accounts both of an accident and of its subject, either of both separately or else of one of them, and then look and see if anything untrue has been assumed as true in the accounts. Thus (e.g) to see if it is possible to wrong a god, ask what is to wrong? For if it be to injure deliberately, clearly it is not possible for a god to be wronged; for it is impossible that God should be injured. Again, to see if the good man is jealous, ask who is the jealous man and what is jealousy. For if jealousy is pain at the apparent success of some honest person, clearly the good man is not jealous; for then he would be bad. Again, to see if the indignant man is jealous, ask who each of them is; for then it will be obvious whether the statement is true or false; e.g. if he is jealous who grieves at the successes of the good, and he is indignant who grieves at the successes of the evil, then clearly the indignant man would not be jealous. A man should substitute accounts also for the words contained in his account, and not stop until he comes to something familiar; for often when the account is given as a whole, the point at issue is not cleared up, whereas if for one of the words used in the account an account be stated, it becomes obvious.

Moreover, a man should make the problem into a proposition for himself, and then bring an objection against it; for the objection will be a ground of attack upon the thesis. This rule is very nearly the same as the rule to look into cases where a predicate has been said to belong to all or none of something; but it differs in the turn of the argument.

Moreover, you should determine what kind of things should be called as most men call them, and what should not. For this is useful both for establishing and for overthrowing a view: e.g. you should say that we ought to use our words to mean the same things as most people mean by them, but when we ask what kinds of things are or are not of such and such a kind, we should not here go with the multitude: e.g. it is right to call healthy whatever tends to produce health, as do most men; but in saying whether the object before us tends to produce health or not, we should adopt the language no longer of the multitude but of the doctor.

3 · Moreover, if a term be used in several ways, and it has been laid down that it belongs or that it does not belong to something, you should prove your case of one of its several uses, if you cannot prove it of both. This rule is to be observed in cases where the difference of use is undetected; for supposing this to be obvious, then the other man will object that the point which he himself questioned has not been discussed, but only the other point. This commonplace rule is convertible for purposes both of establishing and of overthrowing a view. For if we want to establish a statement, we shall prove that in one use the attribute belongs, if we cannot show it of both; whereas if we are overthrowing a statement, we shall prove that in one use the attribute does not belong, if we cannot prove it of both. Of course, in overthrowing a statement there is no need to start the discussion by securing any admission, whether the attribute is said to belong to all or to none of something; for if we prove that in any case whatever the attribute does not belong, we shall have demolished the universal assertion of it, and likewise if we prove that it belongs even in a single case, we shall demolish the universal denial of it. Whereas in establishing a statement we ought to secure a preliminary admission that if it belongs in any case whatever, it belongs universally, supposing this claim to be a plausible one. For it is not enough to argue for a single instance in order to prove that an attribute belongs

universally; e.g. to argue that if the soul of man is immortal, then every soul is immortal, so that a previous admission must be secured that if any soul whatever is immortal, then every soul is immortal. This is not to be done in every case, but only whenever we are not easily able to quote any single argument applying to all cases in common, as (e.g.) the geometrician can argue that the triangle has its angles equal to two right angles.

If, again, the multiplicity of uses of a term is obvious, distinguish how many uses it has before proceeding either to demolish or to establish: e.g. supposing the right thing to do to be the expedient or the honourable, you should try either to establish or to demolish both of the subject in question; e.g. by showing that it is honourable and expedient, or that it is neither honourable nor expedient. Supposing, however, that it is impossible to show both, you should prove the one, adding an indication that it is true in the one sense and not in the other. The same rule applies also when the number of uses into which it is divided is more than two.

Again, consider those terms whose uses are many, but differ not by way of homonymy, but in some other way: e.g. The science of many things is one: here many things may be the end and the means to that end, as (e.g.) medicine is the science both of producing health and of dieting; or they may be both of them ends, as the science of contraries is said to be the same (for of contraries the one is no more an end than the other); or again they may be an essential and an accidental attribute, as (e.g.) the essential fact that the triangle has its angles equal to two right angles, and the accidental fact that the equilateral figure has them so—for it is because of the accident of the equilateral triangle happening to be a triangle that we know that it has its angles equal to two right angles. If, then, it is not possible in any way that the science of many things should be the same, it clearly is altogether impossible that it should be so; or, if it is possible in some way, then clearly it is possible. Distinguish as many uses as are required: e.g. if we want to establish a view, we should bring forward such uses as admit that view, and should divide them only into those which also are required for the establishment of our case; whereas if we want to overthrow a view, we should bring forward all that do not admit that view, and leave the rest aside. We must proceed thus in this case too when the multiplicity of uses goes unnoticed. Further, that one thing is, or is not, of or for another should be established by means of the same commonplace rules; e.g. that a particular science is of a particular thing, treated either as an end or as a means to its end, or as accidentally connected with it; or again that it is not of or for it in any of the aforesaid ways. The same rule holds true also of desire and all other terms that have more than one object. For the desire for something may be the desire for it as an end (e.g. the desire for health) or as a means to an end (e.g. the desire for being doctored), or as a thing desired accidentally, as, in the case of wine, the sweet-toothed person desires it not because it is wine but because it is sweet. For he desires the sweet for itself, and the wine only accidentally; for if it is dry, he no longer desires it. His desire for it is therefore accidental. This rule is useful in dealing with relative terms; for cases of this kind are generally cases of relative terms.

4 · Moreover, it is well to alter a word into one more familiar, e.g. to substitute 'clear' for 'precise' in describing a conception, and 'meddling' for 'officious'; for when the expression is made more familiar, the thesis becomes easier to attack. This commonplace rule also is available for both purposes alike, both for establishing and for overthrowing a view.

In order to prove that contrary attributes belong to the same thing, look at its genus; e.g. if we want to prove that rightness and wrongness are possible in regard to perception: to perceive is to judge, and it is possible to judge rightly or wrongly; thus in regard to perception as well rightness and wrongness must be possible. In the present instance the demonstration proceeds from the genus and relates to the species; for judging is the genus of perceiving; for the man who perceives judges in a certain way. Again, it may proceed from the species to the genus; for all the attributes that belong to the species belong to the genus as well; e.g. if there is a bad and a good knowledge there is also a bad and a good disposition; for disposition is the genus of knowledge. Now the former commonplace argument is false for purposes of establishing a view, while the second is true. For there is no necessity that all the attributes that belong to the genus should belong also to the species; for animal is winged and quadruped, but not so man. All the attributes, on the other hand, that belong to the species must of necessity belong also to the genus; for if man is good, then animal also is good. On the other hand, for purposes of overthrowing a view, the former argument is true while the latter is false; for all the attributes which do not belong to the genus do not belong to the species either; whereas all those that are wanting to the species are not of necessity wanting to the genus.

Since those things of which the genus is predicated must also of necessity have one of its species predicated of them, and since those things that are possessed of the genus in question, or are described by terms derived from that genus, must also of necessity be possessed of one of its species or be described by terms derived from one of its species (e.g. if knowledge is predicated of something, then so too will be grammatical or musical knowledge, or knowledge of one of the other sciences; and if any one possesses knowledge or is described by a term derived from knowledge, then he will also possess grammatical or musical knowledge or knowledge of one of the other sciences, or will be described by a term derived from one of them, e.g. as a grammarian or a musician)—therefore if any expression be asserted that is in any way derived from the genus (e.g. that the soul is in motion), look and see whether it is possible for the soul to be moved with any of the species of motion; whether (e.g.) it can grow or be destroyed or come to be, and so forth with all the other species of motion. For if it cannot be moved in any of these ways, clearly it does not move at all. This commonplace rule is common for both purposes, both for overthrowing and for establishing a view; for if the soul moves with one of the species of motion, clearly it does move; while if it does not move with any of the species of motion, clearly it does not move.

If you are not well equipped with an argument against the thesis, look among the definitions, real or apparent, of the thing before you, and if one is not enough, draw upon several. For it will be easier to attack people when committed to a definition. [For an attack is always more easily made on definitions.][6]

Moreover, look and see in regard to the thing in question, what is such that if it is the case the thing in question is the case, or what is necessarily the case if the thing in question is the case: if you wish to establish a view inquire what there is such that if it is the case the thing in question will be the case (for if the former be proved to hold, then the thing in question will also have been proved to hold); while if you want to overthrow a view, ask what it is that is the case if the thing in question is the case (for if we show that what follows from the thing in question is not the case, we shall have demolished the thing in question).

Moreover, look at the time involved, to see if there is any discrepancy anywhere: e.g. suppose a man to have stated that what is being nourished of necessity grows; for animals are always being nourished, but they do not always grow. Likewise, also, if he has said that knowing is remembering; for the one is concerned with past time, whereas the other has to do also with the present and the future. For we are said to know things present and future (e.g. that there will be an eclipse), whereas it is impossible to remember anything save what is past.

5 · Moreover, there is the sophistic turn of argument, whereby we draw our opponent into the kind of statement against which we shall be well supplied with lines of argument. This process is sometimes a real necessity, sometimes an apparent necessity, sometimes neither an apparent nor a real necessity. It is really necessary whenever the answerer has denied any view that would be useful in attacking the thesis, and the questioner thereupon addresses his arguments to the support of this view, and when moreover the view in question happens to be one of a kind on which he has a good stock of lines of argument. Likewise, also, it is really necessary whenever starting from the view laid down, he reduces it to something else and then tries to demolish that statement; for when this has been demolished, the view originally laid down is demolished as well. It is an apparent necessity, when the point to which the arguments come to be directed appears to be useful, and relevant to the thesis, without being really so; whether it be that the man who is undertaking the argument has refused to concede something, or whether the questioner has reached it by a reputable reduction based upon the thesis and then tries to demolish it. The remaining case is when the point to which the argument comes to be directed is neither really nor apparently necessary, and it turns out that the answer is refuted on an irrelevant issue. You should beware of the last of the aforesaid methods; for it appears to be wholly disconnected from, and foreign to, the art of dialectic. For this reason, moreover, the answerer should not lose his temper, but assent to those statements that are of no use in attacking the thesis, adding an indication whenever he assents although he does not agree with the view. For, for the most part, it increases the confusion of questioners if, after all propositions of this kind have been granted them, they can then draw no conclusion.

Moreover, any one who has made any statement whatever has in a certain

[6] This sentence is excised by Brunschwig.

sense made several statements, inasmuch as each statement has a number of necessary consequences: e.g. anyone who said that something is a man has also said that it is an animal and that it is animate and a biped and capable of acquiring reason and knowledge, so that by the demolition of any single one of these consequences, of whatever kind, the original statement is demolished as well. But you should beware here of making a change to a more difficult subject; for sometimes the consequence, and sometimes the original thesis, is the easier to demolish.

6 · In regard to subjects which must have one and one only of two predicates, as (e.g.) a man must have either illness or health, supposing we are well supplied as regards the one for arguing its presence or absence, we shall be well equipped as regards the remaining one as well. This rule is convertible for both purposes; for when we have proved that the one attribute belongs, we shall have proved that the remaining one does not belong; while if we prove that the one does not belong, we shall have proved that the remaining one does belong. Clearly then the rule is useful for both purposes.

Moreover, you may attack by reinterpreting a word in respect of its account, with the implication that it is most fitting so to take it rather than in its established meaning: e.g. it is not, as established use has it, the courageous man who is strong-hearted, but rather the man the state of whose heart is strong—just as the man whose arms are strong is strong-armed.[7] Likewise also the man whose star is good is well-starred—as Xenocrates says, he who has a noble soul is well-starred. For a man's star is his soul.

Some things occur of necessity, others for the most part, others however it may chance; if therefore what is necessary has been asserted to hold for the most part, or if what holds for the most part (either itself or its contrary) has been stated to hold of necessity, it always gives an opportunity for attack. For if what is necessary has been asserted to hold for the most part, clearly the speaker has denied an attribute to be universal which is universal, and so has made a mistake; and so he has if he has declared what holds for the most part to be necessary; for then he declares it to belong universally when it does not so belong. Likewise also if he has declared the contrary of what holds for the most part to be necessary. For the contrary of what holds for the most part is always a comparatively rare attribute: e.g. if men are for the most part bad, they are comparatively seldom good, so that his mistake is even worse if he has declared them to be good of necessity. The same is true also if he has declared a matter of chance to hold of necessity or for the most part; for a matter of chance holds neither of necessity nor for the most part. If the thing holds for the most part, then even supposing his statement does not distinguish whether he meant that it holds for the most part or that it holds necessarily, it is open to you to discuss it on the assumption that he meant that it holds necessarily: e.g. if he has stated without any distinction that disinherited persons are bad, you may assume in discussing it that he means that they are so necessarily.

[7]Literally: 'the man who hopes for good things is hopeful (εὔελπις)'.

Moreover, look and see also if he has stated a thing to be an accident of itself, taking it to be a different thing because it has a different name, as Prodicus used to divide pleasures into joy and delight and good cheer; for all these are names of the same thing, to wit, pleasure. If then any one says that joyfulness is an accidental attribute of cheerfulness, he would be declaring it to be an accidental attribute of itself.

7 · Inasmuch as contraries can be conjoined with each other in six ways, and four of these conjunctions constitute a contrariety, we must take hold of contraries in whatever way they may be of use both in demolishing and in establishing a view. Well then, that the modes of conjunction are six is clear; for either each of the one pair of contraries will be conjoined to each of the other; and this gives two modes, e.g. to do good to friends and to do evil to enemies, or *per contra* to do evil to friends and to do good to enemies. Or else both of the first pair may be attached to one of the second; and this too gives two modes, e.g. to do good to friends and to do evil to friends, or to do good to enemies and to do evil to enemies. Or one of the first pair may be attached to both of the second; and this also gives two modes, e.g. to do good to friends and to do good to enemies, or to do evil to friends and evil to enemies.

The first two then of the aforesaid conjunctions do not constitute any contrariety; for the doing of good to friends is not contrary to the doing of evil to enemies; for both courses are desirable and belong to the same disposition. Nor is the doing of evil to friends contrary to the doing of good to enemies; for both of these are objectionable and belong to the same disposition; and one objectionable thing is not thought to be the contrary of another, unless the one refers to an excess, and the other to a defect—for an excess is thought to belong to the class of objectionable things, and likewise also a defect. But the other four all constitute a contrariety. For to do good to friends is contrary to the doing of evil to friends; for it proceeds from the contrary disposition, and the one is desirable, and the other objectionable. The case is the same also in regard to the other conjunctions; for in each combination the one course is desirable, and the other objectionable, and the one belongs to an honourable disposition and the other to a bad. Clearly, then, from what has been said, the same thing has more than one contrary. For the doing of good to friends has as its contrary both the doing of good to enemies and the doing of evil to friends. Likewise, if we examine them in the same way, we shall find that the contraries of each of the others also are two in number. Select therefore whichever of the two contraries is useful in attacking the thesis.

Moreover, if the accident of a thing has a contrary, see whether it belongs to the subject to which the accident in question has been declared to belong; for if the latter belongs the former could not belong; for it is impossible that contrary predicates should belong at the same time to the same thing.

Or again, look and see if anything has been said about something, of such a kind that if it is true, contrary predicates must necessarily belong to the thing; e.g. if he has said that the Ideas exist in us. For then the result will be that they are both in motion and at rest, and moreover that they are objects both of sensation and of thought. For according to those who posit the existence of Ideas, those Ideas are at rest and are objects of thought; while if they exist in us, it is impossible that they should be unmoved; for when we move, it follows necessarily that all that is in us moves with us as well. Clearly also they are objects of sensation, if they exist in us; for it is through the sensation of sight that we recognize the form present in each individual.

Again, if there be posited an accident which has a contrary, look and see if that which admits of the accident will admit of its contrary as well; for the same thing admits of contraries. Thus (e.g.) if he has asserted that hatred follows anger, hatred would in that case be in the spirited faculty; for that is where anger is. You should therefore look and see if its contrary is also in the spirited faculty; for if not—if friendship is in the faculty of desire—then hatred will not follow anger. Likewise also if he has asserted that the faculty of desire is ignorant. For if it were capable of ignorance, it would be capable of knowledge as well: and this does not seem to be so—I mean that the faculty of desire is capable of knowledge. For purposes, then, of overthrowing a view you should proceed as we have said; but for purposes of establishing one, though the rule will not help you to assert that the accident actually belongs, it will help you to assert that it may possibly belong. For having proved that the thing in question will not admit of the contrary, we shall have proved that the accident neither belongs nor can possibly belong; while on the other hand, if we prove that the contrary belongs, or that the thing is capable of the contrary, we shall not indeed as yet have proved that the accident asserted does belong as well; our proof will merely have gone to this point, that it is possible for it to belong.

8 · Seeing that the modes of opposition are four in number, you should look among the contradictories of your terms, reversing the order of their sequence, both when demolishing and when establishing a view; and you should grasp this by means of induction. E.g. if man is an animal, what is not an animal is not a man; and likewise also in other instances of contradictories. For here the sequence is reversed; for animal follows upon man, but not-animal does not follow upon not-man, but the reverse—not-man upon not-animal. In all cases, therefore, a claim of this sort should be made, (e.g.) that if the honourable is pleasant, what is not pleasant is not honourable, while if the latter is not so, neither is the former. Likewise, also, if what is not pleasant is not honourable, then what is honourable is pleasant. Clearly, then, reversing the sequence in the case of contradictories is a method convertible for both purposes.

Then look also at the case of the contraries, and see if the contrary of the one follows upon the contrary of the other, either directly or conversely, both when you are demolishing and when you are establishing a view; and grasp this too by means of induction. Now the sequence is direct in a case such as that of courage and cowardice; for upon the one of them virtue follows, and vice upon the other; and upon the one it follows that it is desirable, while upon the other it follows that it is objectionable. The sequence in the latter case also is direct; for the desirable is the contrary of the objectionable. Likewise also in other cases. The sequence is converse in such a case as this: health follows upon vigour, but disease does not follow upon debility; rather debility follows upon disease. In this case, then, clearly the sequence is converse. Converse sequence is, however, rare in the case of contraries; usually the sequence is direct. If, therefore, the contrary of the one term does not follow upon the contrary of the other either directly or conversely, clearly neither does the one term follow upon the other in the statement made; whereas if the one follows the other in the case of the contraries, it must of necessity do so as well in the original statement.

You should look also into cases of privation and possession in like manner to the case of contraries. Only, in the case of privations the converse sequence does not occur: the sequence is always bound to be direct; e.g. as perception follows sight, while absence of perception follows blindness. For perception is opposed to absence of perception as possession and privation; for the one of them is a possession, and the other privation.

The case of relative terms should also be studied in like manner to privation; for the sequence of these as well is direct; e.g. if thrice is a multiple, then a third is a fraction; for thrice is relative to a third, and so is a multiple to a fraction. Again, if knowledge is a belief, then also the object of knowledge is an object of belief; and if sight is a perception, then also the object of sight is an object of perception. An objection may be made that there is no necessity for the sequence to take place, in the case of relative terms, in the way described; for an object of perception is an object of knowledge, whereas perception is not knowledge. The objection, however, does not seem to be true; for many people deny that there is knowledge of objects of perception. Moreover, the principle stated is just as useful for the contrary purpose, e.g. to show that the object of perception is not an object of knowledge, on the ground that neither is perception knowledge.

9 · Again look at the co-ordinates and the inflexions, both in demolishing and in establishing. By co-ordinates are meant things such as the following: just deeds and the just man are co-ordinates of justice, and courageous deeds and the courageous man are co-ordinates of courage. Likewise also things that tend to produce and to preserve anything are co-ordinates of that which they tend to produce and to preserve, as e.g. healthy habits are co-ordinates of health and vigorous habits of vigour—and so forth also in other cases. Such things, then, are usually called co-ordinates. Inflexions are such as the following: 'justly', 'courageously', 'healthily', and such as are formed in this way. It is usually held that inflected forms as well are co-ordinates, as (e.g.) 'justly' in relation to justice, and 'courageously' to courage; and then all the members of the same series are co-ordinates, e.g. justice, just man, just deed, justly. Clearly, then, when any one member, whatever its kind, of the same series is proved to be good or praiseworthy, then all the rest as well come to be proved to be so: e.g. if justice is something praiseworthy, then so will a just man, and a just deed, and 'justly' connote something praiseworthy. Then 'justly' will be rendered also 'praiseworthily',

derived by the same inflexion from the praiseworthy as 'justly' is derived from justice.

Look not only in the case of the subject mentioned, but also in the case of its contrary, for the contrary predicate: e.g. argue that good is not necessarily pleasant; for neither is evil painful; or that, if the latter is the case, so is the former. Also, if justice is knowledge, then injustice is ignorance: and if 'justly' means 'knowingly' and 'skilfully', then 'unjustly' means 'ignorantly' and 'unskilfully'; whereas if the latter is not true, neither is the former, as in the instance given just now—for 'unjustly' is more likely to seem equivalent to 'skilfully' than to 'unskilfully'. This commonplace rule has been stated before in dealing with the sequence of contraries; for all we are claiming now is that the contrary follows the contrary.

Moreover, look at the modes of generation and destruction of a thing, and at the things which tend to produce or to destroy it, both in demolishing and in establishing a view. For those things whose modes of generation rank among good things, are themselves also good; and if they themselves are good, so also are their modes of generation. If, on the other hand, their modes of generation are evil, then they themselves also are evil. In regard to modes of destruction the converse is true; for if the modes of destruction rank as good things, then they themselves rank as evil things; whereas if the modes of destruction count as evil, they themselves count as good. The same argument applies also to things tending to produce and destroy; for things whose productive causes are good, themselves also rank as good; whereas if causes destructive of them are good, they themselves rank as evil.

10 · Again, look at things which are like the subject in question, and see if they are in like case; e.g. if one branch of knowledge has more than one object, so also will one opinion; and if to possess sight is to see, then also to possess hearing will be to hear. Likewise also in the case of other things, both those which are and those which are held to be like. The rule in question is useful for both purposes; for if it is as stated in the case of some one like thing, it is so with the other like things as well, whereas if it is not so in the case of some one of them, neither is it so in the case of the others. Look and see also whether the cases are alike as regards a single thing and a number of things; for sometimes there is a discrepancy. Thus, if to know a thing is to think of it, then also to know many things is to be thinking of many things; whereas this is not true; for it is possible to know many things but not to be thinking of them. If, then, the latter is not true, neither was the former that dealt with a single thing, viz. that to know a thing is to think of it.

Moreover, argue from greater and less degrees. There are four commonplace rules. One is: see whether a greater degree of the predicate follows a greater degree of the subject: e.g. if pleasure is good, see whether also a greater pleasure is a greater good; and if to do a wrong is evil, see whether also to do a greater wrong is a greater evil. Now this rule is of use for both purposes; for if an increase of the accident follows an increase of the subject, as we have said, clearly the accident belongs; while if it does not follow, the accident does not belong. You should establish this by induction. Another rule is: if one predicate is attributed to two subjects, then supposing it does not belong to the subject to which it is the more likely to belong, neither does it belong where it is less likely to belong; while if it does belong where it is less likely to belong, then it belongs as well where it is more likely. Again: if two predicates are attributed to one subject, then if the one which is more generally thought to belong does not belong, neither does the one that is less generally thought to belong; or, if the one that is less generally thought to belong does belong, so also does the other. Moreover: if two predicates are attributed to two subjects, then if the one which is more usually thought to belong to the one subject does not belong, neither does the remaining predicate belong to the remaining subject; or, if the one which is less usually thought to belong to the one subject does belong, so too does the remaining predicate to the remaining subject.

Moreover, you can argue from the fact that an attribute belongs, or is thought to belong, in a like degree, in three ways, viz. those described in the last three rules given in regard to a greater degree. For supposing that one predicate belongs, or is thought to belong, to two subjects in a like degree, then if it does not belong to the one, neither does it belong to the other; while if it belongs to the one, it belongs to the remaining one as well. Or, supposing two predicates to belong in a like degree to the same subject, then, if the one does not belong, neither does the remaining one; while if the one does belong, the remaining one belongs as well. The case is the same also if two predicates belong in a like degree to two subjects; for if the one predicate does not belong to the one subject, neither does the remaining predicate belong to the remaining subject, while if the one predicate does belong to the one subject, the remaining predicate belongs to the remaining subject as well.

11 · You can argue, then, from greater or less or like degrees in the aforesaid manner of ways. Moreover, you should argue from the addition of one thing to another. If the addition of one thing to another makes that other good or white, whereas formerly it was not white or good, then the thing added will be white or good—it will possess the character it imparts to the whole as well. Moreover, if an addition of something to a given object intensifies the character which it had, then the thing added will itself as well be of that character. Likewise, also, in the case of other attributes. The rule is not applicable in all cases, but only in those in which an increased intensity is found to take place. The above rule is, however, not convertible for overthrowing a view. For if the thing added does not make the other good, it is not thereby made clear whether in itself it may not be good; for the addition of good to evil does not necessarily make the whole good, any more than the addition of white to black makes the whole white.

Again, any predicate of which we can speak of greater or less degrees belongs also without qualification; for greater or less degrees of good or of white will not be attributed to what is not good or white; for a bad thing will never be said to have a greater or less degree of goodness, but always of badness. This rule is not convertible, either, for the purpose of overthrowing; for several predicates of which we cannot speak of a greater degree belong without qualification; for the term man is not attributed in greater and less degrees, but a man is a man for all that.

You should examine in the same way predicates attributed in a given respect, and at a given time and place; for if the predicate is possible in some respect, it is possible also without qualification. Likewise, also, what is predicated at a given time or place; for what is without qualification impossible is not possible either in any respect or at any place or time. An objection may be raised that in a given respect people may be good by nature, e.g. they may be generous or temperately inclined, while they are not good by nature without qualification. Likewise, also, it is possible for a destructible thing to escape destruction at a given time, whereas it is not possible for it to escape without qualification. In the same way also it is a good thing at certain places to follow such and such a diet, e.g. in infected areas, though it is not a good thing without qualification. Moreover, in certain places it is possible for there to be just one man, but without qualification it is not possible for there to be just one man. In the same way also it is in certain places honourable to sacrifice one's father, e.g. among the Triballi, whereas, without qualification, it is not honourable. Or possibly this may indicate a relativity not to places but to persons; for it makes no difference wherever they may be; for everywhere it will be honourable for them. Again, at certain times it is a good thing to take medicines, e.g. when one is ill, but it is not so without qualification. Or possibly this again may indicate a relativity not to a certain time, but to a certain state of health; for it makes no difference when it occurs, if only one is in that state. A thing is without qualification so which without any addition you are prepared to say is honourable or the contrary. Thus (e.g.) you will deny that to sacrifice one's father is honourable: it is honourable only to certain persons; it is not therefore honourable without qualification. On the other hand, to honour the gods you will declare to be honourable without adding anything; hence that is honourable without qualification. So that whatever without any addition is thought to be honourable or dishonourable or anything else of that kind, will be said to be so without qualification.

BOOK III

1 · The question which is the more desirable, or the better, of two or more things, should be examined upon the following lines; only first of all it must be clearly laid down that the inquiry we are making concerns not things that are widely divergent and that exhibit great differences from one another (for nobody raises any doubt whether happiness or wealth is more desirable), but things that are nearly related and about which we discuss for which of the two we ought rather to vote, because we do not see any advantage on either side as compared with the other. Clearly, then, in such cases if we can prove a single advantage, or more than one, our judgement will record our assent that whichever side happens to have the advantage is the more desirable. 116a1

First, then, that which is more lasting or secure is more desirable than that which is less so; and so is that which is more likely to be chosen by the prudent or by the good man or by the right law, or by men who are good in any particular line, when they make their choice as such; i.e. either whatever most of them or what all of them would choose; e.g. in medicine (or in carpentry) those things are more desirable which most, or all, doctors would choose; or, in general, whatever most men or all men or all things would choose, e.g. the good; for everything aims at the good. You should direct the argument to whatever purpose you require. What is absolutely better or more desirable is determined by the better science; what is relatively better, by the appropriate science.

In the second place, that which is essentially so is more desirable than that which does not come within the genus—e.g. justice than a just man; for the former falls within the genus, whereas the other does not, and the former is essentially good, whereas the latter is not; for nothing which does not happen to belong to the genus is essentially the genus; e.g. a white man is not essentially a colour. Likewise also in other cases.

Also, that which is desired for itself is more desirable than that which is desired for something else; e.g. health is more desirable than gymnastics; for the former is desired for itself, the latter for something else. Also, that which is desirable in itself is more desirable than what is desirable *per accidens;* e.g. justice in our friends than justice in our enemies; for the former is desirable in itself, the latter *per accidens;* for we desire that our enemies should be just *per accidens,* in order that they may do us no harm. This last principle is the same as the one that precedes it, with, however, a different turn of expression. For we desire justice in our friends for itself, even though it will make no difference to us, and even though they be in India; whereas in our enemies we desire it for something else, in order that they may do us no harm.

116b1 Also, that which is in itself the cause of good is more desirable than what is so *per accidens,* e.g. virtue than luck (for the former is in itself, and the latter *per accidens,* the cause of good things), and so in other cases of the same kind. Likewise also in the case of the contrary; for what is in itself the cause of evil is more objectionable than what is so *per accidens,* e.g. vice and chance; for the one is so in itself, whereas chance is so *per accidens.*

Also, what is good absolutely is more desirable than what is good for a particular person, e.g. recovery of health than a surgical operation; for the former is good absolutely, the latter only for a particular person, viz. the man who needs an operation. So too what is good by nature is more desirable than the good that is not so by nature, e.g. justice than the just man; for the one is good by nature, whereas in the other case the goodness is acquired. Also the attribute is more desirable which belongs to the better and more honourable subject, e.g. to a god rather than to a man, and to the soul rather than to the body. So too the property of the better thing is better than the property of the worse, e.g. the property of God than the property of man; for whereas in respect of what is common in both of them they do not differ at all from each other, in respect of their properties the one surpasses the other. Also that is better which is inherent in things better or prior or more honourable: thus (e.g.) health is better than strength and beauty; for the former is inherent in the moist and the dry, and the hot and the cold, in short in all the primary constituents of an animal, whereas the others are inherent in what is posterior, strength being a feature of the sinews and bones, while beauty is thought to consist in a certain symmetry of the limbs. Also the end is generally supposed to be more desirable than the means, and of two means, that which lies nearer the end. In general, too, a means directed towards the end of life is more desirable than a means to anything else, e.g. that which contributes to happiness than that which contributes to prudence. Also the possible is more desirable than the impossible. Moreover, of two productive agents that one is more desirable whose end is better; while between a productive agent and an end we can decide by a proportional sum: whenever the excess of the one end over the other is greater than that of the latter over its own productive means—e.g. supposing the excess of happiness over health to be greater than that of health over what produces health—then what produces happiness is better than health. For what produces happiness exceeds what produces health just as much as happiness exceeds health. But health exceeds what produces health by a smaller amount; hence, the excess of what produces happiness over what produces health is greater than that of health over what produces health. Clearly, therefore, what produces happiness is more desirable than health; for it exceeds the same standard by a greater amount.

Moreover, what is in itself nobler and more precious and praiseworthy is more desirable, e.g. friendship than wealth, and justice than strength. For the former belong in themselves to the class of things precious and praiseworthy, while the latter do so not in themselves but for something else; for no one prizes wealth for itself but always for something else, whereas we prize friendship for itself, even though nothing else is likely to come to us from it.

2 · Moreover, whenever two things are very much like one another, and we cannot see any superiority in the one over the other of them, we should look at them from the standpoint of their consequences. For the one which is followed by the greater good is the more desirable; or, if the consequences be evil, that is more desirable which is followed by the less evil. For though both may be desirable, yet there may still be some unpleasant consequence. Our survey from the point of view of consequences lies in two directions, for there are prior consequences and later consequences: e.g. if a man learns, it follows that he was ignorant before and knows afterwards. For the most part, the later consequence is the better. You should take, therefore, whichever of the consequences suits your purpose.

Moreover, a greater number of good things is more desirable than a smaller, either absolutely or when the one is included in the other, viz. the smaller number in the greater. An objection may be raised if in some particular case the one is for the sake of the other; for then the two together are not more desirable than the one; e.g. recovery of health and health, than health alone, inasmuch as we desire recovery of health for the sake of health. Also it is quite possible for what are not good things to be more desirable than a number of good things, e.g. the combination of happiness and something else which is not good may be more desirable than the combination of justice and courage. Also, the same things are more valuable if accompanied than if unaccompanied by pleasure, and likewise when free from pain than when attended with pain.

Also, everything is more desirable at the season when it is of greater consequence; e.g. freedom from pain in old age more than in youth; for it is of greater consequence in old age. On the same principle also, prudence is more desirable in old age; for no man chooses the young as leaders, because he does not expect them to be prudent. With courage, the converse is the case, for it is in youth that the active exercise of courage is more imperatively required. Likewise also with temperance; for the young are more troubled by their passions than are their elders.

Also, that is more desirable which is more useful at every season or at most seasons, e.g. justice and temperance rather than courage; for they are always useful, while courage is only useful at times. Also, that one of two things which if all possess, we do not need the other thing, is more desirable than that which all may possess and still we want the other one as well. Take the case of justice and courage: if everybody were just, there would be no use for courage, whereas all might be courageous, and still justice would be of use.

Moreover, judge by the destructions and losses and generations and acquisitions and contraries of things; for things whose destruction is more objectionable are themselves more desirable. Likewise also with the losses and contraries of things; for a thing whose loss or whose contrary is more objectionable is itself more desirable. With the generations or acquisitions of things the opposite is the case; for things whose acquisition or generation is more desirable are themselves also more desirable.

Another commonplace rule is that what is nearer to the good is better and more desirable; and also what more nearly resembles the good: thus justice is better than a just man. Also, the one which is more like something better than them both, as e.g. some say that Ajax was a better man than Odysseus because he was more like Achilles. (An objection may be raised to this that it is not true; for it is quite possible that Ajax did not resemble Achilles more nearly in the points which made Achilles the best of them, and that Odysseus was a good man, though unlike Achilles. Look also to see whether the resemblance tends to the ridiculous, like the resemblance of a monkey to a man, whereas a horse bears none; for the monkey is not the more handsome creature, despite its nearer resemblance to a man.) Again, in the case of two things, if one is more like the better thing while another is more like the worse, then that will be better which is more like the better. (This too, however, admits of an objection; for quite possibly the one only slightly resembles the better, while the other strongly resembles the worse, e.g. supposing the resemblance of Ajax to Achilles to be slight, while that of Odysseus to Nestor is strong.) Also it may be that the one which is like the better resembles it for the worse, whereas the one which is like the worse resembles it for the better: witness the likeness of a horse to a donkey, and that of a monkey to a man.

Another rule is that the more conspicuous good is more desirable than the less conspicuous, and the more difficult than the easier; for we appreciate better the possession of things that cannot be easily acquired. Also the more personal possession is more desirable than the more widely shared. Also, that which we share less in common with evil men; [for what is not attended by any unpleasantness is more desirable than what is so attended.][8]

Moreover, if one thing is without qualification better than another, then also the best of the members of the former is better than the best of the members of the latter; e.g. if man is better than horse, then also the best man is better than the best horse. Also, if the best is better than the best, then also the former is better than the latter without qualification; e.g. if the best man is better than the best horse, then also man is better than horse without qualification.

Moreover, things which our friends can share are more desirable than those they cannot. Also, things which we like rather to do to a friend are more desirable than those we like to do to anyone, e.g. just dealing and the doing of good rather than the semblance of them; for we would rather really do good to our friends than seem to do so, whereas towards anyone the converse is the case.

Also, superfluities are better than necessities, and are sometimes more desirable as well; for the good life is better than mere life, and good life is a superfluity, whereas mere life itself is a necessity. Sometimes, though, what is better is not also more desirable; for there is no necessity that because it is better it should also be more desirable: at least to be a philosopher is better than to make money, but it is not more desirable for a man who lacks the necessities of life. There is superfluity whenever a man possesses the necessities of life and sets to work to secure as well other noble acquisitions. Roughly speaking, perhaps, necessities are more desirable, while superfluities are better.

Also, what cannot be got from another is more desirable than what can be got from another as well, as (e.g.) is the case of justice compared with courage. Also, a thing is more desirable if it is desirable without the other, but not the other without it: power (e.g.) is not desirable without prudence, but prudence is desirable without power. Also, if of two things we repudiate the one in order to be thought to possess the other, then that one is more desirable which we wish to be thought to possess; thus (e.g.) we repudiate hard work in order that people may think us naturally gifted.

Moreover, that is more desirable in whose absence it is less blameworthy for people to be vexed; and that is more desirable in whose absence it is more blameworthy for a man not to be vexed.

3 · Moreover, of things that belong to the same species one which possesses the virtue appropriate to the species is more desirable than one which does not. If both possess it, then the one which possesses it in a greater degree is more desirable.

[8]Brunschwig excises this sentence.

Moreover, if one thing makes good whatever it affects, while another does not, the former is more desirable, just as also what makes things warm is warmer than what does not. If both do so, then that one is more desirable which does so in a greater degree, or if it renders good the better and more important object—if (e.g.) the one affects the soul, and the other the body.

Moreover, judge things by their inflexions and uses and actions and effects, and judge these by them; for they go with each other: e.g. if 'justly' is more desirable than 'courageously', then also justice is more desirable than courage; and if justice is more desirable than courage, then also 'justly' is more desirable than 'courageously'. Similarly also in the other cases.

118b1 Moreover, if one thing exceeds while the other falls short of the same standard of good, the one which exceeds is the more desirable; or if the one exceeds an even higher standard. Again, if there are two things both more desirable than something, the one which is more desirable to a greater degree is more desirable than the one more desirable to a less degree. Moreover, when the excess of a thing is more desirable than the excess of something else, that thing is itself also more desirable than the other, as (e.g.) friendship than money; for an excess of friendship is more desirable than an excess of money. So also that of which a man would rather that it were his by his own doing is more desirable than what he would rather get by another's doing, e.g. friends than money.

Moreover, judge by means of an addition, and see which when added to the same thing makes the whole more desirable. You must, however, beware of adducing a case in which the common term uses, or in some other way helps the case of, one of the things added to it, but not the other, as (e.g.) if you took a saw and a sickle in combination with the art of carpentry; for in the combination the saw is a more desirable thing, but it is not a more desirable thing without qualification. Again, a thing is more desirable if, when added to a lesser good, it makes the whole a greater good. Likewise, also, you should judge by means of subtraction; for the thing upon whose subtraction the remainder is a lesser good may be taken to be a greater good, whichever it be whose subtraction makes the remainder a lesser good.

Also, if one thing is desirable for itself, and the other because of opinion, the former is more desirable, as (e.g.) health than beauty. A thing is defined as being desired because of opinion if, supposing no one knew of it, you would not care to have it. Also, it is more desirable if it is desirable both for itself and because of opinion, while the other thing is desirable on the one ground alone. Also, whichever is the more precious in itself, is also better and more desirable. A thing may be taken to be more precious in itself which we choose rather for itself, without anything else being likely to come of it.

Moreover, you should distinguish in how many ways things are called desirable, and with a view to what ends, e.g. expediency or honour or pleasure. For what is useful for all or most of them is more desirable, if they belong to the same degree. If the same characters belong to both things you should look and see which possesses them more markedly, i.e. which of the two is the more pleasant or more honourable or more expedient. Again, that is more desirable which serves the better purpose, e.g. that which serves to promote virtue more than that which serves to promote pleasure. Likewise also in the case of objectionable things; for that is more objectionable which stands more in the way of what is desirable, e.g. disease more than ugliness; for disease is a greater hindrance both to pleasure and to being good.

Moreover, argue by proving that the thing in question is in like measure objectionable and desirable; for a thing of such a character that a man might well desire and object to it alike is less desirable than the other which is desirable only.

4 · Comparisons of things with one another should be conducted in the manner prescribed. The same commonplace rules are useful also for showing that anything is desirable or objectionable; for we have only to subtract the excess of one thing over another. For if what is more precious is more desirable, then also what is precious is desirable; and if what is more useful is more desirable, then also what is useful is desirable. Likewise, also, in the case of other things which admit of comparisons of that kind. For in some cases in the very course of comparing the things together we at once assert also that each of them, or the one of them, is desirable, e.g. whenever we call the one good by nature and the other not by nature; for clearly what is good by nature is desirable.

5 · The commonplace rules relating to comparative degrees and amounts ought to be taken in the most general possible form; for when so taken they are likely to be useful in a large number of instances. It is possible to render some of the actual rules given above more universal by a slight alteration of the expression, e.g. that what by nature exhibits such and such a quality exhibits that quality in a greater degree than what exhibits it not by nature. Also, if one thing does, and another does not, impart such and such a quality to that which possesses it, then whichever does impart it is of that quality in greater degree than the one which does not impart it; and if both impart it, then that one exhibits it in a greater degree which imparts it in a greater degree.

Moreover, if in any character one thing exceeds and another falls short of the same standard; also, if the one exceeds something which possesses the character, while the other exceeds something which does not, then clearly the first thing exhibits that character in a greater degree. Moreover, you should judge by means of addition, and see if when added to the same thing it imparts to the whole such and such a character in a more marked degree, or if, when added to a thing which exhibits that character in a less degree, it imparts that character to the whole in a greater degree. Likewise, also, you may judge by means of subtraction; for a thing upon whose subtraction the remainder exhibits such and such a character in a less degree, itself exhibits that character in a greater degree. Also, things exhibit such and such a character in a greater degree if more free from admixture with their contraries; e.g. that is whiter which is more free from admixture with black. Moreover, apart from the rules given above, that has such and such a character in greater degree which admits in a greater degree of the account proper to the given character; e.g. if the account of 'white' is a colour which disperses the vision, then that is whiter which is in a greater degree a colour that disperses the vision.

6 · If the problem is put in a particular and not in a universal form, in the first place[9] the universal constructive or destructive commonplace rules that have been given may all be brought into use. For in demolishing or establishing a thing universally we also prove it in particular; for if it belongs to all, it belongs also to some, and if to none, not to some. Especially handy and of general application are the commonplace rules that are drawn from the opposites and co-ordinates and inflexions; for it is equally reputable to claim that if all pleasure is good, then also all pain is evil, and that if some pleasure is good, then also some pain is evil. Moreover, if some form of perception is not a capacity, then also some form of failure of perception is not a failure of capacity. Also, if some objects of belief are objects of knowledge, then also some form of belief is knowledge. Again, if what happens unjustly is in some cases good, then some unjust things are good. Also, if what is done with pleasure is in some cases objectionable, then pleasure is in some cases an objectionable thing. On the same principle, also, if what is pleasant is in some cases beneficial, then pleasure is in some cases good. The case is the same also as regards the things that destroy, and the processes of generation and destruction. For if some things that destroy pleasure or knowledge are good, then pleasure or knowledge is in some cases an evil thing. Likewise, also, if the destruction of knowledge is in some cases a good thing or its production an evil thing, then knowledge will be in some cases an evil thing; e.g. if for a man to forget his disgraceful conduct is a good thing, or to remember it an evil thing, then the knowledge of his disgraceful conduct is an evil thing. The same holds also in other cases; for all are equally reputable.

Moreover you should judge by means of greater or less or like degree; for if some member of another genus exhibits such and such a character in a more marked degree, while no member of that genus exhibits that character at all, then the object in question will not exhibit it; e.g. if some form of knowledge is good in a greater degree than pleasure, while no form of knowledge is good, then pleasure is not good either. Also, you should judge by a less or like degree in the same way; for so you will find it possible both to demolish and to establish a view, except that whereas both are possible by means of like degrees, by means of a less degree it is possible only to establish, not to overthrow. For if a certain capacity is good in a like degree to knowledge, and a certain capacity is good, then also is knowledge; while if no capacity is good, then neither is knowledge. If, too, a certain capacity is good in a less degree than knowledge, and a certain capacity is good, then so also is knowledge; but if no capacity is good, there is no necessity that no form of knowledge either should be good. Clearly, then, it is only possible to establish a view by means of a less degree.

Not only by means of another genus can you overthrow a view, but also by

[9]Reading πρῶτον.

means of the same, if you take the most marked instance of the character in question; e.g. if it is maintained that some form of knowledge is good, then, suppose it to be proved that prudence is not good, neither will any other kind be good, seeing that not even the kind upon which there is most general agreement is so. Moreover, you should argue from an hypothesis: you should claim that the attribute, if it belongs or does not belong in one case, does so in a like degree in all, e.g. that if the soul of man is immortal, so are other souls as well, while if this one is not so, neither are the others. If, then, it is maintained that in some instance the attribute belongs, you must prove that in some instance it does not belong; for then it will follow, by reason of the hypothesis, that it does not belong in any instance. If, on the other hand, it is maintained that it does not belong in some instance, you must prove that it does belong in some instance, for in this way it will follow that it belongs in all instances. It is clear that the maker of the hypothesis universalizes the problem, whereas it was stated in a particular form; for he claims that anyone who agrees to the particular should agree to the universal, inasmuch as he claims that if the attribute belongs in one instance, it belongs also in all instances alike.

If the problem is indefinite, it is possible to overthrow it in only one way; e.g. if a man has asserted that some pleasure is good or is not good, without any further definition. For if he has asserted that some pleasure is good, you must prove universally that no pleasure is good, if the proposition in question is to be demolished. And likewise, also, if he has asserted that some pleasure is not good you must prove universally that all pleasure is good: it is impossible to demolish it in any other way. For if we prove that some pleasure is not good or is good, the proposition in question is not yet demolished. It is clear, then, that it is possible to demolish an indefinite statement in one way, whereas it can be established in two ways; for whether we prove universally that all pleasure is good, or that some pleasure is good, the proposition in question will have been proved. Likewise, also, supposing we are required to argue that some pleasure is not good, if we prove that no pleasure is good or that some pleasure is not good, we shall have produced an argument in both ways, both universally and in particular, to show that some pleasure is not good. If, on the other hand, the thesis is definite, it will be possible to demolish it in two ways; e.g. if it is maintained that it is an attribute of some pleasure to be good, while of some it is not; for whether it is proved that all pleasure, or that no pleasure, is good, the proposition in question will have been demolished. If, however, he has stated that only one single pleasure is good, it is possible to demolish it in three ways; for by proving that all pleasure, or that no pleasure, or that more than one pleasure, is good, we shall have demolished the statement in question. If the thesis is still more definite, e.g. that prudence alone of the virtues is knowledge, there are four ways of demolishing it; for if it is proved that all virtue is knowledge, or that no virtue is, or that some other virtue (e.g. justice) is, or that prudence itself is not knowledge, the proposition in question will have been demolished.

It is useful also to take a look at individual instances, in cases where some attribute has been said to belong or not to belong, as in the case of universal problems. Moreover, you should take a look among genera, dividing them by their

species until you come to those that are not further divisible, as has been said before; for whether the attribute is found to belong in all cases or in none, you should, after adducing many instances, claim that he should either admit your point universally, or else bring an objection showing in what case it does not hold. Moreover, in cases where it is possible to divide the accident either specifically or numerically, you should look and see whether none of them belongs, showing e.g. that time is not
120b1 moved, nor yet is a movement, by enumerating all the species of movement; for if none of these belongs to time, clearly it does not move, nor yet is a movement. Likewise, also, you can show that the soul is not a number, by dividing all numbers into either odd or even; for if the soul is neither odd nor even, clearly it is not a number.

In regard then to accident, you should set to work by means like these, and in this manner.

BOOK IV

1 · Next we must go on to examine questions relating to genus and property. These are elements in the questions that relate to definitions, but dialecticians seldom address their inquiries to these by themselves.

If, then, a genus is suggested for something that is, first take a look at all objects which belong to the same genus as the thing mentioned, and see whether the genus suggested is not predicated of some of them, as in the case of accident: e.g. if good is laid down as the genus of pleasure, see whether some pleasure is not good; for, if so, clearly good is not the genus of pleasure; for the genus is predicated of all the members of the same species. Secondly, see whether it is predicated not in what it is, but as an accident, as white is predicated of snow, or self-moved of the soul. For snow is not just what is white, and therefore white is not the genus of snow, nor is the soul just what is moving—its motion is an accident of it, as it often is of an animal to walk or to be walking. Moreover, moving does not seem to indicate what something is, but rather a state of doing or of undergoing. Likewise, also, white; for it indicates not what snow is, but a certain quality of it. So that neither of them is predicated in what it is.

Especially you should take a look at the definition of accident, and see whether it fits the genus mentioned, as (e.g.) is the case in the instances just given. For it is possible for a thing to be and not to be self-moved, and likewise, also, for it to be and not to be white. So that neither of these is the genus but an accident, since we said that an accident is an attribute which can belong to a thing and also not belong.

Moreover, see whether the genus and the species are not found in the same division, but the one is a substance while the other is a quality, or the one is a relative while the other is a quality, as (e.g.) snow and swan are each a substance, while white is not a substance but a quality, so that white is not a genus either of
121a1 snow or of swan. Again, knowledge is a relative, while good and noble are each a

quality, so that good, or noble, is not the genus of knowledge. For the genera of relatives ought themselves also to be relatives, as is the case with double; for multiple, which is the genus of double, is itself also a relative. To speak generally, the genus ought to fall under the same division as the species; for if the species is a substance, so too should be the genus, and if the species is a quality, so too the genus should be a quality; e.g. if white is a quality, so too should colour be. Likewise, also, in other cases.

Again, see whether it is necessary or possible for the genus to partake of the object which has been placed in the genus. Partaking is defined as admitting the account of that which is partaken. Clearly, therefore, the species partake of the genera, but not the genera of the species; for the species admits the account of the genus, whereas the genus does not admit that of the species. You must look, therefore, and see whether the alleged genus partakes or can partake of the species, e.g. if any one were to render anything as genus of being or of one; for then the result will be that the genus partakes of the species; for of everything that is, being and one are predicated, and therefore their account as well.

Moreover, see if there is anything of which the alleged species is true, while the genus is not, e.g. supposing being or object of knowledge were stated to be the genus of object of opinion. For object of opinion will be a predicate of what does not exist; for many things which do not exist are objects of opinion; whereas that being or object of knowledge is not predicated of what does not exist is clear. So that neither being nor object of knowledge is the genus of object of opinion; for of the objects of which the species is predicated, the genus ought to be predicated as well.

Again, see whether the object placed in the genus cannot partake of any of its species; for it is impossible that it should partake of the genus if it does not partake of any of its species, unless it is one of the species reached by the first division—these partake of the genus alone. If, therefore, motion is stated as the genus of pleasure, you should look and see if pleasure is neither locomotion nor alteration, nor any of the rest of the given modes of motion; for clearly it will not partake of any of the species, and therefore not of the genus either, since what partakes of the genus must necessarily partake of one of the species as well; so that pleasure could not be a species of motion, nor yet be one of the individual phenomena falling under a species of motion.[10] For individuals as well partake in the genus and the species, as (e.g.) an individual man partakes of both man and animal.

Moreover, see if the term placed in the genus has a wider denotation than the 121b1
genus, as (e.g.) object of opinion has, as compared with being; for both what is and what is not are objects of opinion, so that object of opinion could not be a species of being; for the genus is always of wider denotation than the species. Again, see if the species and its genus have an equal denotation; suppose, for instance, that of the attributes which go with everything, one were to be stated as a species and the other as its genus, as for example being and one; for everything has being and one, so that neither is the genus of the other, since their denotation is equal. Likewise, also, if primitives and principles were to be placed one under the other; for a principle is a

[10]Reading τῶν ὑπό τι εἶδος τῆς κινήσεως ὄντων.

primitive and a primitive a principle, so that either the two are identical or neither is the genus of the other. The elementary principle in regard to all such cases is that the genus has a wider denotation than the species and its differentia; for the differentia too has a narrower denotation than the genus.

See also whether the genus mentioned fails, or might be thought to fail, to apply to some object which is not specifically different from the thing in question; or, if your argument is constructive, whether it does so apply. For all things that are not specifically different have the same genus. If, therefore, it is proved to apply to one, then clearly it applies to all, and if it fails to apply to one, clearly it fails to apply to any; e.g. if any one who assumes that there are indivisible lines were to say that the indivisible is their genus. For the aforesaid term is not the genus of divisible lines, and these do not differ as regards their species—for straight lines are never different from each other as regards their species.

2 · Look and see, also, if there is any other genus of the given species which neither embraces the given genus nor falls under it, e.g. suppose any one were to lay down that knowledge is the genus of justice. For virtue is its genus as well, and neither of these genera embraces the remaining one, so that knowledge could not be the genus of justice; for it seems that whenever one species falls under two genera, the one is embraced by the other. Yet a principle of this kind gives rise to a difficulty in some cases. For some people hold that prudence is both virtue and knowledge, and that neither of its genera is embraced by the other—although certainly not everybody admits that prudence is knowledge. If, however, any one were to admit the truth of this assertion, yet it would still be thought to be necessary that the genera of the same object must at any rate be subordinate either the one to the other or both to the same thing as actually is the case with virtue and knowledge. For both fall under the same genus; for each of them is a state and a disposition. You should look, therefore, and see whether neither of these things is true of the given genus; for if the genera are subordinate neither the one to the other nor both to the same thing, then what is given could not be the genus.

Look, also, at the genus of the given genus, and so continually at the next higher genus, and see whether all are predicated of the species, and predicated in what it is; for the higher genus should be predicated of the species in what it is . If, then, there is anywhere a discrepancy, clearly what is given is not the genus. Again, see whether either the genus itself, or one of its higher genera, partakes of the species; for the higher genus does not partake of any of the lower. If, then, you are overthrowing a view, follow the rule as given; if establishing one, then—suppose that what has been named as genus is admitted to belong to the species, only it is disputed whether it belongs as genus—it is enough to prove that one of its higher genera is predicated of the species in what it is. For if one of them is predicated in what it is, all of them, both higher and lower than this one, if predicated at all of the species, will be predicated of it in what it is; so that what has been given as genus is also predicated in what it is. The proposition that when one genus is predicated in what it is, all the rest, if predicated at all, will be predicated in what it is, should be secured by induction. Supposing, however, that it is disputed whether the given genus belongs at all, it is not enough to prove that one of the higher genera is predicated of the species in what it is: e.g. if any one has given locomotion as the genus of walking, it is not enough to prove that walking is motion in order to prove that it is locomotion, seeing that there are other forms of motion as well; but one must prove in addition that walking does not partake of any of the species of motion produced by the same division as locomotion. For of necessity what partakes of the genus partakes also of one of the species produced by the first division. If, therefore, walking does not partake either of increase or decrease or of the other kinds of motion, clearly it will partake of locomotion, so that locomotion will be the genus of walking.

Again, look among the things of which the given species is predicated as genus, and see if what is given as its genus is also predicated in what it is of the very things of which the species is so predicated, and likewise if all the genera higher than this genus are so predicated as well. For if there is anywhere a discrepancy, clearly what has been given is not the genus; for had it been the genus, then both the genera higher than it, and it itself, would all have been predicated in what it is of those objects of which the species too is predicated in what it is. If, then, you are overthrowing a view, it is useful to see whether the genus fails to be predicated in what it is of those things of which the species is predicated. If establishing a view, it is useful to see whether it is predicated in what it is; for if so, the result will be that the genus and the species will be predicated of the same object in what it is, so that the same object falls under two genera; the genera must therefore of necessity be subordinate one to the other, and therefore if it is proved that the one we wish to establish as genus is not subordinate to the species, clearly the species will be subordinate to it, so that it is proved that it is the genus.

Look, also, at the accounts of the genera, and see whether they apply both to the given species and to the objects which partake of the species. For of necessity the accounts of its genera must be predicated of the species and of the objects which partake of the species; if, then, there is anywhere a discrepancy, clearly what has been given is not the genus.

Again, see if he has given the differentia as the genus, e.g. immortal as the genus of God. For immortal is a differentia of living being, seeing that of living beings some are mortal and others immortal. Clearly, then, a mistake has been made; for the differentia of a thing is never its genus. And that this is true is clear; for a thing's differentia never signifies what it is, but rather some quality, as do walking and biped.

Also, see whether he has placed the differentia inside the genus, e.g. saying that the odd is essentially a number. For odd is a differentia of number, not a species. Nor is the differentia thought to partake of the genus; for what partakes of the genus is always either a species or an individual, whereas the differentia is neither a species nor an individual. Clearly, therefore, the differentia does not partake of the genus, so that odd too is no species, seeing that it does not partake of the genus.

Moreover, see whether he has placed the genus inside the species, e.g. by taking contact to be essentially continuity, or mixture essentially fusion, or, as in Plato's definition,[11] change of place to be locomotion. For there is no necessity that contact should be continuity: rather, conversely, continuity must be contact; for what is in contact is not always continuous, though what is continuous is always in contact. Likewise, also, in the remaining instances; for mixture is not always a fusion (for to mix dry things does not fuse them), nor is change of place always locomotion. For walking is not thought to be locomotion; for it is mostly used of things that change one place for another involuntarily, as happens in the case of inanimate things. Clearly, also, the species, in the instances given, has a wider denotation than the genus, whereas it ought to be vice versa.

Again, see whether he has placed the differentia inside the species, by taking (e.g.) immortal to be essentially a god. For the result will be that the species has an equal or wider denotation; for always the differentia has an equal or a wider denotation than the species. Moreover, see whether he has placed the genus inside the differentia, by making colour (e.g.) to be essentially dispersive, or number essentially odd. Also, see if he has mentioned the genus as differentia; for it is possible for a man to bring forward a thesis of this kind as well, e.g. that mixture is a differentia of fusion, or that change of place is a differentia of locomotion. All such cases should be examined by means of the same principles; for they depend upon common rules; for the genus should have a wider denotation than its differentia, and also should not partake of its differentia; whereas, if it is given in this manner, neither of the aforesaid requirements can be satisfied; for the genus will both have a narrower denotation than its differentia, and will partake of it.

Again, if no differentia belonging to the genus is predicated of the given species, neither will the genus be predicated of it; e.g. of soul neither odd nor even is predicated; neither therefore is number. Moreover, see whether the species is naturally prior and abolishes the genus along with itself; for the contrary seems to be the case. Moreover, if it is possible for the genus stated, or for its differentia, to be absent, e.g. for movement to be absent from the soul, or truth and falsehood from opinion, then neither of the terms stated can be its genus or its differentia; for it seems that the genus and the differentia accompany the species, as long as it exists.

3 · Look and see, also, if what is placed in the genus partakes or could partake of any contrary of the genus; for in that case the same thing will at the same time partake of contrary things, seeing that the genus is never absent from it, while it partakes, or can partake, of the contrary as well. Moreover, see whether the species shares in any character which it is utterly impossible for any member of the genus to have. Thus (e.g.) if the soul has a share in life, while it is impossible for any number to live, then the soul will not be a species of number.

You should look and see, also, if the species is a homonym of the genus, and

[11] See *Theaetetus* 181D.

employ as your elementary principles those already stated for dealing with homonyms;[12] for the genus and the species are synonymous.

Seeing that of every genus there is more than one species, look and see if it is impossible that there should be another species belonging to the genus stated, for if there is none, then clearly what has been stated will not be a genus at all.

Look and see, also, if he has given as genus something spoken of metaphorically, describing (e.g.) temperance as a harmony; for a genus is always predicated of its species in its literal sense, whereas harmony is predicated of temperance not in a literal sense but metaphorically; for a harmony always consists in notes.

Moreover, if there is any contrary of the species, examine it. The examination may take different forms; first of all see if the contrary as well is found in the same genus, supposing the genus to have no contrary; for contraries ought to be found in the same genus, if there is no contrary to the genus. Supposing, on the other hand, that there is a contrary to the genus, see if the contrary of the species is found in the contrary genus; for of necessity the contrary must be in the contrary, if there is any contrary to the genus. Each of these points is made plain by means of induction. Again, see whether the contrary of the species is not found in any genus at all, but is itself a genus, e.g. the good; for if this is not found in any genus, neither will its contrary be found in any genus, but will itself be a genus, as happens in the case of good and evil; for neither of these is found in a genus, but each of them is a genus. Moreover, see if both genus and species are contrary to something, and one pair of contraries has an intermediary, but not the other. For if the genera have an intermediary, so should their species as well, and if the species have, so should their genera as well, as is the case with virtue and vice, and with justice and injustice; for each pair has an intermediary. (An objection to this is that there is no intermediary between health and disease, although there is one between evil and good.) Or see whether, though there is an intermediary between both, i.e. both between the species and between the genera, yet it is not similarly related, but in one case negatively, but in the other case as a subject. For it is a reputable opinion that the relation should be similar in both cases, as it is in the cases of virtue and vice and of justice and injustice; for the intermediaries between both are purely negative. Moreover, whenever the genus has no contrary, look and see not merely whether the contrary is found in the same genus, but the intermediate as well; for the genus containing the extremes contains the intermediates as well, as (e.g.) in the case of white and black; for colour is the genus both of these and of all the intermediate colours. (An objection may be raised that defect and excess are found in the same genus (for both are in the genus evil), whereas moderate amount, an intermediate between them, is found not in evil but in good.) Look and see also whether, while the genus has a contrary, the species has none; for if the genus is contrary to anything, so too is the species, as virtue and vice, and justice and injustice. Likewise, also, if one were to look at other instances, one would come to see this clearly. (An objection may be raised in the case of health and disease; for health without qualification is

[12]See I 15.

the contrary of disease, whereas a particular disease, e.g. fever and ophthalmia and any other particular disease, has no contrary.)

If, therefore, you are demolishing a view, there are all these ways in which you should make your examination; for if the aforesaid characters do not belong to it, clearly what has been given is not the genus. If, on the other hand, you are establishing a view, there are three ways: in the first place, see whether the contrary is found in the genus stated, supposing the genus to have no contrary; for if the contrary is found in it, clearly the species in question is found in it as well. Moreover, see if the intermediate species is found in the genus stated; for whatever genus contains the intermediate contains the extremes as well. Again, if the genus has a contrary, look and see whether the contrary species is found in the contrary genus; for if so, clearly also the species in question is found in the genus in question.

Again, consider in the case of the inflexions and the co-ordinates, and see whether they follow in the same way, both in demolishing and in establishing a view. For whatever attribute belongs or does not belong to one belongs or does not belong at the same time to all; e.g. if justice is a particular form of knowledge, then also justly is knowingly and the just man is a man of knowledge; whereas if any of these things is not so, then neither is any of the rest of them.

4 · Again, consider the case of things that bear a like relation to one another. Thus (e.g.) the relation of the pleasant to pleasure is like that of the useful to the good; for in each case the one produces the other. If therefore pleasure is essentially good, then also the pleasant will be essentially useful; for clearly it will be productive of good, seeing that pleasure is good. In the same way also consider the processes of generation and destruction; if (e.g.) to build is to be active, then to have built is to have been active, and if to learn is to recollect, then also to have learnt is to have recollected, and if to be decomposed is to be destroyed, then to have been decomposed is to have been destroyed, and decomposition is a kind of destruction. Consider also in the same way the case of things that generate or destroy, and of the capacities and uses of things; and in general, both in demolishing and in establishing, you should examine things in the light of any resemblance of whatever description, as we were saying in the case of generation and destruction. For if what tends to destroy tends to decompose, then also to be destroyed is to be decomposed; and if what tends to generate tends to produce, then to be generated is to be produced, and generation is production. Likewise, also, in the case of the capacities and uses of things; for if a capacity is a disposition, then also to be capable is to be disposed, and if the use of anything is an activity, then to use it is to be active, and to have used it is to have been active.

If the opposite of the species is a privation, there are two ways of demolishing an argument. First of all by looking to see if the opposite is found in the given genus; for either the privation is never absolutely in the same genus, or at least not in the same ultimate genus: e.g. if the ultimate genus containing sight is perception, then blindness will not be a perception. Secondly, if there is a privation opposed to both genus and species, but the opposite of the species is not found in the opposite of the genus, then neither will the given species be in the given genus. If, then, you are demolishing a view, you should follow the rule as stated; but if establishing one there is but one way; for if the opposite species is found in the opposite genus, then also the species in question will be found in the genus in question: e.g. if blindness is a form of lack of perception, then sight is a form of perception.

Again, look at the negations in reverse order, according to the method described in the case of accident:[13] e.g. if the pleasant is essentially good, what is not good is not pleasant. [For were this not so, something not good would then be pleasant.][14] For it is impossible, if good is the genus of pleasant, that anything not good should be pleasant; for of things of which the genus is not predicated, none of the species is predicated either. Also, in establishing a view, you should adopt the same method of examination; for if what is not good is not pleasant, then what is pleasant is good, so that good is the genus of pleasant.

If the species is a relative, see whether the genus is a relative as well; for if the species is a relative, so too is the genus, as is the case with double and multiple; for each is a relative. If, on the other hand, the genus is a relative, there is no necessity that the species should be so as well; for knowledge is a relative, but not so grammar. (Or possibly not even the first statement would seem true; for virtue is essentially noble and essentially good, and yet, while virtue is a relative, good and noble are not relatives but qualities.)

Again, see whether the species fails to be related to the same thing in its own right, and in respect of its genus: e.g. if double is the double of a half, then it ought also to be multiple of a half. Otherwise multiple will not be the genus of double.

Moreover, see whether it fails to be related to the same thing both in respect of its genus and in respect of all the genera of its genus. For if the double is a multiple of a half, then it will also be in excess of a half; and, in general, in respect of all the higher genera it will be related to a half. (An objection may be raised that there is no necessity for a term to be related to the same thing in its own right and in respect of its genus; for knowledge is called knowledge of an object of knowledge, whereas it is called a state and disposition not of an object of knowledge but of the soul.)

Again, see whether the genus and the species are used in the same way in respect of the inflexions they take, e.g. datives and genitives and all the rest.[15] For as the species is used, so should the genus be as well, as in the case of double and its higher genera; for both double and multiple take a genitive. Likewise, also, in the case of knowledge; for both knowledge itself and its genera, e.g. disposition and state, take a genitive. (An objection may be raised that in some cases it is not so; for different and contrary take a dative, whereas other, which is the genus of these terms, takes a genitive—for we talk of being other than something.)

[13]See 113b15–26.

[14]This sentence is excised by Brunschwig.

[15]Literally, 'to-something and of-something and the rest'. No grammatical terms appear in the Greek: 'double . . . takes a genitive' (perhaps rather: ' 'double' takes a genitive') renders τὸ διπλάσιον τινός—'the double is of-something'.

Again, see whether terms used in like manner in respect of inflexions fail to yield a like construction when converted, as do double and multiple. For each of these terms takes a genitive both in itself and in its converted form; for both a half and a fraction take the genitive. The case is the same also as regards both knowledge and belief; for they take a genitive themselves, and likewise after conversion; for object of knowledge and object of belief both take a dative. If, then, in any cases the constructions after conversion are not alike, clearly the one term is not the genus of the other.

Again, see whether the species and the genus fail to be used in relation to an equal number of things; for it seems that the uses of both are alike and equal in number, as is the case with transfers and gifts. For a transfer is of something and to someone, and also a gift is of something and to someone; and transfer is the genus of gift, for a gift is a transfer that need not be returned. In some cases, however, it turns out that they are not related to an equal number of things; for while double is double of something, in excess and greater are in something, as well as of something; for what is in excess or greater is always in excess in something, as well as in excess of something.[16] Hence the terms in question are not the genera of double, inasmuch as they are not used in relation to an equal number of things with the species. Or perhaps it is not universally true that species and genus are used in relation to an equal number of things.

See, also, if the opposite of the species has the opposite of the genus as its genus, e.g. whether, if multiple is the genus of double, fraction is of half. For the opposite of the genus should always be the genus of the opposite. If, then, anyone were to assert that knowledge is essentially perception, then also the object of knowledge will have to be essentially an object of perception, whereas it is not; for an object of knowledge is not always an object of perception; for objects of knowledge include some of the objects of the intellect as well. Hence object of perception is not the genus of object of knowledge; and if it is not, neither is perception the genus of knowledge.

Seeing that of relatives some are of necessity found in, or about, the things in relation to which they happen at any time to be used (e.g. composition and state and balance; for in nothing else can the aforesaid terms possibly be found except in the things in relation to which they are used), while others need not be found in the things in relation to which they are used at any time, though they still may be (e.g. if the soul is an object of knowledge, for it is quite possible that the soul should possess knowledge of itself, but it is not necessary—for knowledge may just as well be found in something different), while for others, again, it is absolutely impossible that they should be found in the things in relation to which they happen at any time to be used (as e.g. that a contrary should be found in its contrary or knowledge in the object of knowledge unless the object of knowledge happens to be a soul or a man)—you should look, therefore, and see whether he places a term of one kind inside a genus that is not of that kind, e.g. suppose he has said that memory is a persisting of

[16]E.g. 'Aristotle is in excess of Plato in wisdom'—the Greek verb ὑπερέχειν takes a genitive and a dative (and the Greek sentences Aristotle hints at here are perfectly natural, unlike the English sentences suggested by the translation).

knowledge. For a persisting is always found in that which persists, and is about it, so that the persisting of knowledge also will be found in knowledge. Memory, then, is found in knowledge, seeing that it is a persisting of knowledge. But this is impossible; for memory is always found in the soul. The aforesaid commonplace rule is common to the subject of accident as well; for it makes no difference whether you say that persisting is the genus of memory, or allege that it is an accident of it. For if in any way whatever memory is a persisting of knowledge, the same argument in regard to it will apply.

5 · Again, see if he has placed what is a state inside the genus activity, or an activity inside the genus state, e.g. by calling perception a movement communicated through the body; for perception is a state, whereas movement is an activity. Likewise, also, if he has said that memory is a state that is retentive of a belief; for memory is never a state, but rather an activity.

They also make a mistake who rank a state within the capacity that attends it, e.g. by calling good temper mastery of anger, and courage and justice mastery of fears and of gains; for courage and good temper belong to the man who is immune from passion, whereas mastery is exhibited by the man who is exposed to passion and not led by it. Quite possibly, indeed, each of the former is attended by a capacity such that, if he were exposed to passion, he would control it and not be led by it; but, for all that, this is not what is meant by being courageous in the one case, and good-tempered in the other; what is meant is an absolute immunity from any passions of that kind at all.

Sometimes, also, people state any kind of attendant feature as the genus, e.g. pain as the genus of anger and belief as that of conviction. For both of the things in question follow in a certain sense upon the given species, but neither of them is genus to it. For when the angry man feels pain, the pain has appeared in him earlier than the anger; for his anger is not the cause of his pain, but his pain of his anger, so that anger simply is not pain. By the same reasoning, neither is conviction belief; for it is possible to have the same belief even without being convinced of it, whereas this is impossible if conviction is a species of belief; for it is impossible for a thing still to remain the same if it is entirely transferred out of its species, just as the same animal could not at one time be, and at another not be, a man. If, on the other hand, anyone says that a man who has a belief must of necessity be also convinced of it, then belief and conviction will be used with an equal denotation, so that not even so could the former be the genus of the latter—for the denotation of the genus should be wider.

See, also, whether both naturally come to be in the same thing; for what contains the species contains the genus as well: e.g. what contains white contains colour as well, and what contains knowledge of grammar contains knowledge as well. If, therefore, any one says that shame is fear, or that anger is pain, the result will be that genus and species are not found in the same thing; for shame is found in the reasoning faculty, whereas fear is in the spirited faculty; and pain is found in the faculty of desire (for in this pleasure also is found), whereas anger is found in the spirited faculty. Hence the terms given are not the genera, seeing that they do not naturally come to be in the same thing as the species. Likewise, also, if friendship is found in the faculty of desire, it is not a form of wishing; for wishing is always found in the reasoning faculty. This commonplace rule is useful also in dealing with accident; for the accident and that of which it is an accident are both found in the same thing, so that if they do not appear in the same thing, clearly it is not an accident.

Again, see if the species partakes of the alleged genus only in some particular respect; for it seems that the genus is not partaken in only in some particular respect; for a man is not an animal in a particular respect, nor is grammar knowledge. Likewise also in other instances. Look, therefore, and see if in certain cases the genus is partaken in only in a certain respect; e.g. if animal has been described as essentially an object of perception or of sight. For an animal is an object of perception or of sight in a particular respect only; for it is in respect of its body that it is perceived and seen, not in respect of its soul; so that object of sight and object of perception will not be the genus of animal.

Sometimes also people unawares place the whole inside the part, calling (e.g) animal an animate body; whereas the part is not predicated in any sense of the whole, so that body could not be the genus of animal, seeing that it is a part.

See also if he has put anything that is blameworthy or objectionable into capacity or the capable, e.g. by calling a sophist or a slanderer or a thief one who is capable of secretly thieving other people's property. For none of the aforesaid characters is so called because he is capable in one of these respects; for even God and the good man are capable of doing bad things, but that is not their character; for it is always in respect of their choice that bad men are so called. Moreover, a capacity is always a desirable thing; for even the capacities for doing bad things are desirable, and that is why we say that even God and the good man possess them; for they are capable (we say) of doing evil. So then capacity can never be the genus of anything blameworthy. Otherwise, the result will be that some blameworthy thing is desirable; for there will be a capacity that is blameworthy.

Also, see if he has put anything that is precious or desirable for its own sake into capacity or the capable or the productive. For capacity, and what is capable or productive of anything, is always desirable for the sake of something else.

Or see if he has put anything that is in two genera or more into one of them only. For some things it is impossible to place in a single genus, e.g. the cheat and the slanderer; for neither he who has the intention without the capacity, nor he who has the capacity without the intention, is a slanderer or cheat, but he who has both of them. Hence he must be put not into one genus, but into both the aforesaid genera.

Moreover, people sometimes give things the wrong way about, genus as differentia, and differentia as genus, calling (e.g.) astonishment an excess of wonderment and conviction strength of belief. For neither excess nor strength is the genus, but the differentia; for astonishment seems to be an excessive wonderment, and conviction to be a strong belief, [so that wonderment and belief are the genus, while excess and strength are the differentia.][17] Moreover, if any one gives excess

[17] Brunschwig excises this sentence.

and strength as genera, then inanimate things will be convinced and astonished. For the strength and excess of a thing are found in that thing of which they are. If, therefore, astonishment is an excess of wonderment the astonishment will be found in the wonderment, so that wonderment will be astonished. Likewise, also, conviction will be found in belief, if it is strength of belief, so that the belief will be convinced. Moreover, a man who argues in this style will in consequence find himself calling strength strong and excess excessive; for there is such a thing as a strong conviction; if then conviction is strength there will be a strong strength. Likewise, also, there is such a thing as excessive astonishment; if then astonishment is an excess, there will be an excessive excess. But neither of these things seems to be the case any more than that knowledge is an object of knowledge or motion a moving thing.

Sometimes, too, people make the mistake of putting an affection into that which is affected, as its genus, e.g. those who say that immortality is everlasting life; for immortality seems to be a certain affection or accidental feature of life. That this is true would appear clear if anyone were to admit that a man can pass from being mortal and become immortal; for no one will assert that he takes another life, but that a certain accidental feature or affection enters into this one as it is. So then life is not the genus of immortality.

Again, see if they say that an affection is that of which it is an affection, calling (e.g.) wind air in motion; [Rather, wind is a movement of air][18] for the same air persists both when it is in motion and when it is still. Hence wind is not air at all; for then there would also have been wind when the air was not in motion, seeing that the same air which formed the wind persists. Likewise, also, in other cases of the kind. Even, then, if we ought in this instance to admit that wind is air in motion, yet we should not accept this sort of thing in all those things of which the genus is not true, but only in cases where the given genus is truly predicated. For in some cases, e.g. mud or snow, it does not seem to be true. For people say that snow is frozen water and mud is earth mixed with moisture, whereas snow is not water, nor mud earth, so that neither of the given terms could be the genus; for the genus should be true of all its species. Likewise neither is wine fermented water, as Empedocles speaks of 'water fermented in wood'[19]—for it simply is not water at all.

6 · Moreover, see whether the given term fails to be the genus of anything at all; for then clearly it also fails to be the genus of the species mentioned. Examine the point by seeing whether the objects that partake of the genus fail to be specifically different from one another, e.g. white objects; for these do not differ specifically from one another, whereas of a genus the species are always different, so that white will not be the genus of anything.

Again, see whether he has named as genus or differentia some feature that goes with everything; for there are several attributes that follow everything: thus (e.g.) being and one are among the attributes that follow everything. If, therefore, he has rendered being as a genus, clearly it will be the genus of everything, seeing

[18]Excised by Brunschwig.
[19]Frag. 81 Diels-Kranz.

that it is predicated of everything; for the genus is never predicated of anything except of its species. Hence one will be a species of being. The result, therefore, is that of all things of which the genus is predicated, the species is predicated as well, seeing that being and one are predicates of absolutely everything, whereas the predication of the species ought to be of narrower range. If, on the other hand, he has named as differentia some attribute that follows everything, clearly the denotation of the differentia will be equal to, or wider than, that of the genus. For if the genus, too, is an attribute that follows everything, the denotation of the differentia will be equal to its denotation, while if the genus does not follow everything, it will be wider.

127b1 Moreover, see if the given genus is said to be *in* the species as subject, as white in the case of snow, thus showing clearly that it will not be the genus; for the genus is only said *of* the species as subject.

Look and see also if the genus fails to be synonymous with its species. For the genus is always predicated of its species synonymously.

Moreover, beware, whenever both species and genus have a contrary, and he places the better of the contraries inside the worse genus; for the result will be that the remaining species will be found in the remaining genus, seeing that contraries are found in contrary genera, so that the better species will be found in the worse genus and the worse in the better; but it seems that of the better species the genus too is better. Also see if he has placed something inside the worse and not inside the better genus, when it is related in like manner to both, as (e.g.) if he has called the soul essentially a form of motion or a moving thing. For the same soul seems to be a principle alike of rest and of motion, so that, if rest is the better of the two, this is the genus into which the soul should have been put.

Moreover, judge by means of greater and less degrees: if overthrowing a view, see whether the genus admits of a greater degree, whereas neither the species itself nor anything that is called after it does so; e.g. if virtue admits of a greater degree, so too does justice and the just man; for one man is called more just than another. If, therefore, the given genus admits of a greater degree, whereas neither the species itself nor anything called after it does so, then what has been given will not be the genus.

Again, if what is more generally, or as generally, thought to be the genus is not so, clearly neither is the given genus. The commonplace rule in question is useful especially in cases where the species appears to have several predicates in what it is, and where it has not been determined and we cannot say which of them is genus; e.g. both pain and belief seem to be predicated of anger in what it is; for the angry man is both in pain and also believes that he is slighted. The same mode of inquiry may be applied also to the case of the species, by comparing it with some other species; for if the one which is more generally, or as generally, thought to be found in the given genus is not found herein, then clearly neither will the given species be found therein.

In demolishing a view, therefore, you should follow the rule as stated. In establishing one, on the other hand, the commonplace rule that you should see if both the given genus and the species admit of a greater degree will not serve; for even though both admit it, it is still possible for one not to be the genus of the other. For both beautiful and white admit of a greater degree, and neither is the genus of the other. On the other hand, the comparison of the genera and of the species one with another is of use: e.g. supposing this and that to have a like claim to be genus, then if one is a genus, so also is the other. Likewise also, if what has less claim is a genus, so also is what has more claim: e.g. if capacity has more claim than virtue to be a genus of self-control, and virtue is a genus, so also is capacity. The same observations will apply also in the case of the species. For instance, supposing this and that to have a like claim to be a species of the genus in question, then if the one is a species, so also is the other; and if that which is less generally thought to be so is a species, so also is that which is more generally thought to be so.

Moreover, to establish a view, you should look and see if the genus is predicated in what it is of those things to which it has been ascribed as genus, supposing there to have been given not one single species but several different ones; for then clearly it will be the genus. If, on the other hand, a single species has been given, look and see whether the genus is predicated of the other species as well; for then, again, the result will be that it is predicated of several different species.

Since some people think that the differentia, too, is a predicate of the various species in what it is, you should distinguish the genus from the differentia by employing the aforesaid elementary principles—first, that the genus has a wider denotation than the differentia; then, that in giving what a thing is it is more fitting to state the genus than the differentia, for anyone who says that man is an animal shows what man is better than he who describes him as terrestrial; also that the differentia always signifies a quality of the genus, whereas the genus does not do this of the differentia; for he who says terrestrial describes an animal of a certain quality, whereas he who says animal does not describe a terrestrial thing of a certain quality.

The differentia, then, should be distinguished from the genus in this manner. Now since it seems that if what is musical, in being musical, possesses knowledge in some respect, then also music is a particular kind of knowledge; and also that if what walks is moved in walking, then walking is a particular kind of movement; you should therefore examine in the aforesaid manner any genus in which you want to establish the presence of something: e.g., if you wish to prove that knowledge is essentially conviction, see whether the knower in knowing is convinced; for then clearly knowledge will be a particular kind of conviction. You should proceed in the same way also in regard to the other cases of this kind.

Moreover, seeing that it is difficult to distinguish whatever always follows along with a thing, and is not convertible with it, from its genus, if this follows that universally, whereas that does not follow this universally—as e.g. calm always follows windlessness and divisible follows number, but not conversely (for the divisible is not always a number, nor windlessness calm)—you may yourself argue as though the one which always follows is the genus, whenever the other is not convertible with it; if, on the other hand, some one else puts forward the proposition, do not accept it universally. An objection to it is that not-being always follows what is coming to be (for what is coming to be is not) and is not convertible with it (for what is not is not always coming to be), but nevertheless not-being is not the genus of coming to be; for not-being has not any species at all.

Questions, then, in regard to genus should be investigated in the ways described.

BOOK V

1 · The question whether the attribute stated is or is not a property, should be examined by the following methods. A property is given either in its own right and for always or relative to something else and for a time: e.g. it is property in its own right of man to be by nature a civilized animal; a relative property is one like that of the soul in relation to the body, viz. that the one is fitted to command, and the other to obey; a property that always holds is one like the property which belongs to God, of being an immortal living being; a property that holds for a time is one like the property which belongs to any particular man of walking in the gymnasium.

When a property is given relatively to something else, there are either two problems or four. For if you ascribe this same property to one thing and deny it of another, only two problems arise, as in the case of a statement that it is a property of a man, in relation to a horse, to be a biped. For one might try both to show that a man is not a biped, and also that a horse is a biped: in both ways the property would be upset. If on the other hand you ascribe one of two attributes to each of two things, and deny it in each case of the other, there will then be four problems; as in the case of a statement that it is a property of a man in relation to a horse for the former to be a biped and the latter a quadruped. For then it is possible to try to show both that a man is not naturally a biped, and that he is a quadruped, and also that the horse is a biped, and that it is not a quadruped. If you prove any of these at all, the intended attribute is demolished.[20]

A property in its own right is one which is ascribed to a thing in comparison with everything else and distinguishes it from everything else, as does being a mortal living being capable of receiving knowledge in the case of man. A property relative to something else is one which separates its subject off not from everything else but only from a particular definite thing, as does the property which virtue possesses, relative to knowledge, viz. that the former is naturally produced in more than one faculty, whereas the latter is produced in that of reason alone, and in those who have a reasoning faculty. A property for always is one which is true at every time, and never fails, like being compounded of soul and body, in the case of a living creature. A property for a time is one which is true at some particular time, and does not of necessity always follow; as, of some particular man, that he walks in the market-place.

[20] Some scholars place this paragraph after 129a16.

To ascribe a property relatively to something else means to state the difference between them as it is found either universally and always, or for the most part and in most cases: thus a difference that is found universally and always, is one such as man possesses relatively to a horse, viz. being a biped; for a man is always and in every case a biped, whereas no horse is ever a biped. On the other hand, a difference that is found for the most part and in most cases, is one such as the faculty of reason possesses relative to that of desire and spirit, in that the former commands, while the latter obeys; for the reasoning faculty does not always command, but sometimes also is under command, nor is that of desire and spirit always under command, but also on occasion assumes the command, whenever the man's soul is vicious.

Of properties the most general are those which hold in their own right and always and the relative. For a relative property gives rise, as we said before, to several problems; for of necessity the problems arising are either two or four, so that arguments in regard to these are several. A property in its own right and one for always you can discuss in relation to many things, or can observe in relation to many periods of time: if in its own right, discuss it in relation to many things; for the property ought to belong to its subject relatively to every single thing that there is, so that if the subject is not distinguished relatively to everything else, the property will not have been given correctly. A permanent property you should observe in relation to many periods of time; for if it does not or did not, or is not going to, belong, it will not be a property. On the other hand, about a temporary property we do not inquire further than in regard to the present; and so arguments in regard to it are not many; whereas a general problem is one in regard to which it is possible for arguments both numerous and good to arise.

The so-called relative property, then, should be examined by means of the commonplace arguments relating to accident, to see whether it belongs to the one thing and not to the other; on the other hand, permanent and essential properties should be considered by the following methods.

2 · First, see whether the property has or has not been rendered correctly. Of 129b1
a rendering being incorrect or correct, one test is to see whether the terms in which the property is stated are not or are more familiar—for destructive purposes, whether they are not so, and for constructive purposes, whether they are so. Of the terms not being more familiar, one test is to see whether the property which he renders is altogether more unintelligible than the subject whose property he has stated; for, if so, the property will not have been stated correctly. For we form a property for the sake of knowledge; the terms, therefore, in which it is rendered should be more familiar; for in that case it will be possible to conceive it more adequately. E.g. anyone who has stated that it is a property of fire to bear a very close resemblance to the soul, uses the term soul, which is less intelligible than fire—for we know better what fire is than what soul is—, and therefore bearing a very close resemblance to the soul can not be a correctly stated property of fire. Another test is to see whether the attribution of the one to the other fails to be more familiar. For not only should the property be more familiar than its object, but also it should be something whose attribution to it is more familiar. For he who does not

know whether it belongs to the object, will not know either whether it belongs to it alone. Hence whichever of these results happens, the property becomes unclear. Thus (e.g.) a man who has stated that it is a property of fire to be the primary element wherein the soul is naturally found, has introduced something more unintelligible than fire, viz. whether the soul is found in it, and whether it is found there primarily; and therefore to be the primary element in which the soul is naturally found will not be a correctly stated property of fire. On the other hand, for constructive purposes, see whether the terms in which the property is stated are more familiar, and whether they are more familiar in each of the aforesaid ways. For then the property will have been correctly stated in this respect; for of constructive rules for correctness, some will prove correctness in a certain respect only, while others will prove it without qualification. Thus (e.g.) a man who has said that the possession of perception is a property of animal has both used more familiar terms and has rendered the property more familiar in each of the aforesaid senses; so that to possess perception will in this respect have been correctly rendered as a property of animal.

Next, for destructive purposes, see whether any of the words given in the property is used in more than one way, or whether the whole expression too signifies more than one thing. For then the property will not have been correctly stated. Thus (e.g.) seeing that to perceive signifies more than one thing, viz. to possess perception, and to use perception, having perception will not be a correctly stated property of animal. The reason why neither the word, nor the whole expression signifying the property should have more than one use is this, that an expression having more than one use makes what is said unclear, because the man who is about to attempt an argument is in doubt which of the various uses the expression has; and this will not do, for the object of giving the property is to gain knowledge. Moreover, in addition to this, it is inevitable that those who render a property after this fashion should be somehow refuted whenever any one addresses his deduction to that one of the several uses which does not agree. For constructive purposes, on the other hand, see whether neither any of the terms nor the expression as a whole has more than one use; for then the property will have been correctly stated in this respect. Thus (e.g.) seeing that 'body' does not bear several meanings, nor 'quickest to move upwards in space', nor yet the whole expression made by putting them together, it would be in this respect a correctly stated property of fire to be the body quickest to move upwards in space.

Next, for destructive purposes, see if the term of which he renders the property is used in more than one way, and it has not been determined which of them it is whose property he is stating; for then the property will not have been correctly rendered. The reasons why this is so are quite clear from what has been said above; for the same results are bound to follow. Thus (e.g.) seeing that 'the knowledge of this' signifies many things—for it means the possession of knowledge by it, and the use of knowledge by it, and the possession of knowledge about it, and the use of knowledge about it—no property of the knowledge of this could be rendered correctly unless it were determined which of these it is whose property is being rendered. For constructive purposes, a man should see if the term of which he is stating the property does not have many uses but is one and simple; for then the property will have been correctly stated in this respect. Thus (e.g.) seeing that man is used in a single way, being a naturally civilized animal will be in this respect correctly stated as a property of man.

Next, for destructive purposes, see whether the same term has been repeated in the property. For people often do this unawares in rendering properties, just as they do in their definitions as well; but a property to which this has happened will not have been correctly stated; for the repetition of it confuses the hearer. Thus inevitably it becomes unclear, and further, such people are thought to babble. Repetition of the same term is likely to happen in two ways: one is, when a man repeatedly uses the same word, as would happen if any one were to render, as a property of fire, the body which is the most rarefied of bodies (for he has repeated the word 'body'); the second is, if a man replaces words by their definitions, as would happen if any one were to render, as a property of earth, the substance which is by its nature most easily of all bodies borne downwards in space, and were then to substitute 'substances of such and such a kind' for 'bodies' (for a body and a substance of such and such a kind are one and the same thing). For he will have repeated the word 'substance'. Hence neither of the properties will be correctly stated. For constructive purposes, on the other hand, see whether he avoids ever repeating the same word; for then the property will in this respect have been correctly rendered. Thus (e.g.) seeing that he who has stated animal capable of acquiring knowledge as a property of man has not used the same term several times, the property will in this respect have been correctly rendered of man.

Next, for destructive purposes, see whether he has rendered in the property any term that belongs to everything. For one which does not distinguish its subject from other things is useless, and it is the business of what is stated in properties, as also of what is stated in definitions, to distinguish. Hence the property will not have been correctly rendered. Thus (e.g.) a man who has stated that it is a property of knowledge to be belief incontrovertible by argument, because it is one, has used in the property a term of that kind, viz. one, which belongs to everything; and therefore the property of knowledge could not have been correctly stated. For constructive purposes, on the other hand, see whether he has avoided all terms that are common to everything and used a term that distinguishes the subject from something; for then the property will in this respect have been correctly stated. Thus (e.g.) inasmuch as he who has said that it is a property of a living creature to have a soul has used no term that is common to everything, it will in this respect have been correctly stated to be a property of a living creature to have a soul.

Next, for destructive purposes see whether he renders more than one property of the same thing, without a definite proviso that he is stating more than one; for then the property will not have been correctly stated. For just as in the case of definitions too there should be no further addition beside the account which shows the substance of the thing, so too in the case of properties nothing further should be rendered beside the account that makes what is stated a property; for such an addition is made to no purpose. Thus (e.g.) a man who has said that it is a property of fire to be the most rarefied and lightest body has rendered more than one property (for each term is true of fire alone); and so it could not be a correctly stated property of fire to be the most rarefied and lightest body. On the other hand, for constructive purposes, see whether he has avoided giving more than one property of the same thing, and has given one only; for then the property will in this respect have been correctly stated. Thus (e.g.) a man who has said that it is a property of a liquid to be a body adaptable to every shape has given a single property and not several, and so the property of liquid will in this respect have been correctly stated.

3 · Next, for destructive purposes, see whether he has used in addition either the actual subject whose property he is rendering, or any of its species; for then the property will not have been correctly stated. For the object of giving the property is to gain knowledge: now the subject itself is just as unintelligible as itself, while any one of its species is posterior to it, and so is no more familiar. Accordingly it is impossible to gain any knowledge by the use of these terms. Thus (e.g.) any one who has said that it is a property of animal to be the substance to which man belongs as a species has employed one of its species, and therefore the property will not have been correctly stated. For constructive purposes, on the other hand, see whether he avoids introducing either the subject itself or any of its species; for then the property will in this respect have been correctly stated. Thus (e.g.) a man who has stated that it is a property of a living creature to be compounded of soul and body has used in addition neither the subject itself nor any of its species, and therefore in this respect the property of a living creature will have been correctly rendered.

You should inquire in the same way also in the case of other terms that do or do not make the subject more familiar: thus, for destructive purposes, see whether he has used in addition anything either opposite to the subject or, in general, anything simultaneous by nature with it or posterior to it; for then the property will not have been correctly stated. For an opposite is simultaneous by nature with its opposite, and what is simultaneous by nature or is posterior to it does not make its subject more familiar. Thus (e.g.) any one who has said that it is a property of good to be the most direct opposite of evil, has used in addition the opposite of good, and so the property of good could not have been correctly rendered. For constructive purposes, on the other hand, see whether he has used in addition neither anything opposite to, nor, in general, simultaneous by nature with the subject, nor posterior to it; for then the property will in this respect have been correctly rendered. Thus (e.g.) a man who has stated that it is a property of knowledge to be the most convincing belief has not used in addition anything either opposite to, or simultaneous by nature with, or posterior to, the subject; and so the property of knowledge will in this respect have been correctly stated.

Next, for destructive purposes, see whether he has rendered as property something that does not always[21] follow the subject but sometimes ceases to be its

[21] Retaining τὸ μή.

property; for then the property will not have been correctly described. For there is no necessity either that the name of the subject must also be true of anything to which we find it belonging; or that the name of the subject will be untrue of anything to which it is found not to belong. Hence the property will not have been correctly stated. Moreover, in addition to this, even after he has rendered the property it will not be clear whether it belongs, seeing that it is the kind of attribute that may fail; and so the property will not be clear. Thus (e.g.) a man who has stated that it is a property of animal sometimes to move and sometimes to stand still has given as a property the kind of thing which sometimes is not a property, and so the property will not have been correctly stated. For constructive purposes, on the other hand, see whether he has rendered something that of necessity must always be a property; for then the property will have been in this respect correctly stated. Thus (e.g.) a man who has stated that it is a property of virtue to be what makes its possessor good has rendered as property something that always follows, and so the property of virtue will in this respect have been correctly rendered.

Next, for destructive purposes, see whether in rendering a present property he has omitted to make a definite proviso that it is a present property which he is rendering; for else the property will not have been correctly stated. For in the first place, any unusual procedure always needs a definite proviso; and for the most part everybody is accustomed to render as property some attribute that always follows. In the second place, a man who omits to provide definitely whether it was the present property which he intended to state, is obscure; and one should not give any occasion for adverse criticism. Thus (e.g.) a man who has stated it as the property of a particular man to be sitting with a particular man, states the present property, and so he cannot have rendered the property correctly, seeing that he has described it without any definite proviso. For constructive purposes, on the other hand, see whether, in giving a present property, he has, in stating it, made a definite proviso that it is the present property that he is stating; for then the property will in this respect have been correctly stated. Thus (e.g.) a man who has said that it is the property of a particular man to be walking now, has made this distinction in his statement, and so the property will have been correctly stated.

Next, for destructive purposes, see whether he has rendered a property of the kind whose presence is not obvious except by perception; for then the property will not have been correctly stated. For every perceptible attribute, once it passes beyond the range of perception, becomes obscure. For it is not clear whether it still belongs, because it is known only by perception. This will be true in the case of any attributes that do not always and necessarily follow. Thus (e.g.) any one who has stated that it is a property of the sun to be the brightest star that moves over the earth, has used in the property something, viz. moving over the earth, of a kind which is known by perception; and so the sun's property will not have been correctly rendered; for it will be obscure, whenever the sun sets, whether it continues to move over the earth, because perception then fails us. For constructive purposes, on the other hand, see whether he has rendered the property of a kind that is not obvious by perception, or, if it is perceptible, must clearly belong of necessity; for then the property will in this respect have been correctly stated. Thus (e.g.) a man who has stated that it is a property of a surface to be the primary thing that is coloured, has used in addition something perceptible, being coloured, but something which evidently always belongs, and so the property of surface will in this respect have been correctly rendered.

Next, for destructive purposes, see whether he has rendered the definition as a property; for then the property will not have been correctly stated; for the property of a thing ought not to show its essence. Thus (e.g.) a man who has said that it is a property of man to be a terrestrial two-footed animal has rendered as a property of man something that signifies his essence, and so the property of man will not have been correctly rendered. For constructive purposes, on the other hand, see whether the property which he has rendered is predicated convertibly without, however, signifying its essence; for then the property will in this respect have been correctly rendered. Thus (e.g.) he who has stated that it is a property of man to be a naturally civilized animal has rendered the property so as to be predicated convertibly without, however, showing its essence, and so the property of man will in this respect have been correctly rendered.

Next, for destructive purposes, see whether he has rendered the property without having placed it in what it is. For of properties, as also of definitions, the first term to be rendered should be the genus, and then the rest of it should be appended immediately afterwards, and should distinguish its subject from other things. Hence a property which is not stated in this way will not have been correctly rendered. Thus (e.g.) a man who has said that it is a property of a living creature to have a soul has not placed living creature within what it is and so the property of a living creature will not have been correctly stated. For constructive purposes, on the other hand, see whether a man first places within what it is the subject whose property he is rendering, and then appends the rest; for then the property will in this respect have been correctly rendered. Thus (e.g.) he who has stated that it is a property of man to be an animal capable of receiving knowledge, has rendered the property after placing the subject within what it is, and so the property of man will in this respect have been correctly rendered.

4 · The inquiry, then, whether the property has been correctly rendered or no, should be made by these means. The question, on the other hand, whether what is stated is or is not a property at all, you should examine from the following points of view. For the commonplace rules which establish absolutely that the property is correctly stated will be the same as those that constitute it a property at all; accordingly they will be described in the course of them.

Firstly, then, for destructive purposes, take a look at each subject of which he has rendered the property, and see (e.g.) if it fails to belong to any of them at all, or to be true of them in respect of that character of which he has rendered the property; for then what is stated to be a property will not be a property. Thus, for example, inasmuch as it is not true of the geometrician that he cannot be deceived by an argument (for a geometrician is deceived when his figure is misdrawn), it will not be a property of the man of science that he is not deceived by an argument. For constructive purposes, on the other hand, see whether the property rendered be true of every instance, and true in that particular respect; for then what is stated not to be a property will be a property. Thus, for example, inasmuch as being an animal capable of receiving knowledge is true of every man, and true of him *qua* man, it will be a property of man to be an animal capable of receiving knowledge. [This commonplace rule means—for destructive purposes, see if the account fails to be true of that of which the name is true; and if the name fails to be true of that of which the account is true; for constructive purposes, on the other hand, see if the account too is predicated of that of which the name is predicated, and if the name too is predicated of that of which the account is predicated.][22]

Next, for destructive purposes, see if the account fails to apply to that to which the name applies, and if the name fails to apply to that to which the account applies; for then what is stated to be a property will not be a property. Thus (e.g.) inasmuch as being a living being that partakes of knowledge is true of God, while man is not predicated of God, to be a living being that partakes of knowledge will not be a property of man. For constructive purposes, on the other hand, see if the name as well is predicated of that of which the account is predicated, and if the account as well is predicated of that of which the name is predicated. For then what is stated not to be a property will be a property. Thus (e.g.) living creature is true of that of which having a soul is true, and having a soul is true of that of which living creature is true; and so having a soul will be a property of living creature.

Next, for destructive purposes, see if he has rendered a subject as a property of that which is said to be in the subject; for then what has been stated to be a property will not be a property. Thus (e.g.) inasmuch as he who has rendered fire as the property of the body with the most rarefied particles, has rendered the subject as the property of its predicate, fire will not be a property of the body with the most rarefied particles. The reason why the subject will not be the property of that which is found in the subject is this, that then the same thing will be the property of a number of things that are specifically different. For the same thing has quite a number of specifically different predicates that belong to it alone, and the subject will be a property of all of these, if anyone states the property in this way. For constructive purposes, on the other hand, see if he has rendered what is found in the subject as a property of the subject; for then what has been stated not to be a property will be a property, if it is predicated only of the things of which it has been stated to be a property. Thus (e.g.) he who has said that it is a property of earth to be specifically the heaviest body has rendered of the subject as its property something that is said of the object alone, and is said of it as a property, and so the property of earth will have been rightly stated.

Next, for destructive purposes, see if the property has been given by way of participation; for then what is stated to be a property will not be a property. For an attribute which belongs by way of participation is a constituent part of the essence; and an attribute of that kind will be a differentia applying to some one species. E.g.,

[22]This paragraph, which is a doublet of the succeeding paragraph, was excised by Pacius.

inasmuch as he who has said that being terrestrial and two-footed is a property of man has rendered the property by way of participation, being terrestrial and two-footed will not be a property of man. For constructive purposes, on the other hand, see if he has avoided rendering the property by way of participation, or as showing the essence, though the subject is predicated convertibly with it; for then what is stated not to be a property will be a property. Thus (e.g.) he who has stated that to be naturally percipient is a property of animal has rendered the property neither by way of participation nor as showing the essence, though the subject is predicated convertibly with it; and so to be naturally percipient will be a property of animal.

Next, for destructive purposes, see if the property may belong not simultaneously, but either as posterior or as prior to the name; for then what is stated to be a property will not be a property—either never, or not always. Thus (e.g.) inasmuch as it is possible for walking through the market-place to belong to an object as prior and as posterior to 'man,'[23] walking through the market-place will not be a property of man—either never, or not always. For constructive purposes, on the other hand, see if it always and of necessity belongs simultaneously, without being either a definition or a differentia; for then what is stated not to be a property will be a property. Thus (e.g.) being an animal capable of receiving knowledge always and of necessity belongs simultaneously with 'man', and is neither differentia nor definition, and so being an animal capable of receiving knowledge will be a property of man.

Next, for destructive purposes, see if the same thing fails to be a property of things that are the same so far as they are the same; for then what is stated to be a property will not be a property. Thus, for example, inasmuch as it is no property of an object of pursuit to appear good to certain persons, it will not be a property of the desirable either to appear good to certain persons; for an object of pursuit and the desirable are the same. For constructive purposes, on the other hand, see if the same thing is a property of something that is the same in so far as it is the same. For then what is stated not to be a property will be a property. Thus (e.g.) inasmuch as it is said to be a property of a man, in so far as he is a man, to have a tripartite soul, it will also be a property of a mortal, in so far as he is a mortal, to have a tripartite soul. This commonplace rule is useful also in dealing with accident; for the same attributes ought either to belong or not belong to the same things, in so far as they are the same.

Next, for destructive purposes, see if the property of things that are the same in kind fails to be always the same in kind; for then neither will what is stated to be a
133b1 property be a property of the subject in question. Thus (e.g.) inasmuch as a man and a horse are the same in kind, and it is not always a property of a horse to stand still by his own initiative, it will not be a property of a man to move by his own initiative; for to stand still and to move by one's own initiative are the same in kind, because they belong to each of them in so far as each is an animal. For constructive purposes, on the other hand, see if of things that are the same in kind the property is always

[23]Reading τὸ βαδίζειν . . . ἢ τὸ ἄνθρωπος.

the same in kind; for then what is stated not to be a property will be a property. Thus (e.g.) since it is a property of man to be two-footed and terrestrial, it will also be a property of a bird to be two-footed and winged; for each of these is the same in kind, in so far as the one pair are species that fall under the same genus, being under the genus animal, while the other pair are differentiae of the genus, viz. of animal. This commonplace rule is false whenever one of the properties mentioned belongs to some one species only while the other belongs to many, as does terrestrial quadruped.

Inasmuch as 'same' and 'different' are used in several ways, it is a job to render to a sophistical questioner a property that belongs to one thing and that only. For an attribute that belongs to something qualified by an accident will also belong to the accident taken along with the subject which it qualifies; e.g. an attribute that belongs to man will belong also to white man, if there is a white man, and one that belongs to white man will belong also to man. One might, then, discredit the majority of properties, by representing the subject as being one thing in itself, and another thing when combined with its accident, saying, for example, that man is one thing, and white man another. Again, one might do so by representing as different a certain state and what is called after that state; for an attribute that belongs to the state will belong also to what is called after that state, and one that belongs to what is called after a state will belong also to the state: e.g. inasmuch as the condition of the scientist is called after his science, it will not be a property of science that it is incontrovertible by argument; for then the scientist also will be incontrovertible by argument. For constructive purposes, however, you should say that the subject of an accident is not different without qualification from the accident taken along with its subject; though it is called another thing because what it is to be them is different; for it is not the same thing for a man to be a man and for a white man to be a white man. Moreover, you should take a look along the inflections, and say that the man of science is not that which is incontrovertible by argument, but he who is incontrovertible by argument, and that science is not that which is incontrovertible by argument, but she who is incontrovertible by argument.[24] For against an objector who sticks at nothing the defence should stick at nothing.

5 · Next, for destructive purposes, see if, while intending to render an attribute that naturally belongs, he states it in his language in such a way as to indicate one that invariably belongs; for then it would seem that what has been stated to be a property is upset. Thus (e.g.) the man who has said that being two-footed is a property of man intends to render the attribute that naturally belongs, but his expression indicates one that invariably belongs; accordingly, being two-footed will not be a property of man; for not every man is possessed of two feet. For constructive purposes, on the other hand, see if he intends to render the property that naturally belongs, and indicates it in that way in his language; for then the property will not be upset in this respect. Thus (e.g.) he who renders as a property of man, being an animal capable of receiving knowledge, both intends, and by his

[24]Greek sciences are female; i.e. ἐπιστήμη ('science') is a feminine noun.

language indicates, the property that belongs by nature, and so being an animal capable of receiving knowledge will not be upset or shown in that respect not to be a property of man.

Moreover, as regards all the things that are called as they are primarily after something else, or primarily in themselves, it is a job to render the property of such things. For if you render a property of what is so called after something else, then it will be true of its primary subject as well; and if you state it of its primary subject, then it will be predicated also of the thing that is so called after this other. Thus (e.g.) if any one renders being coloured as a property of surface, being coloured will be true of body as well; whereas if he ascribes it to body, it will be predicated also of surface. Hence the name as well will not be true of that of which the account is true.

In the case of some properties it happens for the most part that some error is incurred because of a failure to define how and to what things the property is stated to belong. For every one tries to render as the property of a thing something that belongs to it either naturally, as being two-footed belongs to man, or actually, as having four fingers belongs to a particular man, or specifically, as consisting of most rarefied particles belongs to fire, or without qualification, as living to living being, or in virtue of something else, as being prudent to the soul, or as the primary subject, as being prudent to the rational faculty, or because the thing is in a certain state, as being incontrovertible by argument belongs to a scientist (for simply and solely by reason of his being in a certain state will he be incontrovertible by argument), or because it is the state possessed by something, as being incontrovertible by argument belongs to science, or because it is partaken of, as perceiving belongs to animal (for other things as well perceive, e.g. man, but they perceive because they partake of animal), or because it partakes of something else, as living belongs to a particular kind of living being. Accordingly he makes a mistake if he has failed to add the word 'naturally' (because what belongs naturally may fail to belong to the thing to which it naturally belongs, as (e.g.) it belongs to man to have two feet); or if he does not make a definite proviso that he is rendering what actually belongs (because it will not be such as to belong to it, e.g. the man's possession of four fingers); or if he has not shown that he states it as the primary subject, or in virtue of something else (because then its name will not also be true of that of which the account is true, as is the case with being coloured, whether rendered as a property of surface or of body); or if he has not said beforehand that he has rendered a property to a thing either because that thing possesses a state, or because it is a state possessed by something (because then it will not be a property—for, supposing he renders the property to something as being a state possessed, it will belong to what possesses that state; while supposing he renders it to what possesses the state, it will belong to the state possessed, as did being incontrovertible by argument when stated as a property of science or of the scientist); or if he has not indicated beforehand that the property belongs because the thing partakes of, or is partaken of by, something (because then the property will belong to certain other things as well—for if he renders it because its subject is partaken of, it will belong to the things which partake of it; whereas if he renders it because its subject partakes of something else, it will belong to the things partaken of, as (e.g.) if he were to state living to be a property of a particular kind of living being, or just of living being); or if he has not expressly distinguished the property that belongs specifically (because then it will belong only to one of the things that fall under the term of which he states the property—for the superlative belongs only to one of them, e.g. being lightest as applied to fire). Sometimes, too, a man may even add the word 'specifically', and still make a mistake. For the things in question should all be of one species, whenever the word 'specifically' is added; and in some cases this does not occur, as it does not, in fact, in the case of fire. For fire is not all of one species; for live coals and flame and light are each of them fire, but are of different species. The reason why, whenever 'specifically' is added, there should not be any species other than the one mentioned, is this, that if there is, then the property in question will belong to some of them in a greater and to others in a less degree, as happens with consisting of most rarefied particles in the case of fire; for light consists of more rarefied particles than live coals and flame. And this should not happen unless the name too is predicated in a greater degree of that of which the account is true to a greater degree; otherwise it will not be the case that where the account is true to a greater degree the name too is true to a greater degree. Moreover, in addition to this, the same attribute will be the property both of the term which has it without qualification and of that element therein which has it[25] in the highest degree, as is the condition of consisting of most rarefied particles in the case of fire; for this same attribute will be a property of light as well; for it is light that consists of the most rarefied particles. If, then, any one else renders a property in this way one should attack it; for oneself, one should not give occasion for this objection, but should define in what manner one states the property at the actual time of making the statement.

Next, for destructive purposes, see if he has stated a thing as a property of itself; for then what has been stated to be a property will not be a property. For a thing itself always shows its own essence, and what shows the essence is not a property but a definition. Thus (e.g.) he who has said that becoming is a property of beautiful has rendered the term as a property of itself (for beautiful and becoming are the same); and so becoming will not be a property of beautiful. For constructive purposes, on the other hand, see if he has avoided rendering a thing as a property of itself, but has yet stated a convertible predicate; for then what is stated not to be a property will be a property. Thus he who has stated animate substance as a property of living creature has not stated living creature as a property of itself, but has rendered a convertible predicate, so that animate substance will be a property of living creature.

Next, in the case of things consisting of like parts, you should look and see, for destructive purposes, if the property of the whole is not true of the part, or if that of the part is not predicated of the whole; for then what has been stated to be a

[25]Reading τοιούτου.

property will not be a property. In some cases it happens that this is so; for sometimes in rendering a property in the case of things that consist of like parts a man may have his eye on the whole, while sometimes he may address himself to what is predicated of the part; and then in neither case will it have been rightly rendered. Take an instance referring to the whole: the man who has said that it is a property of the sea to be the largest volume of salt water, has stated the property of something that consists of like parts, but has rendered an attribute of such a kind as is not true of the part (for a particular sea is not the largest volume of salt water); and so the largest volume of salt water will not be a property of the sea. Now take one referring to the part: the man who has stated that it is a property of air to be breathable has stated the property of something that consists of like parts, but he has stated an attribute such as, though true of some air, is still not predicable of the whole (for the whole of the air is not breathable); and so breathable will not be a property of air. For constructive purposes, on the other hand, see whether, while it is true of each of the things with similar parts, it is also a property of them taken as a collective whole; for then what has been stated not to be a property will be a property. Thus (e.g.) while it is true of earth everywhere that it naturally falls downwards, it is a property of the various particular pieces of earth taken as the Earth,[26] so that it will be a property of earth naturally to fall downwards.

6 · Next, look from the point of view of the opposites, and first from that of the contraries, and see, for destructive purposes, if the contrary of the term rendered fails to be a property of the contrary subject. For then neither will the contrary of the first be a property of the contrary of the second. Thus (e.g.) inasmuch as injustice is contrary to justice, and the lowest evil to the highest good, but to be the highest good is not a property of justice, therefore to be the lowest evil will not be a property of injustice. For constructive purposes, on the other hand, see if the contrary is the property of the contrary; for then also the contrary of the first will be a property of the contrary of the second. Thus (e.g.) inasmuch as evil is contrary to good, and objectionable to desirable, and desirable is a property of good, objectionable will be a property of evil.

Secondly look from the point of view of relative terms and see, for destructive purposes, if the correlative of the term rendered fails to be a property of the correlative of the subject; for then neither will the correlative of the first be a property of the correlative of the second. Thus (e.g.) inasmuch as double is relative to half, and in excess to exceeded, while in excess is not a property of double, exceeded will not be a property of half. For constructive purposes, on the other hand, see if the correlative is a property of the correlative; for then also the correlative of the first will be a property of the correlative of the second: e.g. inasmuch as double is relative to half, and the proportion 1 : 2 is relative to the proportion 2 : 1, while it is a property of double to be in the proportion of 1 : 2: it will be a property of half to be in the proportion of 2 : 1.

[26] Reading καὶ τῆς τινὸς γῆς κατὰ τὴν γῆν.

Thirdly, for destructive purposes, see if an attribute described in terms of a possession fails to be a property of the given possession; for then neither will the attribute described in terms of the privation be a property of the privation. Also if an attribute described in terms of the privation is not a property of the given privation, neither will the attribute described in terms of the possession be a property of the possession. Thus, for example, inasmuch as it is not predicated as a property of deafness to be a lack of perception, neither will it be a property of hearing to be a perception. For constructive purposes, on the other hand, see if an attribute described in terms of a possession is a property of the given possession; for then also the attribute that is described in terms of the privation will be a property of the privation. Also, if an attribute described in terms of a privation is a property of the privation, then also the attribute that is described in terms of the possession will be a property of the possession. Thus (e.g.) inasmuch as to see is a property of sight, in so far as we have sight, failure to see will be a property of blindness, in so far as we have not got the sight we should naturally have.

Next, look from the point of view of affirmations and negations; and first from the point of view of the predicates taken by themselves. This commonplace rule is useful only for a destructive purpose. Thus (e.g.) see if the affirmation or the attribute predicated affirmatively is a property of the subject; for then neither the negation nor the attribute predicated negatively will be a property of the subject. Also if the negation or the attribute predicated negatively is a property of the subject, then neither the affirmation nor the attribute predicated negatively will be a property of the subject: e.g. inasmuch as animate is a property of living creature, inanimate will not be a property of living creature.

Secondly look from the point of view of the predicates, positive or negative, and their respective subjects; and see, for destructive purposes, if the affirmation fails to be a property of the affirmation; for then neither will the negation be a property of the negation. Also, if the negation fails to be a property of the negation, neither will the affirmation be a property of the affirmation. Thus (e.g.) inasmuch as animal is not a property of man, neither will not-animal be a property of not-man. Also if not-animal seems not to be a property of not-man, neither will animal be a property of man. For constructive purposes, on the other hand, see if the affirmation is a property of the affirmation; for then the negation will be a property of the negation as well. Also if the negation is a property of the negation, the affirmation will be a property of the affirmation as well. Thus (e.g.) inasmuch as it is a property of not-animal not to live, it will be a property of animal to live; also if it seems to be a property of animal to live, it will also seem to be a property of not-animal not to live.

Thirdly, look from the point of view of the subjects taken by themselves, and see, for destructive purposes, if the property rendered is a property of the affirmation; for then the same term will not be a property of the negation as well. Also, if the term rendered is a property of the negation, it will not be a property of the affirmation. Thus (e.g.) inasmuch as animate is a property of living creature, animate will not be a property of not-living creature. For constructive purposes, on the other hand, see if the term rendered fails to be a property of the affirmation; for if it is not a property of the affirmation,[27] it will be a property of the negation. This commonplace rule is, however, false; for an affirmation is not a property of a negation, or a negation of an affirmation. For an affirmation does not belong at all to a negation, while a negation, though it belongs to an affirmation, does not belong as a property.

Next, look from the point of view of the co-ordinate members of a division, and see, for destructive purposes, if none of the one set of co-ordinate members is a property of any of the remaining set of co-ordinate members; for then neither will the term stated be a property of that of which it is stated to be a property. Thus (e.g.) inasmuch as perceptible living being is not a property of any of the other living beings, intelligible living being will not be a property of God. For constructive purposes, on the other hand, see if some one or other of the remaining co-ordinate members is a property of each of these co-ordinate members; for then the remaining one too will be a property of that of which it has been stated not to be a property. Thus (e.g.) inasmuch as it is a property of prudence to be essentially the natural virtue of the rational faculty, and so too taking each of the other virtues in this way, it will be a property of temperance to be essentially the natural virtue of the faculty of desire.

7 · Next, look from the point of view of the inflexions, and see, for destructive purposes, if the inflexion fails to be a property of the inflexion; for then neither will the other inflexion be a property of the other inflexion. Thus (e.g.) inasmuch as beautifully is not a property of justly, neither will beautiful be a property of just. For constructive purposes, on the other hand, see if the inflexion is a property of the inflexion; for then also the other inflexion will be a property of the other inflexion. Thus (e.g.) inasmuch as being terrestrial and two-footed is a property of man, it will be a property of 'to a man' to be described as 'to a terrestrial and two-footed thing'. Not only in the case of the actual term mentioned should one look at the inflexions, but also in the case of its opposites, as we said in the case of the former commonplace rules as well.[28] Thus, for destructive purposes, see if the inflexion of the opposite fails to be the property of the inflexion of the opposite; for then neither will the inflexion of the other opposite be a property of the inflexion of the other opposite. Thus (e.g.) inasmuch as 'well' is not a property of 'justly', neither will 'badly' be a property of 'unjustly'. For constructive purposes, on the other hand, see if the inflexion of the opposite is a property of the inflexion of the opposite; for then also the inflexion of the other opposite will be a property of the inflexion of the other opposite. Thus (e.g.) inasmuch as best is a property of the good, worst also will be a property of the evil.

Next, look from the point of view of things that are in a like relation, and see, for destructive purposes, if what is in a like relation fails to be a property of what is in a like relation; for then neither will what is in a relation like that of the first be a

[27]Reading *τῆς φάσεως ἴδιον· ⟨εἰ γὰρ μὴ τῆς φάσεως, ἴδιον⟩ εἴη* . . . (Wallies).
[28]See 114^{b}6–15.

property of what is in a relation like that of the second. Thus (e.g.) inasmuch as the relation of the builder towards the production of a house is like that of the doctor towards the production of health, and it is not a property of a doctor to produce health, it will not be a property of a builder to produce a house. For constructive purposes, on the other hand, see if what is in a like relation is a property of what is in a like relation; for then also what is in a relation like that of the first will be a property of what is in a relation like that of the second. Thus (e.g.) inasmuch as the relation of a doctor towards the possession of ability to produce health is like that of a trainer towards the possession of ability to produce vigour, and it is a property of a trainer to possess the ability to produce vigour, it will be a property of a doctor to possess the ability to produce health.

Next look from the point of view of things that are identically related, and see, for destructive purposes, if what is identically related fails to be a property of what is identically related; for then neither will what is identically related be a property of what is identically related. If, on the other hand, what is identically related is a property of what is identically related, then it will not be a property of that of which it has been stated to be a property. Thus (e.g.) inasmuch as prudence is identically related to both the noble and the base, since it is knowledge of each of them, and it is not a property of prudence to be knowledge of the noble, it will not be a property of prudence to be knowledge of the base. And if prudence is a property of knowledge of the noble, it will not be a property of knowledge of the base.[29] For it is impossible for the same thing to be a property of more than one subject. For constructive purposes, on the other hand, this commonplace rule is of no use; for what is identically related is a single thing brought into comparison with more than one thing.

Next, for destructive purposes, see if the predicate qualified by the verb 'to be' fails to be a property of the subject qualified by the verb 'to be'; for then neither will the destruction of the one be a property of the other qualified by the verb 'to be destroyed', nor will the becoming of the one be a property of the other qualified by the verb 'to become'. Thus (e.g.) inasmuch as it is not a property of man to be an animal, neither will it be a property of becoming a man to become an animal; nor will the destruction of an animal be a property of the destruction of a man. You should argue from becoming to being and to being destroyed, and from being destroyed to being and to becoming, exactly as we have just argued from being to becoming and being destroyed. For constructive purposes, on the other hand, see if the predicate qualified by the verb 'to be' is a property of the subject so qualified; for then also the subject qualified by the verb 'to become' will have the predicate qualified by 'to become' as its property, and the subject qualified by the verb 'to be destroyed' will have as its property the predicate rendered with this qualification. Thus, for example, inasmuch as it is a property of man to be a mortal, it will be a property of becoming a man to become a mortal, and the destruction of a mortal will be a property of the destruction of a man. In the same way one should argue from becoming and being destroyed both to being and to the conclusions that follow from them, exactly as was said in the case of destruction.

[29]Reading εἰ δ' ἐστιν ἴδιον φρόνησις τοῦ ἐπιστήμην εἶναι καλοῦ οὐκ ἂν εἴη ἴδιον τοῦ ἐπιστήμην εἶναι αἰσχροῦ.

Next take a look at the Idea of the subject stated, and see, for destructive purposes, if it fails to belong to the Idea, or fails to belong to it in virtue of that character which causes it to bear the description of which the property was rendered; for then what has been stated to be a property will not be a property. Thus (e.g.) inasmuch as being motionless does not belong to man-himself *qua* man, but *qua* Idea, it could not be a property of man to be motionless. For constructive purposes, on the other hand, see if the property in question belongs to the Idea, and belongs to it in that respect in virtue of which there is predicated of it that character of which the predicate in question has been stated not to be a property; for then what has been stated not to be a property will be a property. Thus (e.g.) inasmuch as it belongs to living-creature-itself to be compounded of soul and body, and further this belongs to it *qua* living-creature, it will be a property of living-creature to be compounded of soul and body.

8 · Next look from the point of view of greater and less degrees, and first for destructive purposes, see if what is so-and-so to a greater degree fails to be a property of what is such-and-such to a greater degree; for then neither will what is less be a property of what is less, nor least of least, nor most of most, nor will what is so-and-so without qualification be a property of what is such-and-such without qualification. Thus (e.g.) inasmuch as being more highly coloured is not a property of what is more a body, neither will being less highly coloured be a property of what is less a body, nor being coloured be a property of body at all. For constructive purposes, on the other hand, see if what is more is a property of what is more; for then also what is less will be a property of what is less, and least of least, and most of most, and without qualification of without qualification. Thus (e.g.) inasmuch as a higher degree of perception is a property of a higher degree of life, a lower degree of perception will be a property of a lower degree of life, and the highest of the highest and the lowest of the lowest degree, and perception without qualification of life without qualification.

Also you should look at the argument from unqualified predication to these qualified types, and see, for destructive purposes, if what is so-and-so without qualification fails to be a property of what is such-and-such without qualification; for then neither will more be a property of more, nor less of less, nor most of most, nor least of least. Thus (e.g.) inasmuch as virtuous is not a property of man, neither will more virtuous be a property of what is more human. For constructive purposes, on the other hand, see if what is without qualification is a property of what is without qualification; for then more will be a property of more, and less of less, and least of least, and most of most. Thus (e.g.) a tendency to move upwards by nature is a property of fire, and so also a greater tendency to move upwards by nature will be a property of what is more fiery. In the same way too one should look at the arguments from the others to all these.

Secondly, for destructive purposes, see if the more fails to be a property of the more; for then neither will the less be a property of the less. Thus (e.g.) inasmuch as perceiving is more a property of animal than knowing of man, and perceiving is not a property of animal, knowing will not be a property of man. For constructive purposes, on the other hand, see if the less is a property of the less; for then too the more will be a property of the more. Thus (e.g.) inasmuch as to be naturally civilized is less a property of a man than to live of an animal, and it is a property of man to be naturally civilized, it will be a property of animal to live.

Thirdly, for destructive purposes, see if the predicate fails to be a property of that of which it is more a property; for then neither will it be a property of that of which it is less a property; while if it is a property of the former, it will not be a property of the latter. Thus (e.g.) inasmuch as to be coloured is more a property of a surface than of a body, and it is not a property of a surface, to be coloured will not be a property of body; while if it is a property of a surface, it will not be a property of a body. For constructive purposes, on the other hand, this commonplace rule is not of any use; for it is impossible for the same thing to be a property of more than one thing.

Fourthly, for destructive purposes, see if what is more a property of a given subject fails to be its property; for then neither will what is less a property of it be its property. Thus (e.g.) inasmuch as perceptible is more a property of animal than divisible, and perceptible is not a property of animal, divisible will not be a property of animal. For constructive purposes, on the other hand, see if what is less a property of it is a property; for then what is more a property of it will be a property as well. Thus, for example, inasmuch as perception is less a property of animal than life, and perception is a property of animal, life will be a property of animal.

Next, look from the point of view of the attributes that belong in a like degree, and first, for destructive purposes, see if what is as much a property fails to be a property of that of which it is as much a property; for then neither will that which is as much a property as it be a property of that of which it is as much a property. Thus (e.g.) inasmuch as desiring is as much a property of the faculty of desire as reasoning is a property of the faculty of reason, and desiring is not a property of the faculty of desire, reasoning will not be a property of the faculty of reason. For constructive purposes, on the other hand, see if what is as much a property is a property of that of which it is as much a property; for then also what is as much a property as it will be a property of that of which it is as much a property. Thus (e.g.) inasmuch as it is as much a property of the faculty of reason to be the primary seat of prudence as it is of the faculty of desire to be the primary seat of temperance, and it is a property of the faculty of reason to be the primary seat of prudence, it will be a property of the faculty of desire to be the primary seat of temperance.

Secondly, for destructive purposes, see if what is as much a property of anything fails to be a property of it; for then neither will what is as much a property be a property of it. Thus (e.g.) inasmuch as seeing is as much a property of man as hearing, and seeing is not a property of man, hearing will not be a property of man. For constructive purposes, on the other hand, see if what is as much a property of it is its property; for then what is as much a property of it will be its property as well. Thus (e.g.) it is as much a property of the soul for a part of it to be the primary seat of desire as for a part to be the primary seat of reason, and it is a property of the soul for a part of it to be the primary seat of desire, and so it will be a property of the soul for a part of it to be the primary seat of reason.

Thirdly, for destructive purposes, see if it fails to be a property of that of which it is as much a property; for then neither will it be a property of that of which it is as much a property; while if it is a property of the former, it will not be a property of the other. Thus (e.g.) inasmuch as to burn is as much a property of flame as of live coals, and to burn is not a property of flame, to burn will not be a property of live coals: while if it is a property of flame, it will not be a property of live coals. For constructive purposes, on the other hand, this commonplace rule is of no use.

The rule based on things that are in a like relation differs from the rule based on attributes that belong in a like degree, because the former point is secured by analogy, not from reflection on the belonging of any attribute, while the latter is judged by a comparison based on the fact that an attribute belongs.

9 · Next, for destructive purposes, see if in rendering the property potentially, he has also through that potentiality rendered the property relatively to something that does not exist, when the potentiality cannot belong to what does not exist; for then what is stated to be a property will not be a property. Thus (e.g.) he who has said that breathable is a property of air has rendered the property potentially (for that is breathable which is such as can be breathed), and he has also rendered the property relatively to what does not exist (for while air may exist, even though there exists no animal so constituted as to breathe the air, it is not possible to breathe it if no animal exists; so that it will not be a property of air to be such as can be breathed at a time when there exists no animal such as to breathe it) and so it follows that breathable will not be a property of air.

139a1 For constructive purposes, see if in rendering the property potentially he renders the property either relatively to something that exists, or to something that does not exist, when the potentiality can belong to what exists;[30] for then what has been stated not to be a property will be a property. Thus (e.g.) he who renders it as a property of existing to be capable of being acted upon or of acting, in rendering the property potentially, has rendered the property relatively to something that exists; for when it is existent, it will be capable of being acted upon or of acting in a certain way; so that to be capable of being acted upon or of acting will be a property of existing.

Next, for destructive purposes, see if he has stated the property in the superlative; for then what has been stated to be a property will not be a property. For people who render the property in that way find that of the object of which the account is true, the name is not true as well; for though the object perishes the account will continue in being none the less; for it will belong in the greatest degree to something that is in being. An example would be supposing anyone were to render the lightest body as a property of fire; for, though fire may perish, there will still be some form of body that is the lightest, so that the lightest body will not be a property of fire. For constructive purposes, on the other hand, see if he has avoided

[30]Omitting μή (Verdenius).

rendering the property in the superlative; for then the property will in this respect have been correctly stated. Thus (e.g.) inasmuch as he who states a naturally civilized animal as a property of man has not rendered the property in the superlative, the property will in this respect have been correctly stated.

BOOK VI

1 · The discussion of definitions falls into five parts. For you have to show either that it is not true at all to apply the account to that to which the name is applied (for the definition of man ought to be true of every man); or that though the object has a genus, he has failed to put the object defined into the genus, or to put it into the appropriate genus (for the framer of a definition should first place the object in its genus, and then append its differences; for of the elements of the definition the genus seems to be the principal mark of the substance of what is defined); or that the account is not proper to the object (for, as we said above as well,[31] a definition ought to be proper); or else see if, though he has observed all the aforesaid cautions, he has yet failed to define the object, that is, to express the essence of what is being defined. It remains, apart from the foregoing, to see if he has defined it, but defined it incorrectly.

Whether, then, the account is not also true of that of which the name is true you should examine according to the commonplace rules that relate to accident. For there too the question is always 'Is so and so true or untrue?'; for whenever we argue that an accident belongs, we declare it to be true, while whenever we argue that it does not belong, we declare it to be untrue. Whether he has failed to place the object in the appropriate genus, or whether the given account is not proper, we must examine according to the commonplace rules that relate to genus and property.

It remains, then, to say how to investigate whether the object has been either not defined at all, or else defined incorrectly. First, then, we must examine if it has been defined incorrectly; for with anything it is easier to do it than to do it correctly—clearly, then, more mistakes are made in the latter task on account of its greater difficulty, so that the attack becomes easier in the latter case than in the former.

Incorrectness falls into two branches: first, the use of obscure language (for the language of a definition ought to be the very clearest possible, seeing that the purpose of rendering it is to make something known); secondly, if the account is longer than is necessary (for all additional matter in a definition is superfluous). Again, each of the aforesaid branches is divided into a number of others.

2 · One commonplace rule, then, in regard to obscurity is to see if what is stated is homonymous with something, e.g. that becoming is a passage into being, or

[31]See 101^b19.

that health is the balance of hot and cold elements. Here passage and balance are homonymous; it is accordingly not clear which of the several possible senses of the term he intends to convey. Likewise also, if the term defined is used in different ways and he has spoken without distinguishing between them; for then it is not clear to which of them the definition rendered applies, and one can then bring a captious objection on the ground that the account does not apply to all the things whose definition he has rendered—this kind of thing is particularly easy in the case where the definer does not see the homonymy. Or, again, the questioner may himself distinguish the various uses of the term rendered in the definition, and then produce a deduction; for if the expression used is not adequate to the subject in any of its senses, it is clear that he cannot have defined it aright.

Another rule is to see if he has used a metaphorical expression, as, for instance, if he has defined knowledge as unsupplantable, or the earth as a nurse, or temperance as a harmony. For a metaphorical expression is always obscure. It is possible, also, to argue captiously against the user of a metaphorical expression as though he had used it in its literal sense; for the definition stated will not apply, e.g. in the case of temperance; for harmony is always found between notes. Moreover, if harmony is the genus of temperance, then the same object will occur in two genera of which neither contains the other; for harmony does not contain virtue, nor virtue harmony.

Again, see if he uses terms that are not in current use, as when Plato describes the eye as brow-shaded, or a certain spider as poison-fanged, or the marrow as bone-formed. For an unusual phrase is always obscure.

Sometimes a phrase is used neither homonymously, nor yet metaphorically, nor yet literally, as when the law is said to be the measure or image of the things that are by nature just. Such phrases are worse than metaphor; for metaphor does make what it signifies to some extent familiar because of the likeness involved (for those who use metaphors do so always in view of some likeness), whereas this kind of thing makes nothing familiar, (for there is no likeness in virtue of which the law is a measure or image nor is the law ordinarily so called). So then, if a man says that the law is literally a measure or an image, he speaks falsely; for an image is something produced by imitation, and this is not found in the case of the law. If, on the other hand, he does not mean the term literally, it is clear that he has used an obscure expression, and one that is worse than any sort of metaphorical expression.

Moreover, see if from the expression used the account of the contrary is not clear; for definitions that have been correctly rendered also indicate their contraries as well. Or, again, see if, when it is merely stated by itself, it is not evident what it defines—just as in the works of the old painters, unless there were an inscription, the figures used to be unrecognizable.

3 · If, then, the definition is not clear, you should examine on lines such as these. If he has phrased the definition redundantly, first of all look and see whether he has used any attribute that belongs universally, either to entities in general, or to all that fall under the same genus as the object defined; for the mention of this is

sure to be redundant. For the genus ought to divide the object from other things, and the differentia from any of the things contained in the same genus. Now any term that belongs to everything separates off the given object from absolutely nothing, while any that belongs to all the things that fall under the same genus does not separate it off from the things contained in the same genus. Any addition, then, of that kind will be pointless.

Or see if, though the additional matter is proper to the given term, yet when it is struck out the rest of the account too is proper and makes clear the substance of the term. Thus, in the account of man, the addition 'capable of receiving knowledge' is superfluous; for strike it out, and still the account is proper and makes clear his substance. Speaking generally, everything is superfluous upon whose removal the 140b1 remainder still makes the term that is being defined clear. Such, for instance, would also be the definition of the soul, assuming it to be stated as a self-moving number; for the soul is just what is self-moving, as Plato defined it.[32] Or perhaps the expression used, though proper, yet does not show the substance if number is eliminated. Which of the two is the real state of the case it is difficult to determine clearly: the right way to treat the matter in all cases is to be guided by convenience. Thus (e.g.) it is said that the definition of phlegm is the undigested moisture that comes first off food. What is first is one, not many; so that the addition of the word 'undigested' is superfluous; so that even when this is left out the remaining account will still be proper; for it is impossible that both phlegm and also something else should both be the first to arise from the food. Or perhaps the phlegm is not absolutely the first thing to come off the food, but only the first of the undigested matters, so that the addition 'undigested' is required; for stated the other way the definition would not be true unless the phlegm comes first of all.

Moreover, see if anything contained in the account fails to apply to everything that falls under the same species; for this sort of account is worse than those which include an attribute belonging to all things universally. For in that case, if the remainder of the account is proper, the whole too will be proper; for absolutely always, if to something proper anything whatever that is true is added, the whole too becomes proper. Whereas if any part of the account does not apply to everything that falls under the same species, it is impossible that the account as a whole should be proper; for it will not be predicated convertibly with the object; e.g. a terrestrial two-footed animal six feet high—for an account of that kind is not predicated convertibly with the object, because being six feet high does not belong to everything that falls under the same species.

Again, see if he has said the same thing more than once, saying (e.g.) that desire is appetition for the pleasant. For desire is always for the pleasant, so that what is the same as desire will also be for the pleasant. Accordingly our definition of desire becomes appetition for the pleasant for the pleasant; for there is no difference between desire and appetition for the pleasant, so that both alike will be for the pleasant. Or perhaps there is no absurdity in this; for man is a biped; therefore, what is the same as man is a biped; but a terrestrial biped animal is the same as man, and

[32] *Phaedrus* 245E.

therefore a terrestrial biped animal is a biped. But this involves no real absurdity. For biped is not predicated of terrestrial animal (if it were, then we should certainly have biped predicated twice of the same thing); but the subject said to be a biped is a terrestrial biped animal, so that biped is only predicated once. Likewise in the case of desire as well; for being of the pleasant is not predicated of appetition, but rather of the whole, so that there too the predication is only made once. Absurdity results, not when the same word is uttered twice, but when the same thing is more than once predicated of a subject—as Xenocrates says that prudence defines and contemplates reality; for definition is a certain type of contemplation, so that by adding 'and contemplates' he says the same thing twice over. Likewise those who say that cooling is the privation of natural heat. For all privation is a privation of some natural attribute, so that the addition of 'natural' is superfluous: it would have been enough to say privation of heat, for privation itself makes it familiar that the heat meant is natural heat.

Again, see if a universal has been mentioned and then a particular case of it added as well, e.g. Equity is a remission of what is expedient and just; for what is just is a branch of what is expedient and is therefore included in the latter: it is therefore redundant, an addition of the particular after the universal has been already stated. So also, if he defines medicine as knowledge of what makes for health in animals and men, or the law as the image of what is by nature noble and just; for what is just is a branch of what is noble, so that he says the same thing more than once.

4 · Whether, then, a man defines a thing correctly or incorrectly you should examine on these and similar lines. But whether he has mentioned and defined its essence or not, should be examined as follows.

First of all, see if he has failed to make the definition through terms that are prior and more familiar. For a definition is rendered in order to come to know the term stated, and we come to know things by taking not any random terms, but such as are prior and more familiar, as is done in demonstrations (for so it is with all teaching and learning); accordingly, it is clear that a man who does not define through terms of this kind has not defined at all. Otherwise, there will be more than one definition of the same thing; for clearly he who defines through terms that are prior and more familiar has framed a better definition, so that both will then be definitions of the same object. This sort of thing, however, does not seem to be so; for of each entity there is a single essence; if, then, there are to be a number of definitions of the same thing, the object defined will be the same as the essences represented in each of the definitions; but these are not the same, inasmuch as the definitions are different. Clearly, then, any one who has not defined a thing through terms that are prior and more familiar has not defined it at all.

The statement that a definition has not been made through more familiar terms may be understood in two ways either supposing that its terms are without qualification less intelligible, or supposing that they are less intelligible to us; for either way is possible. Thus the prior without qualification is more familiar than the posterior, a point, for instance, than a line, a line than a plane, and a plane than a solid; just as a unit is more intelligible than a number; for it is prior to and a principle of all number. Likewise, also, a letter is more familiar than a syllable. Whereas to us it sometimes happens that the converse is the case; for a solid falls under perception most of all, and a plane more than a line, and a line more than a point; for most people learn such things earlier; for any ordinary intelligence can grasp them, whereas the others require a precise and exceptional understanding.

Absolutely, then, it is better to try to come to know what is posterior through what is prior, inasmuch as such a way of procedure is more scientific. Of course, in dealing with persons who cannot recognize things through terms of that kind, it may perhaps be necessary to frame the account through terms that are familiar to them. Among definitions of this kind are those of a point, a line, and a plane, all of which explain the prior by the posterior; for they say that a point is the limit of a line, a line of a plane, a plane of a solid. One must, however, not fail to observe that those who define in this way cannot show the essence of what they define, unless it so happens that the same thing is more familiar both to us and also without qualification, since a correct definition must define a thing through its genus and its differentiae, and these belong to the order of things which are without qualification more familiar than, and prior to, the species. For annul the genus and differentia, and the species too is annulled, so that these are prior to the species. They are also more familiar; for if the species is known, the genus and differentia must of necessity be known as well (for any one who knows what a man is knows also what animal and terrestrial are), whereas if the genus or the differentia is known it does not follow of necessity that the species is known as well; thus the species is less intelligible. Moreover, those who say that such definitions, viz. those which proceed from what is familiar to some individual, accord with the truth, will have to say that there are several definitions of one and the same thing. For in fact different things are more familiar to different people, not the same things to all; and so a different definition would have to be rendered to each several person, if the definition is to be constructed from what is more familiar to particular individuals. Moreover, to the same people different things are more familiar at different times: first of all the objects of sense; then, as they become more acute, the converse; so that those who hold that a definition ought to be rendered through what is more familiar to particular individuals will not have to render the same definition at all times even to the same person. It is clear, then, that the right way to define is not through terms of that kind, but through what is without qualification more familiar; for only in this way could the definition come always to be one and the same. Perhaps, also, what is familiar without qualification is what is familiar, not to all, but to those who are in a sound state of understanding, just as what is without qualification healthy is what is healthy to those in a sound state of body. All such points as this ought to be made very precise, and made use of in the course of discussion as occasion requires.

The demolition of a definition will most surely win a general approval if the definer happens to have framed his account neither from what is without qualification more intelligible nor yet from what is so to us.

One form, then, of the failure to work through more familiar terms is the exhibition of the prior through the posterior, as we remarked before. Another form occurs if we find that the account has been rendered of what is at rest and definite through what is indefinite and in motion; for what is still and definite is prior to what is indefinite and in motion.

Of the failure to use terms that are prior there are three forms. The first is when an opposite has been defined through its opposite, e.g. good through evil; for opposites are always simultaneous by nature. Some people think, also, that both are objects of the same science, so that the one is not even more familiar than the other. One must, however, observe that it is perhaps not possible to define some things in any other way, e.g. the double without the half, and all terms that are essentially relative; for in all such cases to be them is the same as to be somehow related to something, so that it is impossible to know the one without the other, and accordingly in the account of the one the other too must be embraced. One ought to recognize all such points as these, and use them as occasion may seem to require.

Another is—if he has used the term defined itself. This passes unobserved when the actual name of the object being defined is not used, e.g. supposing anyone had defined the sun as a star that appears by day. For in bringing in day he brings in the sun. To detect errors of this sort, exchange the name for its account, e.g. the account of day as the passage of the sun over the earth. Clearly, whoever has mentioned the passage of the sun over the earth has mentioned the sun, so that in bringing in the day he has brought in the sun.

Again, see if he has defined one co-ordinate member of a division by another, e.g. an odd number as that which is greater by one than an even number. For the co-ordinate members of a division that are derived from the same genus are simultaneous by nature, and odd and even are such terms; for both are differentiae of number.

Likewise also, see if he has defined a superior through a subordinate term, e.g. an even number as a number divisible into halves, or the good as a state of virtue. For 'into halves' is derived from 'two', and two is an even number; and virtue is a kind of good—so that the latter terms are subordinate to the former. Moreover, in using the subordinate term one is bound to use the other as well; for whoever introduces virtue introduces the good, seeing that virtue is a certain kind of good; likewise, also, whoever employs 'into halves' employs the even, for to be divided into halves means to be divided into two, and two is even.

5 · Generally speaking, then, one commonplace rule relates to the failure to frame the account by means of terms that are prior and more familiar; and of this the subdivisions are those specified above. A second is to see whether, though the object is in a genus, it has not been placed in a genus. This sort of error is always found where what the object is does not stand first in the account, e.g. the definition of body as that which has three dimensions, or the definition of man, supposing anyone to give it, as that which knows how to count; for it is not stated what it is that has three dimensions, or what it is that knows how to count; whereas the genus is meant to indicate what it is, and is submitted first of the terms in the definition.

Moreover, see if, while the term to be defined is used in relation to many things, he has failed to render it in relation to all of them; as (e.g.) if he defines grammar as the knowledge how to write from dictation; for he ought also to say that it is a knowledge how to read as well. For one who renders it as knowledge of writing has no more defined it than one who renders it as knowledge of reading: neither in fact has succeeded, but only one who mentions both these things, since it is impossible that there should be more than one definition of the same thing. It is only, however, in some cases that what has been said corresponds to the actual state of things: in some it does not, e.g. all those terms which are not used in their own right in relation to both things—as medicine is said to deal with the production of disease and health; for it is said in its own right to do the latter, but the former only by accident; for it is absolutely alien to medicine to produce disease. Here, then, the man who renders medicine as relative to both of these things has not defined it any better than he who mentions the one only. In fact he has done it perhaps worse; for any one else besides the doctor is capable of producing disease.

Moreover, in a case where the term to be defined is used in relation to several things, see if he has rendered it as relative to the worse rather than to the better; for every form of knowledge and potentiality is generally thought to be relative to the best.

Again, if the thing in question is not placed in its own proper genus, one must examine it according to the elementary rules in regard to genera, as has been said before.

Moreover, see if he passes over the genera, defining, e.g., justice as a state that produces equality or distributes what is equal; for by defining it so he passes over virtue, and so by leaving out the genus of justice he fails to express its essence; for the substance of a thing in each case involves its genus. This is the same as not putting the object into its nearest genus; for the man who puts it into the nearest one has stated all the higher genera, seeing that all the higher genera are predicated of the lower. Either, then, it ought to be put into its nearest genus, or else to the higher genus all the differentiae ought to be appended whereby the nearest genus is defined. For then he would not have left out anything, but would have mentioned the subordinate genus by an account instead of by a name. On the other hand, he who mentions merely the higher genus by itself, does not state the subordinate genus as well: in mentioning a plant a man does not mention a tree.

6 · Again, in regard to the differentiae, we must examine in like manner whether the differentiae that he has stated are those of the genus. For if a man has not defined the object by the differentiae to it, or has mentioned something such as is utterly incapable of being a differentia of anything, e.g. animal or substance, clearly he has not defined it at all; for the aforesaid terms are not differentiae of anything at all. Further, we must see whether the differentia stated possesses anything that is co-ordinate with it in a division; for, if not, clearly the one stated will not be a differentia of the genus. For a genus is always divided by differentiae that are co-ordinate members of a division, as, for instance, animal by terrestrial,

and winged [and aquatic and biped].[33] Or see if, though the contrasted differentia exists, it yet is not true of the genus; for then, clearly, neither of them could be a differentia of the genus; for differentiae that are co-ordinates in a division are all true of the genus. Likewise, also, see if, though it is true, yet the addition of it to the genus fails to make a species. For then, clearly, this will not be a specific differentia of the genus; for a specific differentia, along with the genus, always makes a species. If, however, this is no differentia, no more is the one adduced, seeing that it is a co-ordinate member of a division with this.

Moreover, see if he divides the genus by a negation, as those do who define a line as length without breadth; for this means simply that it has not any breadth. The genus will then be found to partake of its own species; for, since of everything either the affirmation or the negation is true, length must always either lack breadth or possess it, so that length as well, i.e. the genus of line, will be either with or without breadth. But length without breadth is the account of a species, as also is length with breadth; for without breadth and with breadth are differentiae, and the genus and differentia constitute the account of the species. Hence the genus will admit of the account of its species. Likewise, also, it will admit of the account of the differentia, seeing that one or the other of the aforesaid differentiae is of necessity predicated of the genus. This principle is useful against those who posit Ideas; for if length itself exists, how will it be predicable of the genus that it has breadth or that it lacks it? For one assertion or the other will have to be true of length universally, if it is to be true of the genus; and this is contrary to the fact; for there exist both lengths which have, and lengths which have not, breadth. Hence the only people against whom the rule can be employed are those who assert that every genus is numerically one; and this is what is done by those who posit the Ideas; for they allege that length itself and animal itself are the genus. It may be that in some cases the definer is obliged to employ a negation, e.g. in defining privations. For a thing is blind which cannot see when its nature is to see.

There is no difference between dividing the genus by a negation, and dividing it by such an affirmation as is bound to have a negation as its co-ordinate in a division, e.g. supposing he had defined something as length possessed of breadth; for co-ordinate in the division with that which is possessed of breadth is that which possesses no breadth and that only, so that again the genus is divided by a negation.

Again, see if he rendered the species as a differentia, as do those who define contumely as insolence accompanied by jeering; for jeering is a kind of insolence, hence it is a species and not a differentia.

Moreover, see if he has stated the genus as the differentia, e.g. virtue as a good or noble state; for good is the genus of virtue. Or possibly good here is not the genus but the differentia, on the principle that the same thing cannot be in two genera of which neither contains the other; for good does not include state, nor vice versa; for not every state is good nor every good a state. Both, then, will not be genera, and consequently, if state is the genus of virtue, clearly good cannot be its genus: it must

[33] Excised by Düring.

rather be a differentia. Moreover, a state indicates what virtue is, whereas good indicates not what it is but a quality, and to indicate a quality seems to be the function of the differentia.

See, further, whether the given differentia indicates a certain 'this' rather than a quality; for it seems that the differentia always expresses a quality.

Look and see, further, whether the differentia belongs only by accident to the object defined. For the differentia is never an accidental attribute, any more than the genus is; for the differentia of a thing cannot both belong and not belong to it.

Moreover, if either the differentia or the species, or any of the things which are under the species, is predicated of the genus, then he will not have defined the term. For none of the aforesaid can be predicated of the genus, seeing that the genus is the term with the widest range of all. Again, see if the genus is predicated of the differentia; for it seems that the genus is predicated, not of the differentia, but of the objects of which the differentia is predicated. Animal (e.g.) is predicated of man and ox and other terrestrial animals, not of the differentia itself, which we predicate of the species. For if animal is to be predicated of each of its differentiae, then many animals will be predicated of the species; for the differentiae are predicated of the species. Moreover, the differentiae will be all either species or individuals, if they are animals; for every animal is either a species or an individual.

Likewise you must inquire also if the species or any of the objects that come under it is predicated of the differentia; for this is impossible, seeing that the differentia is a term with a wider range than the species. Moreover, if any of the species is predicated of it, the result will be that the differentia is a species: if man is predicated, the differentia is clearly man. Again, see if the differentia fails to be prior to the species; for the differentia ought to be posterior to the genus, but prior to the species.

Look and see also if the differentia mentioned belongs to a different genus, neither contained in nor containing the genus in question. For it seems that the same differentia cannot be used of two genera neither of which contains the other. Otherwise, the result will be that the same species as well will be in two genera neither of which contains the other; for each of the differentiae imports its appropriate genus, e.g. terrestrial and biped import with them animal. Hence each of the genera as well is true of that of which the differentia is true; and it clearly follows that the species must be in two genera neither of which contains the other. Or perhaps it is not impossible for the same differentia to be used of two genera neither of which contains the other, and we ought to add 'if they do not both fall under the same genus'. Thus terrestrial animal and winged animal are genera neither of which contains the other, and biped is a differentia of both. So we ought to add 'if they do not both fall under the same genus'; for both these are subordinate to animal. From this possibility, that the same differentia may be used of two genera neither of which contains the other, it is clear also that there is no necessity for the differentia to carry with it every appropriate genus, but only the one or the other together with the genera that are higher than this, as biped carries with it either winged or terrestrial animal.

See, too, if he has rendered being in something as the differentia of a thing's substance; for it seems that locality cannot differentiate between one substance and another. Hence, too, people condemn those who divide animals by means of the terms terrestrial and aquatic, on the ground that terrestrial and aquatic indicate locality. Or possibly in this case the censure is undeserved; for aquatic does not mean 'in' anything; nor does it denote a locality, but a certain quality; for even if the thing is on the dry land, still it is aquatic—and likewise a land animal, even though it is in the water, will still be a land animal and not aquatic. But all the same, if ever the differentia does denote being in something, clearly he will have made a mistake.

Again, see if he has rendered an affection as the differentia; for every affection, if intensified, subverts the substance of the thing, while the differentia is not of that kind; for the differentia seems rather to preserve that which it differentiates; and it is absolutely impossible for a thing to exist without its appropriate differentia—if there is nothing terrestrial, there will be no man. To speak generally, a thing cannot have as its differentia anything in respect of which it is subject to alteration; for all things of that kind, if intensified, subvert its substance. If, then, a man has rendered any differentia of this kind, he has made a mistake; for we undergo absolutely no alteration in respect of our differentiae.

Again, see if he has failed to render the differentia of a relative term relatively to something else; for the differentiae of relative terms are themselves relative, as in the case of knowledge. This is classed as speculative, practical, and productive; and each of these denotes a relation; for it speculates upon something, and produces something, and does something.

Look and see also if the definer renders each relative term relatively to its natural correlative; for while some things can be used in relation to their natural correlative only and to nothing else, some can be used in relation to something else as well. Thus sight can only be used for seeing, but a strigil can also be used to draw off liquid. Still, if any one were to define a strigil as an instrument for drawing off liquid, he would make a mistake; for that is not its natural correlative. The definition of a thing's natural correlative is that for which it would be used by the prudent man, acting as such, and by the science appropriate to that thing.

Or see if, whenever a term happens to be used in a number of relations, he has failed to introduce it in its primary relation: e.g. by defining prudence as the virtue of man or of the soul, rather than of the reasoning faculty; for prudence is the virtue primarily of the reasoning faculty; for it is in virtue of this that both the man and his soul are said to be prudent.

Moreover, if the thing of which the term defined has been stated to be an affection or disposition, or whatever it may be, is unable to admit it, the definer has made a mistake. For every disposition and every affection is formed naturally in that of which it is an affection or disposition, as knowledge is formed in the soul, being a disposition of soul. Sometimes, however, people make mistakes in matters of this sort, e.g. all those who say that sleep is an incapacity to perceive, or that perplexity is a state of equality between contrary reasonings, or that pain is a violent disruption of parts that are naturally conjoined. For sleep is not an attribute of perception, whereas it ought to be, if it is an incapacity to perceive. Likewise, perplexity is not an attribute of opposite reasonings, nor pain of parts naturally conjoined; for then inanimate things will be in pain, since pain will be present in them. Similar in character, too, is the definition of health, if it is a balance of hot and cold elements; for then health will be necessarily exhibited by the hot and cold elements; for a balance of anything belongs to those things of which it is the balance, so that health will be an attribute of them. Moreover, people who define in this way put effect for cause, or cause for effect. For the disruption of parts naturally conjoined is not pain, but a cause of pain; nor again is an incapacity to perceive sleep, but the one is the cause of the other—for either we go to sleep because of the incapacity, or we are incapable because we go to sleep. Likewise also an equality between contrary reasonings would seem to be a cause of perplexity; for it is when we reflect on both sides of a question and find everything alike to be in keeping with either course that we are perplexed which of the two we are to do.

Moreover, with regard to all periods of time look and see whether there is any discrepancy: e.g. supposing the immortal to be defined as a living thing immune at present from destruction. For a living thing that is immune at present from destruction will be immortal at present. Possibly, indeed, in this case this result does not follow, owing to the ambiguity of the words 'immune at present from destruction'; for they may mean either that the thing has not been destroyed at present, or that it cannot be destroyed at present, or that at present it is such that it never can be destroyed. Whenever, then, we say that a living thing is at present immune from destruction, we mean that it is at present a living thing of such a kind as never to be destroyed; and this is equivalent to saying that it is immortal, so that it is not meant that it is immortal only at present. Still, if ever it does happen that the attribute given by the account belongs in the present or past, whereas that given by the name does not so belong, then the two will not be the same. So, then, this commonplace rule ought to be used as we have said.

7 · You should look and see also whether the term defined is applied in consideration of something other than the account given. Suppose (e.g.) a definition of justice as the ability to distribute what is equal. Now it is the man who chooses, rather than the man who is able, to distribute what is equal who is just; so that justice will not be an ability to distribute what is equal; for then also the most just 146a1
man will be the man with the most ability to distribute what is equal.

Moreover, see if the object admits of degrees, whereas what is given by the account does not, or, vice versa, what is given by the account admits of degrees while the object does not. For either both must admit them or else neither, if indeed what is given by the account is the same as the object. Moreover, see if, while both of them admit of degrees, they yet do not both become greater together: e.g. suppose love to be the desire for intercourse; now he who is more intensely in love has not a more intense desire for intercourse, so that both do not become intensified at once: they certainly should, however, had they been the same thing.

Moreover, suppose two things to be before you, see if the object applies in greater degree to the one to which the content of the account is less applicable. Take, for instance, the definition of fire as the body that consists of the most rarefied particles. For flame is fire in greater degree than light is, but flame is less the body that consists of the most rarefied particles than is light; but both ought to be applicable in greater degree to the same thing, if they had been the same. Again, see if the one applies in equal degree to both the objects before you, while the other does not apply to both alike, but more particularly to one of them.

Moreover, see if he renders the definition relative to two things taken separately: thus, the beautiful is what is pleasant to the eyes or to the ears; or the existent is what is capable of being acted upon or of acting. For then the same thing will be both beautiful and not beautiful, and likewise will be both existent and non-existent. For pleasant to the ears will be the same as beautiful, so that not pleasant to the ears will be the same as not beautiful; for of identical things the opposites, too, are identical, and the opposite of beautiful is not beautiful, while of pleasant to the ears the opposite is not pleasant to the ears—clearly, then, not pleasant to the ears is the same thing as not beautiful. If, therefore, something is pleasant to the eyes but not to the ears, it will be both beautiful and not beautiful. In like manner we shall prove also that the same thing is both existent and non-existent.

Moreover, of both genera and differentiae and all the other terms rendered in definitions you should frame accounts in lieu of the names, and then see if there is any discrepancy between them.

8 · If the term defined is relative, either in itself or in respect of its genus, see whether the definition fails to mention that to which the term, either in itself or in
146b1 respect of its genus, is relative, e.g. if he has defined knowledge as an incontrovertible belief or wishing as painless appetition. For of everything relative the substance is relative to something else, seeing that the being of every relative term is identical with being in a certain relation to something. He ought, therefore, to have said that knowledge is belief about a knowable and that wishing is appetition for a good. Likewise, if he has defined grammar as knowledge of letters—for in the definition there ought to be rendered either the thing to which the term itself is relative, or that to which its genus is relative. Or see if a relative term has been described not in relation to its end, the end in anything being whatever is best or gives its purpose to the rest. Certainly it is what is best or final that should be stated, e.g. that desire is not for the pleasant but for pleasure; for this is our purpose in choosing what is pleasant.

Look and see also if that in relation to which he has rendered the term is a process or an activity; for nothing of that kind is an end, for the completion of the activity or process is the end rather than the process or activity itself. Or perhaps this rule is not true in all cases; for almost everybody would rather be enjoying themselves than have ceased enjoying themselves, so that they would count the activity as the end rather than its completion.

Again see in some cases if he has failed to distinguish the quantity or quality or place or other differentiae of an object; e.g. the quality and quantity of the honour the striving for which makes a man ambitious—for all men strive for honour, so that it is not enough to define the ambitious man as him who strives for honour, but the aforesaid differentiae must be added. Likewise, also, in defining the covetous man the quantity of money he aims at, or in the case of the incontinent man the quality of the pleasures, should be stated. For it is not the man who gives way to any sort of pleasure whatever who is called incontinent, but only he who gives way to a certain kind of pleasure. Or again, people sometimes define night as a shadow on the earth, or an earthquake as a movement of the earth, or a cloud as condensation of the air, or a wind as a movement of the air; whereas they ought to specify as well quantity, quality, place, and cause. Likewise, also, in other cases of the kind; for by omitting any differentiae whatever he fails to state the essence. One should always attack deficiency. For a movement of the earth does not constitute an earthquake, nor a movement of the air a wind, irrespective of its manner and the amount involved.

Moreover, in the case of appetitions, and in any other cases where it applies, see if the word 'apparent' is left out: e.g. wishing is an appetition after the good, or desire is an appetition after the pleasant—instead of the apparently good or pleasant. For often those who exhibit the appetition do not perceive what is good or pleasant, so that their aim need not be really good or pleasant, but only apparently so. They ought, therefore, to have rendered the definition accordingly. On the other hand, any one who maintains the existence of Ideas ought to be brought face to face with his Ideas, even though he does render the term in question; for there can be no Idea of anything apparent and it seems that an Idea is always spoken of in relation to an Idea—thus desire itself is for the pleasant itself, and wishing itself is for the good itself; they therefore cannot be for an apparently good or an apparently pleasant; for the existence of the apparently good (or pleasant) itself would be an absurdity.

9 · Moreover, if the definition is of the state of anything, look at what is in the state, while if it is of what is in the state, look at the state; and likewise in other cases of the kind. Thus if the pleasant is essentially beneficial, then, too, the man who is pleased is benefited. Speaking generally, in definitions of this sort it happens that what the definer in a sense defines is more than one thing; for in defining knowledge, a man in a sense defines ignorance as well, and likewise also what has knowledge and what lacks it, and what it is to know and to be ignorant. For if the first is made clear, the others become in a certain sense clear as well. We have, then, to be on our guard in all such cases against discrepancy, using the elementary principles drawn from consideration of contraries and of co-ordinates.

Moreover, in the case of relative terms, see if the species is rendered as relative to a species of that to which the genus is rendered as relative, e.g. supposing belief to be relative to the object of belief, see whether a particular belief is made relative to some particular object of belief; and, if a multiple is relative to a fraction, see whether a particular multiple is made relative to a particular fraction. For if it is not so rendered, clearly a mistake has been made.

See, also, if the opposite of the term has the opposite account, whether (e.g.) the account of half is the opposite of that of double; for if double is that which exceeds another by an equal amount to that other, half is that which is exceeded by an amount equal to itself. In the same way, too, with contraries. For to the contrary term will apply the account that is contrary in some one of the ways in which contraries are conjoined. Thus (e.g.) if useful is productive of good, injurious is productive of evil or destructive of good—for one or the other of these is bound to be contrary to the term originally used. Suppose then, neither of these things to be the contrary of the term originally used, then clearly neither of those rendered later will be an account of the contrary; and therefore the account originally rendered has not been rightly rendered either. Seeing, moreover, that of contraries, the one is sometimes named by the privation of the other, as (e.g.) inequality seems to be the privation of equality (for things that are not equal are called unequal), it is therefore clear that the contrary named by the privation must of necessity be defined through the other; whereas the other cannot then be defined through the one named by the privation; for else we should find that each was being made known by the other. We must in the case of contrary terms keep an eye on this mistake, e.g. supposing any one were to define equality as the contrary of inequality; for then he is defining it through the one named by the privation of it. Moreover, a man who so defines is bound to use in his definition the very term he is defining; and this becomes clear, if for the name we substitute its account. For to say 'inequality' is the same as to say 'privation of equality'. Therefore equality will be the contrary of the privation of equality, so that he will have used the very term to be defined. Suppose, however, that neither of the contraries is named by the privation, but yet the account of it is rendered in a manner like the above, e.g. suppose good to be defined as the contrary of evil, then it is clear that evil will be the contrary of good (for the accounts of things that are contrary in this way must be rendered in a like manner), so that again he uses the very term being defined—for good is inherent in the account of evil. If, then, good is the contrary of evil, and evil is nothing other than the contrary of good, then good will be the contrary of the contrary of good. Clearly, then, he has used the very term to be defined.

Moreover, see if in rendering a term named by the privation, he has failed to render the term of which it is the privation, e.g. the state, or contrary, or whatever it may be whose privation it is; also if he has omitted to add that in which the privation is naturally formed—either without qualification or else that in which it is naturally formed primarily: e.g. whether in defining ignorance as a privation he has failed to say that it is the privation of knowledge; or has failed to add in what it is naturally formed, or, though he has added this, has failed to render the thing in which it is primarily formed, placing it (e.g.) in man or in the soul, and not in the reasoning faculty; for if in any of these respects he fails, he has made a mistake. Likewise, also, if he has failed to say that blindness is the privation of sight in an eye; for a proper rendering of what it is must state both of what it is the privation and what it is that is deprived.

Examine further whether he has defined as a privation something not named by a privation—a mistake of this sort would seem to be incurred in the case of ignorance by any one who is not using it as a merely negative term. For what seems to be ignorant is not that which has no knowledge, but rather that which has been deceived (for this reason we do not talk of inanimate things or of children as being ignorant). Ignorance, then, is not named by the privation of knowledge.

10 · Moreover, see whether the like inflexions in the account apply to the like inflexions of the word; e.g. if beneficial is productive of health, is beneficially productively of health and a benefactor a producer of health?

Look too and see whether the definition given will apply to the Idea as well. For in some cases it will not do so; e.g. in the Platonic definition where he adds the word 'mortal' in his definitions of living creatures; for the Idea (e.g. man itself) is not mortal, so that the account will not fit the Idea. In general, wherever the words 'capable of acting on' or 'capable of being acted upon' are added, the definition and the Idea are bound to be discrepant; for those who assert the existence of Ideas hold that they are incapable of being acted upon, or of motion. In dealing with these people arguments of this kind are useful.

Further, see if he has rendered a single common account of terms that are used homonymously. For things whose account corresponding to their name is one and the same, are synonymous; if, then, the definition applies in a like manner to the whole range of the homonym, it does not define any one of the objects described by the term. This is what happens to Dionysius' definition of life when stated as a movement of a creature sustained by nutriment, congenitally present with it; for this is found in plants as much as in animals, whereas life seems to be not one kind of thing only, but one thing in animals and another in plants. It is possible to hold the view that life is synonymous and of one kind only, and therefore to render the definition in this way on purpose; or it may quite well happen that a man may see the homonymy and wish to render the definition of the one sense only, and yet fail to see that he has rendered an account common to both instead of proper to one. In either case, whichever course he pursues, he is equally at fault. Since homonymies sometimes pass unobserved, it is best in questioning to treat them as though they were synonymous (for the definition of the one will not apply to the other, so that the answerer will seem not to have defined it correctly—for it should apply to the whole range of the synonym, whereas in answering you should yourself distinguish between them). Further, as some answerers call homonymous what is really synonymous, whenever the given account fails to apply to the whole range, and, vice versa, call synonymous what is really homonymous if it applies to both, one should secure a preliminary agreement on such points, or else prove beforehand that so-and-so is homonymous or synonymous, as the case may be; for people are more ready to agree when they do not foresee what the consequence will be. If, however, no agreement has been made, and the man asserts that what is really synonymous is homonymous because the account he has given will not apply to the second sense as well, see if the account of this second sense applies to the others; for if so, this must clearly be synonymous with those others. Otherwise, there will be more than one definition of the others; for there are applicable to them two accounts corresponding to their names, viz. the one previously rendered and also the later one. Again, if anyone were to define a term used in several ways, and, finding that his account does not apply to them all, were to contend not that the term is homonymous, but that the name does not apply to all of them, just because his account will not do so either, then one may retort to such a man that though in some things one must not speak with the vulgar, yet in a question of terminology one is bound to employ the received and traditional usage and not to upset matters of that sort.

11 · Suppose now that a definition has been rendered of some complex, take away the account of one of the elements in the complex, and see if the rest of the account defines the rest of it: if not, it is clear that neither does the whole account define the whole complex. Suppose, e.g., that some one has defined a finite straight line as the limit of a finite plane, such that its centre is in a line with its extremes; if now the account of a finite line is the limit of a finite plane, the rest (viz. 'such that its centre is in a line with its extremes') ought to be an account of straight. But an infinite straight line has neither centre nor extremes and yet is straight, so that the remainder is not an account of the remainder.

Moreover, if the term defined is a compound, see if the account given has as many members as the term defined. An account is said to have as many members as the term defined when the number of the elements compounded is the same as the number of names and verbs in the account. For in such cases, there is bound to be an exchange of word for word, in the case of some if not of all, seeing that there are no more words used now than formerly; whereas in a definition words ought to be rendered by accounts, if possible in every case, or if not, in the majority. For at that rate, simple objects too could be defined by merely calling them by a different name, e.g. cloak instead of doublet.

The mistake is even worse, if in addition a less intelligible word is substituted, e.g. pellucid mortal for white man; for it is no definition, and is less clear when put in that form.

Look and see also whether, in the exchange of words, the sense fails still to be the same. Take, for instance, the explanation of speculative knowledge as speculative belief; for belief is not the same as knowledge—as it certainly ought to be if the whole is to be the same too; for though the word 'speculative' is common to both accounts, yet the remainder is different.

Moreover, see if in replacing one of the names by something else he has exchanged the genus and not the differentia, as in the example just given; for speculative is less intelligible than knowledge; for the one is the genus and the other the differentia, and the genus is always the most familiar of all; so that it is not this, but the differentia, that ought to have been changed, seeing that it is the less intelligible. (It might be held that this criticism is ridiculous because there is no reason why the most familiar name should not describe the differentia, and not the genus; in which case, clearly, the word to be altered should be that denoting the genus and not the differentia.) If, however, a man is substituting for a word not a word but an account, clearly it is of the differentia rather than of the genus that a definition should be rendered, seeing that the object of rendering the definition is to make the subject familiar; for the differentia is less familiar than the genus.

If he has rendered the definition of the differentia, see whether the definition rendered is common to it and something else as well: e.g. whenever he says that an odd number is a number with a middle, further definition is required of how it has a middle; for number is common to both accounts, and it is the word 'odd' for which the account has been substituted. Now both a line and a body have a middle, yet they are not odd; so that this will not be a definition of odd. And if having a middle is used in several ways, the way here intended requires to be defined. So that this will either discredit the definition or prove that it is no definition at all.

12 · Again, see if the account is given of an entity, whereas what falls under the account is a non-entity. E.g., suppose white to be defined as colour mingled with 149b1
fire; for what is bodiless cannot be mingled with body, so that colour cannot be mingled with fire, whereas white does exist.

Moreover, those who in the case of relative terms do not distinguish to what the object is related, but have described it only so as to include it among a number of things, are wrong either wholly or in part; e.g. suppose some one to have defined medicine as a science of what exists. For if medicine is not a science of anything that exists, the definition is clearly altogether false; while if it is a science of some things, but not of others, it is partly false; for it ought to hold of everything, if it is said to be of what exists essentially and not accidentally—as is the case with other relative terms; for every object of knowledge is relative to knowledge. Likewise, also, with other relative terms, inasmuch as all such are convertible. Moreover, if the right way to render account of a thing is to render it as it is not in itself but accidentally, then each relative term will be used in relation not to one thing but to a number of things. For there is no reason why the same thing should not be both existent and white and good, so that it will be a correct rendering to render the object in relation to any one whatsoever of these, if to render what it is accidentally is a correct way to render it. It is, moreover, impossible that an account of this sort should be proper to the term rendered; for not only medicine, but the majority of the other sciences too, have for their object some entity, so that each will be a science of what exists. Clearly, then, such a definition does not define any science at all; for a definition ought to be proper, not common.

Sometimes, again, people define not the object but only the object in a good or perfect condition. Such is the definition of an orator as one who can see what will persuade in any circumstances, and omit nothing; or of a thief, as one who pilfers in secret; for clearly, if they each do this, then the one will be a good orator, and the other a good thief; whereas it is not the actual pilfering in secret, but the wish to do it, that constitutes the thief.

Again, see if he has rendered what is desirable for its own sake as desirable for what it produces or does, or as in any way desirable because of something else, e.g. by saying that justice is what preserves the laws or that wisdom is what produces happiness; for what produces or preserves something else is one of the things desirable because of something else. It might be said that it is possible for what is desirable in itself to be desirable because of something else as well; but still to define what is desirable in itself in such a way is none the less wrong; for what is best in anything is especially part of its substance, and it is better for a thing to be desirable in itself than to be desirable because of something else, so that the definition ought rather to have indicated this.

150a1 **13** · See also whether in defining anything a man has defined it as *these* things, or as made from these things or as this together with that. If he defines it as *these* things, the definition will be true of both and yet of neither of them; suppose, e.g., justice to be defined as temperance and courage. For if of two persons each has one of the two only, both and yet neither will be just; for both together have justice, and yet each singly fails to have it. Even if the situation here described does not so far appear very absurd because of the occurrence of this kind of thing in other cases also (for it is quite possible for two men to have a pound between them, though neither of them has it by himself), yet at least that they should have contrary attributes surely seems quite absurd; and yet this will follow if the one is temperate and cowardly, and the other brave and profligate; for then both will exhibit both justice and injustice; for if justice is temperance and bravery, the injustice will be cowardice and profligacy. In general, too, all the ways of showing that the whole is not the same as the sum of its parts are useful in meeting the type just described; for a man who defines in this way seems to assert that the parts are the same as the whole. The arguments are particularly appropriate in cases where the process of putting the parts together is obvious, as in a house and other things of that sort; for there, clearly, you may have the parts and yet not have the whole, so that parts and whole cannot be the same.

If he has said that the term being defined is not these things but made from these things, look and see in the first place if they cannot in the nature of things have a single product; for some things are so related to one another that nothing can come from them, e.g. a line and a number. Moreover, see if the term that has been defined is in the nature of things found primarily in some single subject, whereas the things from which he has said it is made are not found primarily in any single subject, but each in a separate one. If so, clearly that will not be made from these things; for the whole is bound to be in the same things wherein its parts are, so that the whole will then be found primarily not in one thing, but in a number of them. If, on the other hand, both parts and whole are found primarily in some single subject, see if that is not the same, but one thing in the case of the whole and another in that of the parts. Again, see whether the parts perish together with the whole; for it ought to happen vice versa, that the whole perishes when the parts perish: when the whole perishes, there is no necessity that the parts should perish too. Or again, see if the whole is good or evil, and the parts neither, or, vice versa, if the parts are good or evil and the whole neither. For it is impossible either for a neutral thing to produce something
150b1 good or bad, or for things good or bad to produce a neutral thing. Or again, see if the

one thing is more good than the other is evil, and yet the product is no more good than evil, e.g. suppose shamelessness is the product of courage and false opinion: here courage is more good than false opinion is evil; accordingly the product of these ought to follow the greater, and be either good without qualification, or at least more good than evil. Or it may be that this does not necessarily follow, unless each is in itself good or bad; for many things that are productive are not good in themselves, but only in combination; or, vice versa, they are good taken singly, and bad or neutral in combination. What has just been said is more clearly illustrated in the case of things that make for health or sickness; for some drugs are such that each taken alone is good, but if they are both administered in a mixture, bad.

Again, see whether the whole, as produced from a better and worse, fails to be worse than the better and better than the worse element. This again, however, need not necessarily be the case, unless the elements compounded are in themselves good; if they are not, the whole may very well not be good, as in the cases just instanced.

Moreover, see if the whole is synonymous with one of the elements; for it ought not to be, any more than in the case of syllables; for a syllable is not synonymous with any of the letters of which it is made up.

Moreover, see if he has failed to state the manner of their composition; for saying that it is made from these things is not enough to make the thing intelligible. For the substance of any compound thing is not merely that it is made from these things, but that it is made from them in such and such a way, as in the case of a house; for here the materials do not make a house irrespective of the way they are put together.

If a man has defined an object as this together with that, the first thing to be said is that this together with that is the same as these things, or as what is made from these things. For 'honey together with water' means either 'honey and water', or 'what is made from honey and water'. If, then, he admits that this together with that is the same as either of these two things, the same criticisms will apply as have already been given for meeting each of them. Moreover, distinguish between the different ways in which one thing may be said to be together with another, and see if there is none of them in which this is together with that. Thus e.g. supposing one thing to be together with another either in that some identical thing contains them (as e.g. justice and courage are found in the soul), or as being in the same place or in the same time, and if this is in no way true of the things in question, clearly the definition rendered will not hold of anything, as this is not in any way together with that. If, however, among the various ways distinguished, each is found in the same time as the other, look and see if possibly the two are not used in the same relation. Thus e.g. suppose courage to have been defined as daring with right reasoning: here it is possible that a person exhibits daring in robbery, and right reasoning in regard to the means of health—but he is not courageous just because he has this together with that at the same time. Moreover, even though both are used in the same relation, e.g. in relation to medical treatment (for a man may exhibit both daring and right reasoning in respect of medical treatment), still a man who has this together with that is not yet courageous. For the two must not relate to any casual object that is the same, any more than each to a different object; rather, they must relate to the function of courage, e.g. meeting the perils of war, or whatever is more properly speaking its function than this.

Some definitions rendered in this form fail to come under the aforesaid division at all, e.g. a definition of anger as pain with a consciousness of being slighted. For what this means to say is that it is because of a consciousness of this sort that the pain occurs; but to occur because of a thing is not the same as to occur together with it in any of the aforesaid ways.

14 · Again, if he has described the whole as the composition of these things (e.g. a living creature as a composition of soul and body), first of all see whether he has omitted to state the kind of composition, as (e.g.) in a definition of flesh or bone as the composition of fire, earth, and air. For it is not enough to say it is a composition, but you should also go on to define the kind of composition; for these things do not form flesh irrespective of the manner of their composition, but when compounded in one way they form flesh, when in another, bone. It appears, moreover, that neither of the aforesaid things is the same as a composition at all; for a composition always has a dissolution as its contrary, whereas neither of the aforesaid has any contrary. Moreover, if it is equally plausible that every compound is a composition and that none is, and if every kind of living creature, though a compound, is not a composition, then no other compound will be a composition either.

Again, if two contraries are equally liable to occur naturally in a thing, and the thing has been defined through the one, clearly it has not been defined; otherwise there will be more than one definition of the same thing; for how is it any more a definition to define it through this one than through the other, seeing that both are equally liable to occur naturally in it? Such is the definition of the soul, if defined as a substance capable of receiving knowledge; for it has an equal capacity for receiving ignorance.

Also, even when one cannot attack the definition as a whole because the whole is not familiar, one should attack some part of it, if it is familiar and is evidently incorrectly rendered; for if the part is demolished, so too is the whole definition. Where, again, a definition is obscure, one should first of all correct and reshape it in order to make some part of it clear and get a handle for attack, and then proceed to examine it. For the answerer is bound either to accept the sense as taken by the questioner, or else himself to explain clearly whatever it is that his account means. Moreover, just as in the assemblies the ordinary practice is to introduce a law and, if the introduced law is better, to repeal the existing one, so one ought to do in the case of definitions as well: one ought oneself to propose a second definition; for if it is seen to be better, and more indicative of the object defined, clearly the definition laid down will have been demolished, on the principle that there cannot be more than one definition of the same thing.

In combating definitions it is always one of the chief elementary principles to take by oneself a happy shot at a definition of the object before one, or to adopt some correctly expressed definition. For one is bound, with the model (as it were) before one's eyes, to discern both the lack of any features that the definition ought to have, and also any superfluous addition, so that one is better supplied with lines of attack.

As to definitions, then, let so much suffice.

BOOK VII

1 · Whether two things are the same or different, in the most strict of the meanings ascribed to 'sameness' (and we said[34] that the same applies in the most strict sense to what is numerically one), may be examined in the light of their inflexions and coordinates and opposites. For if justice is the same as courage, then too the just man is the same as the courageous man, and justly is the same as courageously. Likewise, too, in the case of their opposites; for if two things are the same, their opposites also will be the same, in any of the recognized forms of opposition. For it is the same thing to take the opposite of the one or that of the other, seeing that they are the same. Again it may be examined in the light of those things which tend to produce or to destroy the things in question, of their formation and destruction, and in general of anything that is related in like manner to each. For where things are the same without qualification, their formations and destructions also are the same, and so are the things that tend to produce or to destroy them.

Look and see also, in a case where one of two things is said to be something or other in a superlative degree, if the other of these identical things can also be described by a superlative in the same respect. Thus Xenocrates argues that the happy life and the good life are the same, seeing that of all forms of life the good life is the most desirable and so also is the happy life; for only one thing is the most desirable and greatest. Likewise also in other cases of the kind. Each of the two things termed greatest or most desirable must be numerically one: otherwise no proof will have been given that they are the same; for it does not follow because Peloponnesians and Spartans are the bravest of the Greeks, that Peloponnesians are the same as Spartans, seeing that Peloponnesian and Spartan are not numerically one; it only follows that the one must be included under the other as Spartans are under Peloponnesians—for otherwise, if the one class is not included under the other, each will be better than the other. For then the Peloponnesians are bound to be better than the Spartans, seeing that the one class is not included under the other; for they are better than anybody else. Likewise also the Spartans must perforce be better than the Peloponnesians; for they too are better than anybody else; each then is better than the other. Clearly therefore what is styled best and greatest must be numerically one, if it is to be proved to be the same as another. This is why Xenocrates fails to prove his case; for the happy life is not numerically one,

[34] See 103a23.

nor yet the good life, so that it does not follow that, because they are both the most desirable, they are therefore the same, but only that the one falls under the other.

Again, look and see if, supposing the one to be the same as something, the other also is the same as it; for if they are not both the same as the same thing, clearly neither are they the same as one another.

Moreover, examine them in the light of their accidents or of the things of which they are accidents; for any accident belonging to the one must belong also to the other, and if the one belongs to anything as an accident, so must the other also. If in any of these respects there is a discrepancy, clearly they are not the same.

See further whether, instead of both being found in one class of predicates, the one signifies a quality and the other a quantity or relation. Again, see if the genus of each is not the same, the one being good and the other evil, or the one being virtue and the other knowledge; or see if, though the genus is the same, the differentiae predicated of either are not the same, the one being distinguished as a speculative science, the other as a practical science. Likewise also in other cases.

Moreover, from the point of view of degrees, see if the one admits an increase of degree but not the other, or if though both admit it, they do not admit it at the same time; just as it is not the case that a man desires intercourse more intensely, the more intensely he is in love, so that love and the desire for intercourse are not the same.

Moreover, examine them by means of addition, and see whether the addition of each to the same thing fails to make the same whole; or if the subtraction of the same thing from each leaves a different remainder. Suppose (e.g.) that he has declared double a half to be the same as a multiple of a half: then, subtracting a half from each, the remainders ought to have signified the same thing; but they do not; for double and a multiple do not signify the same thing.

Inquire also not only if some impossible consequence results directly from the statement—but also whether it may result from a supposition as happens to those who assert that empty is the same as full of air; for clearly if the air is exhausted, the vessel will not be less but more empty, though it will no longer be full of air. So that by a supposition, which may be true or may be false (it makes no difference which), the one character is annulled and not the other, showing that they are not the same.

Speaking generally, one ought to be on the look-out for any discrepancy anywhere in any sort of predicate of each term, and in the things of which they are predicated. For all that is predicated of the one should be predicated also of the other, and of whatever the one is a predicate, the other should be a predicate as well.

Moreover, as sameness is a term used in many ways, see whether things that are the same in one way are the same also in a different way. For there is either no necessity or even no possibility that things that are the same specifically or generically should be numerically the same—and we face the question whether they are or are not the same in that sense.

Moreover, see whether the one can exist without the other; for, if so, they will not be the same.

2 · Such is the number of commonplace rules that relate to sameness. It is clear from what has been said that all the destructive commonplaces relating to sameness are useful also in questions of definition, as was said before;[35] for if what is signified by the name and by the account are not the same, clearly the account given will not be a definition. None of the constructive commonplaces, on the other hand, 153a1
helps in the matter of definition; for proving that what falls under the account and the name are the same does not suffice to establish that the former is a definition, but a definition must have also all the other characters already announced.

3 · This then is the way, and these the arguments, whereby the attempt to demolish a definition should always be made. If, on the other hand, we desire to establish one, the first thing to observe is that few if any who engage in discussion arrive at a definition by deduction: they always assume something of the kind as their starting point—both in geometry and in arithmetic and the other studies of that kind. In the second place, to say accurately what a definition is, and how it should be given, belongs to another inquiry. At present it concerns us only so far as is required for our present purpose, and accordingly we need only make the bare statement that it is possible for there to be a deduction of a thing's definition and essence. For if a definition is an account signifying the essence of the thing and the predicates contained therein ought also to be the only ones which are predicated of the thing in what it is, and genera and differentiae are predicated in what it is it is obvious that if one were to get an admission that these are the only attributes predicated in what it is, the account containing them will of necessity be a definition; for it is impossible that anything else should be a definition, seeing that there is not anything else predicated of the object in what it is.

That a definition may thus be reached by a process of deduction is obvious. The means whereby it should be established have been more precisely defined elsewhere,[36] but for the purposes of the inquiry now before us the same commonplace rules serve. For we have to examine into the contraries and other opposites of the thing, surveying the accounts used both as wholes and in part; for if the opposite account defines the opposite term, the account given must define the term before us. Seeing, however, that contraries may be conjoined in more than one way, we have to select from those contraries the one to whose definition the definition in question seems most contrary.[37] The accounts, then, have to be examined each as a whole in the way we have said, and also in part as follows. First of all, see that the genus rendered is correctly rendered; for if the contrary is found in the contrary genus, and the thing before you is not in that same genus, then it will clearly be in the contrary genus; for contraries must of necessity be either in the same genus or in contrary genera. And we claim that contrary differentiae are predicated of contraries, e.g. of white and black, for the one disperses the vision, while the other compresses it. So that if contrary differentiae are predicated of the contrary term, 153b1
then those rendered in the definition will be predicated of the term before us.

[35]See 102a11.
[36]Some scholars see a reference to *Posterior Analytics* II 13.
[37]Reading φανῇ for φανερὸς ᾖ.

Seeing, then, that both the genus and the differentiae have been rightly rendered, clearly the account given must be a definition. It might be replied that there is no necessity why contrary differentiae should be predicated of contraries, unless the contraries are found within the same genus: of things whose genera are themselves contraries it may very well be that the same differentia is used of both, e.g. of justice and injustice; for the one is a virtue and the other a vice of the soul: 'of the soul', therefore, is the differentia in both cases, seeing that the body as well has its virtue and vice. But this much at least is true, that the differentiae of contraries are either contrary or else the same. If, then, the contrary differentia is predicated of the contrary term and not of the one in hand, clearly the differentia stated must be predicated of the latter. Speaking generally, seeing that the definition consists of genus and differentiae, if the definition of the contrary term is apparent, the definition of the term before you will be apparent also; for since its contrary is found either in the same genus or in the contrary genus, and likewise also the differentiae predicated of opposites are either contrary or the same, clearly of the term before you there will be predicated either the same genus as of its contrary, while, of its differentiae, either all are contrary to those of its contrary, or at least some of them are so while the rest remain the same; or, vice versa, the differentiae will be the same and the genera contrary; or both genera and differentiae will be contrary. For that both should be the same is not possible; else contraries will have the same definition.

Moreover, look at it from the point of view of its inflexions and coordinates. For genera and definitions are bound to correspond in either case. Thus if forgetfulness is loss of knowledge, to forget is to lose knowledge, and to have forgotten is to have lost knowledge. If, then, anyone whatever of these is agreed to, the others must of necessity be agreed to as well. Likewise, also, if destruction is dissolution of substance, then to be destroyed is for a substance to be dissolved, and destructively is in such a way as to dissolve; if again destructive is apt to dissolve the substance, then also destruction is dissolution of substance. Likewise also with the rest: get an admission of any one of them whatever, and all the rest are admitted too.

Moreover, look at it from the point of view of things that stand in the same relation to each other. For if healthy is productive of health, vigorous will be
154a1 productive of vigour, and useful will be productive of good. For each of these things is related in like manner to its appropriate end, so that if one of them is defined as productive of that end, this will be the definition of each of the rest as well.

Moreover, look at it from the point of view of greater and equal degrees, in all the ways in which it is possible to establish a result by comparing two and two together. Thus if this defines that better than something else defines something else, and the latter is a definition, so too is the former. Further, if this defines that to the same degree as something else defines something else, and the latter is a definition, then so too is the former. This examination from the point of view of greater degrees is of no use when a single definition is compared with two, or two definitions with one; for there cannot possibly be one definition of two things or two of the same thing.

4 · The most handy of the commonplace arguments are those just mentioned and those from coordinates and inflexions, and these therefore are those which it is most important to master and to have ready to hand; for they are the most useful on the greatest number of occasions. Of the rest, too, the most important are those of most general application; for these are the most effective, e.g. that you should examine the individual cases, and that you should look to see in the case of their various species whether the account applies. For the species is synonymous with its individuals. This sort of inquiry is of service against those who assume the existence of Ideas, as has been said before.[38] Moreover see if a man has used a name metaphorically, or predicated it of itself as though it were something different. So too if any other of the commonplace rules is of general application and effective, it should be employed.

5 · That it is more difficult to establish than to overthrow a definition, is obvious from considerations presently to be urged. For to see for oneself, and to secure from those whom one is questioning, an admission of propositions of this sort is no simple matter, e.g. that of the elements of the given account the one is genus and the other differentia, and that the genus and differentiae are predicated in what it is. Yet without these it is impossible to deduce a definition; for if any other things as well are predicated of the object in what it is, there is no telling whether the account stated or some other one is its definition; for a definition is an account indicating the essence of a thing. The point is clear also from the following. It is easier to draw one conclusion than many. Now in demolishing a definition it is sufficient to argue against one point only (for if we have overthrown any single point whatsoever, we shall have demolished the definition); whereas in establishing a definition, one must argue that everything contained in the definition is attributable. Moreover, in establishing a case, the deduction brought forward must be universal; for the definition must be predicated of everything of which the name is, and must moreover be convertible, if the definition rendered is to be proper to the subject. In overthrowing a view, on the other hand, there is no longer any necessity to prove one's point universally; for it is enough to prove that the account is untrue of any one of the things embraced under the name. Further, even supposing it should be necessary to overthrow something by a universal proposition, not even so is there any need for it to be convertible in case of overthrowing. For proving that the definition is predicated of none of the things of which the name is predicated, is enough to overthrow it universally; and there is no need to prove in addition the converse of this, that the name is predicated of things of which the account is not predicated. Moreover, even if it applies to everything embraced under the term, but not to it alone, the definition is demolished.

The case stands likewise in regard to the property and genus of a term also. For in both cases it is easier to overthrow than to establish. As regards the property this is clear from what has been said; for the property is for the most part rendered in a complex phrase, so that to overthrow it, it is only necessary to demolish one of the

[38] See 148a14ff.

terms used, whereas to establish it it is necessary to deduce them all. Then, too, nearly all the other rules that apply to the definition will apply also to the property of a thing. For in establishing a property one has to show that it is true of everything included under the name, whereas to overthrow one it is enough to show in a single case only that it fails to belong; further, even if it belongs to everything falling under the term, but not to that only, it is overthrown in this case as well, as was explained in the case of the definition. In regard to the genus, it is clear that you are bound to establish it in one way only, viz. by showing that it belongs in every case, while of overthrowing it there are two ways; for if it has been proved that it belongs either to none or not to some, the original statement has been demolished. Moreover, in establishing a genus it is not enough to prove that it belongs, but you must prove also that it belongs as a genus; whereas in overthrowing it, it is enough to prove that it does not belong either to some or to all. It appears as though, just as in other things to destroy is easier than to create, so in these matters too to overthrow is easier than to establish.

In the case of an accidental attribute the universal proposition is easier to overthrow than to establish; for to establish it, one has to prove that it belongs in every case, whereas to overthrow it, it is enough to prove that it does not belong in one single case. The particular proposition is, on the contrary, easier to establish than to overthrow; for to establish it, it is enough to prove that it belongs in a particular instance, whereas to overthrow it, it has to be proved that it belongs to none.

It is clear also that the easiest thing of all is to overthrow a definition. For on account of the number of statements involved we are presented in the definition with the greatest number of points for attack, and the more plentiful the material, the quicker a deduction comes; for there is more likelihood of a mistake occurring in a large than in a small number of things. Moreover, the other rules too may be used as means for attacking a definition; for if either the account is not proper, or what is rendered is not the genus, or something included in the account does not belong, the definition is thereby demolished. On the other hand, against the others we cannot bring all of the arguments drawn from definitions, nor yet of the rest; for only those relating to accidental attributes apply generally to all the aforesaid kinds of attribute. For each of the aforesaid kinds must belong; yet the genus may very well not belong as a property without as yet being thereby demolished; likewise also the property need not belong as a genus, nor the accident as a genus or property, so long as they do belong. So that it is impossible to use one set as a basis of attack upon the other except in the case of definition. Clearly, then, it is the easiest of all things to demolish a definition, while to establish one is the hardest. For there one both has to establish all those other points by deduction (i.e. that the attributes stated belong, and that what is rendered is the genus, and that the account is proper), and moreover, besides this, that the account indicates the essence of the thing; and this has to be done correctly.

Of the rest, the property is most nearly of this kind; for it is easier to demolish, because for the most part it contains several terms; while it is the hardest to establish, both because of the number of things that you must argue for, and, besides this, because it belongs to its subject alone and is predicated convertibly with its subject.

The easiest thing of all to establish is an accidental predicate; for in other cases one has to prove not only that the predicate belongs, but also that it belongs in such and such a way; whereas in the case of the accident it is enough to prove merely that it belongs. On the other hand, an accidental predicate is the hardest thing to overthrow, because it affords the least material; for in stating an accident a man does not add how the predicate belongs; and accordingly, while in other cases it is possible to demolish what is said in two ways, by proving either that the predicate does not belong, or that it does not belong in the particular way stated, in the case of an accidental predicate the only way to demolish it is to prove that it does not belong at all.

The commonplace arguments through which we shall be well supplied with lines of argument with regard to our several problems have now been enumerated at about sufficient length.

BOOK VIII

1 · Next there fall to be discussed the problems of arrangement and method in putting questions. Any one who intends to frame questions must, first of all, select the ground from which he should make his attack; secondly, he must frame them and arrange them one by one to himself; thirdly and lastly, he must proceed actually to put them to the other party. Now so far as the selection of his ground is concerned the problem is one alike for the philosopher and the dialectician; but how to go on to arrange his points and frame his questions concerns the dialectician only; for in every problem of that kind a reference to another party is involved. Not so with the philosopher, and the man who is investigating by himself: the premisses of his reasoning, although true and familiar, may be refused by the answerer because they lie too near the original statement and so he foresees what will follow if he grants them; but for this the philosopher does not care. Indeed, he may possibly be even anxious to secure axioms as familiar and as near to the question in hand as possible; for these are the bases on which scientific deductions are built up.

The sources from which one's commonplace rules should be drawn have already been described: we have now to discuss the arrangement and formation of questions and first to distinguish the propositions, other than the necessary ones, which have to be adopted. By necessary propositions are meant those through which the deduction is constructed. Those which are secured other than these are of four kinds: they serve either inductively to secure the universal premiss being granted, or to lend weight to the argument, or to conceal the conclusion, or to render the argument more clear. Beside these there is no other proposition which need be secured: these are the ones whereby you should try to multiply and formulate your questions. Those which are used to conceal the conclusion serve a contentious purpose; but inasmuch as an undertaking of this sort is always conducted against another person, we are obliged to employ them as well.

The necessary propositions through which the deduction is effected, ought not to be propounded directly in so many words. Rather one should keep as far away from them as possible. Thus if one desires to secure an admission that the knowledge of contraries is one, one should claim it not of contraries, but of opposites; for, if he grants this, one will then deduce that the knowledge of contraries is also the same, seeing that contraries are opposites; if he does not, one should secure the admission by induction, by formulating propositions to that effect in the case of particular contraries. For one must secure the necessary propositions either by deduction or by induction, or else partly by one and partly by the other, although any propositions which are too obvious may be formulated in so many words. This is because the coming conclusion is less easily discerned at the greater distance and in the process of induction, while at the same time, even if one cannot reach the required premisses in this way, it is still open to one to formulate them in so many words. The propositions, other than these, that were mentioned above, must be secured with a view to the latter. The way to employ them is as follows: induction should proceed from individual cases to the universal and from the familiar to the unknown; and the objects of perception are more familiar, either without qualification or to most people. Concealment is obtained by securing through preliminary deductions the premisses through which the deduction of the original proposition is going to be constructed—and as many of them as possible. This is likely to be effected by deducing not only the necessary propositions but also some of those which are required to establish them. Moreover, do not state the conclusions but deduce them later all together; for this is likely to keep the answerer at the greatest possible distance from the original proposition. Speaking generally, a man who desires to get information by a concealed method should so put his questions that when he has put his whole argument and has stated the conclusion, people still ask 'Well, but why is that?' This result will be secured best of all by the method above described; for if one states only the final conclusion, it is unclear how it comes about; for the answerer does not foresee on what grounds it is based, because the previous deductions have not been fully articulated; while the deduction of the conclusion is likely to be least articulated if we lay down not the assumptions on which it is based, but only those by which the deduction proceeds.

It is a useful rule, too, not to secure the axioms on which the deductions are based in their proper order, but alternately those that conduce to one conclusion and those that conduce to another; for, if the appropriate ones are set side by side, the conclusion that will result from them is more obvious in advance.

One should also, wherever possible, secure the universal proposition by a definition relating not to the terms themselves but to their co-ordinates; for people are deceived whenever the definition is taken in regard to a co-ordinate, into thinking that they are not making the admission universally. E.g. supposing one had to secure the admission that the angry man desires vengeance on account of an apparent slight, and were to secure that anger is a desire for vengeance on account of an apparent slight, for clearly, if this were secured, we should have universally what we intend. If, on the other hand, people formulate propositions relating to the actual terms themselves, they often find that the answerer refuses to grant them because on the actual term itself he is readier with his objection, e.g. that the angry man does not desire vengeance, because we become angry with our parents, but we do not desire vengeance on them. Very likely the objection is not valid; for upon some people it is vengeance enough to cause them pain and make them sorry; but still it gives a certain plausibility and air of reasonableness to the denial of the proposition. In the case, however, of the definition of anger it is not so easy to find an objection.

Moreover, formulate your proposition as though you did so not for its own sake, but in order to get at something else; for people guard against granting what an opponent's case requires. Speaking generally, a questioner should leave it as far as possible doubtful whether he wishes to secure an admission of the proposition or of its opposite; for if it is uncertain what the argument requires, people are more ready to say what they themselves think.

Moreover, try to secure admissions by means of likeness; for such admissions are plausible, and the universal involved is less patent; e.g. that as knowledge and ignorance of contraries is the same, so too perception of contraries is the same; or vice versa, that since the perception is the same, so is the knowledge also. This argument resembles induction, but is not the same thing; for in induction it is the universal whose admission is secured from the particulars, whereas in arguments from likeness, what is secured is not the universal under which all the like cases fall.

It is a good rule also, occasionally to bring an objection against oneself; for answerers are put off their guard against those who appear to be arguing impartially. It is useful too, to add that so and so is generally held or commonly said; for people are shy of upsetting the received opinion unless they have some objection to urge; and at the same time they are cautious about upsetting such things because they themselves too find them useful. Moreover, do not be insistent, even though you really require the point; for insistence always arouses the more opposition. Further, formulate your premiss as though it were an illustration; for people admit the more readily a proposition made to serve some other purpose, and not required on its own account. Moreover, do not formulate the very proposition you need to secure, but rather something from which that necessarily follows; for people are more willing to admit the latter, because it is not so clear from this what the result will be, and if the one has been secured, the other has been secured also. Again, one should put last the point which one most wishes to have conceded; for people are specially inclined to deny the first questions put to them, because most people in asking questions put first the points which they are most eager to secure. But in dealing with some people propositions of this sort should be put forward first; for ill-tempered men admit most readily what comes first, unless the conclusion that will result actually stares them in the face, while at the close of an argument they

show their ill-temper. Likewise also with those who consider themselves smart at answering; for when they have admitted what comes first they finally quibble to the effect that the conclusion does not follow from their admissions; yet they make admissions readily, confident in their own character, and imagining that they
157a1 cannot suffer any reverse. Moreover, it is well to expand the argument and insert things that it does not require at all, as do those who draw false geometrical figures; for in the mass of material the whereabouts of the falsity is obscured. For this reason also a questioner sometimes evades observation as he adds in a corner what, if he formulated it by itself, would not be granted.

For concealment, then, the rules which should be followed are the above. Ornament is attained by induction and distinction of things closely akin. What sort of process induction is is obvious; as for distinction, an instance of the kind of thing meant is the distinction of one form of knowledge as better than another by being either more precise, or concerned with better objects; or the distinction of sciences into speculative, practical, and productive. For everything of this kind lends additional ornament to the argument, though there is no necessity to say them, so far as the conclusion goes.

For clearness, examples and illustrations should be adduced—and let the illustrations be appropriate and drawn from things that we know, as in Homer and not as in Choerilus; for them the proposition is likely to become clearer.

2 · In dialectical argument, deduction should be employed in reasoning against dialecticians rather than against the crowd; induction, on the other hand, is most useful against the crowd. This point has been mentioned previously as well.[39] In induction, it is possible in some cases to ask the question in its universal form, but in others this is not easy, because there is no established general name that covers all the resemblances: in this case, when people need to secure the universal, they use the phrase 'in all cases of this sort'. But it is one of the very hardest things to distinguish which of the things adduced are of this sort, and which are not; and in this connexion people often mislead one another in their discussion, the one party asserting the likeness of things that are not alike, and the other disputing the likeness of things that are. One ought, therefore, to try oneself to coin a word to cover all things of the given sort, so as to leave no opportunity either to the answerer to dispute, and say that the thing advanced does not answer to a like description, or to the questioner to suggest falsely that it does answer to a like description, for many things appear to answer to like descriptions that do not really do so.

If one has made an induction on the strength of several cases and yet the answerer refuses to grant the universal proposition, then it is fair to demand his objection. But until one has oneself stated in what cases it is so, it is not fair to demand that he shall say in what cases it is not so; for one should make the induction
157b1 first, and then demand the objection. One ought, moreover, to claim that the objections should not be brought in reference to the actual subject of the

[39] See 105a16.

proposition, unless that subject happens to be the one and only thing of the kind, as for instance two is the one prime number among the even numbers; for, unless he can say that this subject is unique of its kind, the objector ought to make his objection in regard to some other. People sometimes object to a universal proposition, and bring their objection not in regard to the thing itself, but in regard to some homonym of it; thus they argue that a man can very well have a colour or a foot or a hand other than his own, for a painter may have a colour that is not his own, and a cook may have a foot that is not his own. To meet them, therefore, you should draw the distinction before putting your question in such cases; for so long as the ambiguity remains undetected, the objection to the proposition will seem valid. If, however, he checks the series of questions by an objection in regard not to some homonym, but to the actual thing asserted, the questioner should withdraw the point objected to, and form the remainder into a universal proposition, until he secures what he requires; e.g. in the case of forgetfulness and having forgotten; for people refuse to admit that the man who has lost his knowledge of a thing has forgotten it, because if the thing alters, he has lost knowledge of it, but he has not forgotten it. Accordingly the thing to do is to withdraw the part objected to, and assert the remainder, e.g. that if a person has lost knowledge of a thing while it still remains, he then has forgotten it. One should similarly treat those who object to the statement that the greater the good, the greater the evil that is its opposite, for they allege that health, which is a less good thing than vigour, has a greater evil as its opposite; for disease is a greater evil than debility. In this case too, therefore, we have to withdraw the point objected to; for when it has been withdrawn, the man is more likely to admit the proposition, e.g. that the greater good has the greater evil as its opposite, unless the one good involves the other as well, as vigour involves health. This should be done not only when he formulates an objection, but also if, without so doing, he refuses to admit the point because he foresees something of the kind; for if the point objected to is withdrawn, he will be forced to admit the proposition because he cannot foresee in the rest of it any case where it does not hold true: if he refuses to admit it, then when asked for an objection he certainly will be unable to render one. Propositions that are partly false and partly true are of this type; for in the case of these it is possible by withdrawing a part to leave the rest true. If, however, you formulate the proposition on the strength of many cases and he has no objection to bring, you may claim that he should admit it; for a dialectical proposition is one which thus holds in several instances and to which no objection is forthcoming.

Whenever it is possible to deduce the same conclusion either through or without a *reductio per impossibile,* if one is demonstrating and not arguing dialectically it makes no difference which method of deduction is adopted, but in argument with another deduction *per impossibile* should be avoided. For where one has deduced without the *reductio per impossibile,* no dispute can arise; if, on the other hand, one deduces an impossible conclusion, unless its falsehood is too plainly 158a1
manifest, people deny that it is impossible, so that the questioners do not get what they want.

One should put forward propositions that hold true of several cases, and to which either no objection whatever appears or at least not any on the surface; for when people cannot see any case in which it is not so, they admit it for true.

The conclusion should not be put in the form of a question; otherwise if he rejects it, it looks as if the deduction has failed. For often, even if it is not put as a question but advanced as a consequence, people deny it, and then those who do not see what follows from the previous admissions do not realize that those who deny it have been refuted; when, then, the one man merely asks it as a question without even saying that it follows, and the other denies it, it looks altogether as if the deduction has failed.

Not every universal seems to be a dialectical proposition, e.g. 'What is man?' or 'In how many ways is the good used?' For a dialectical proposition must be of a form to which it is possible to reply 'Yes' or 'No', whereas to the aforesaid it is not possible. For this reason questions of this kind are not dialectical unless the questioner himself draws distinctions or divisions before expressing them, e.g. 'Is the good used in this way, or in this?' For questions of this sort are easily answered by a Yes or a No. Hence one should endeavour to formulate propositions of this kind in this form. It is at the same time also perhaps fair to ask the other man how many uses of the good there are, whenever you have yourself distinguished and formulated them, and he will not admit them at all.

Any one who keeps on asking one thing for a long time is a bad inquirer. For if he does so though the person questioned keeps on answering the questions, clearly he asks a large number of questions, or else asks the same question a large number of times: in the one case he merely babbles, in the other he fails to deduce; for every deduction rests on a small number of premisses. If, on the other hand, he does it because the person questioned does not answer the questions, he is at fault in not taking him to task or breaking off the discussion.

3 · The same hypotheses may be both difficult to attack and easy to defend. Such are those things which stand first and those which stand last in the order of nature. For the former require definition, while the latter have to be arrived at through many steps if one wishes to secure a continuous proof from first principles, or else the arguments wear the air of sophistry; for to demonstrate anything is impossible unless one begins with the appropriate principles, and connects inference with inference till the last are reached. Now to define first principles is just what answerers do not care to do, nor do they pay any attention if the questioner makes a definition; and yet until it is clear what it is that is proposed, it is not easy to tackle
158b1 it. This sort of thing happens particularly in the case of the first principles; for while the other propositions are proved through these, these cannot be proved through anything else: we are obliged to get to know every item of that sort by a definition.

Things that lie close to the first principle are also hard to tackle; for it is not possible to bring many arguments in regard to them, because of the small number of those steps, between the conclusion and the principle, whereby the succeeding propositions have to be proved. The hardest, however, of all definitions to treat in argument are those that employ names about which, in the first place, it is uncertain whether they are used in one way or several, and, further, it is not known whether they are used literally or metaphorically by the definer. For because of their obscurity, it is impossible to argue; and because of the impossibility of saying whether this obscurity is due to their being used metaphorically, it is impossible to criticize them.

In general, it is safe to suppose that, whenever any problem proves intractable, it either needs definition, or has either several uses or a metaphorical use, or it is not far removed from the first principles; or else the reason is[40] that we have yet to discover in the first place just this—in which of the aforesaid directions the source of our difficulty lies: when we have made this clear, then obviously our business must be either to define or to distinguish, or to supply the intermediate premisses; for it is through these that the final conclusions are proved.

Many theses are not easy to argue about or tackle because the definition has not been correctly rendered: e.g. whether one thing has one contrary or many—here when contraries have been properly defined, it is easy to argue whether it is possible for the same thing to have several contraries or not. Similarly also with other terms requiring definition. It appears also in mathematics that the difficulty in constructing a figure is sometimes due to a defect in definition; e.g. in proving that the line which cuts the plane parallel to one side divides similarly both the line and the area. If the definition is given, the fact asserted becomes immediately clear; for the areas have the same fraction subtracted from them as have the sides and this is the definition of the same ratio. In general, the primary elements are very easy to prove, if the definitions involved, e.g., the nature of a line or of a circle, are laid down (only the arguments that can be brought in regard to each of them are not many, because there are not many intermediate steps); if, on the other hand, the definitions of the principles are not laid down, it is difficult and may even prove quite impossible. It is the same in the case of dialectical arguments.

One must be aware then, whenever a thesis is hard to tackle, that one or other of the aforesaid things has happened to it. Whenever, on the other hand, it is a harder task to argue about the axiom or the proposition than about the thesis, a doubt may arise whether such claims should be admitted or not; for if a man is going to refuse to admit it and claim that it should be argued for, he will be prescribing a harder undertaking than was originally proposed; if, on the other hand, he grants it, he will be convinced on the strength of what is less convincing. If, then, it is essential not to enhance the difficulty of the problem, he had better grant it; if, on the other hand, it is essential to deduce through premisses that are more familiar, he had better refuse. In other words, one who is trying to learn ought not to grant it, unless it is more familiar; but one who is training should grant it, if he is merely satisfied of its truth. Clearly, then, the circumstances under which such admissions should be claimed are different for a questioner and for a teacher.

[40]Reading ἢ διὰ.

4 · As to the formulation, then, and arrangement of one's questions, about enough has been said.

With regard to the giving of answers, we must first define what is the business of a good answerer, as of a good questioner. The business of the questioner is so to develop the argument as to make the answerer utter the most implausible of the necessary consequences of his thesis; while that of the answerer is to make it appear that it is not he who is responsible for the impossibility or paradox, but only his thesis; for one may, no doubt, distinguish between the mistake of taking up a wrong thesis to start with, and that of not maintaining it properly, when once taken up.

5 · Inasmuch as no rules are laid down for those who argue for the sake of training and of examination—for the aim of those engaged in teaching or learning is quite different from that of those engaged in a competition; as is the latter from that of those who discuss things together in the spirit of inquiry; for a learner should always state what he thinks (for no one tries to teach what is false); whereas in a competition the business of the questioner is to appear by all means to produce an effect upon the other, while that of the answerer is to appear unaffected by him; on the other hand, in dialectical meetings held in the spirit not of a competition but of an examination and inquiry, there are as yet no articulated rules about what the answerer should aim at, and what kind of things he should and should not grant for the correct or incorrect defence of his position—inasmuch, then, as we have no tradition bequeathed to us by others, let us try to say something upon the matter for ourselves.

The thesis laid down by the answerer before facing the questioner's argument is bound of necessity to be either reputable or implausible or neither; and reputable or implausible either without qualification or else with a restriction, e.g. to some given person, to the speaker, or to some one else. But the way in which it is reputable or implausible, whatever it be, makes no difference; for the right way to answer, i.e. to admit or to refuse to admit what has been asked, will be the same in either case. If, then, the thesis is implausible, the conclusion is bound to be reputable, whereas if the former is reputable the latter will be implausible; for the conclusion which the questioner tries to draw is always the opposite of the thesis. If, on the other hand, what is laid down is neither implausible nor reputable, the conclusion will be of the same type as well. Now since a man who deduces correctly demonstrates his conclusion from premisses that are more reputable and more familiar, it is clear that where the view laid down by him is implausible without qualification, the answerer ought not to grant either what does not seem to be the case without qualification, or what seems to be the case, but to a less degree than the conclusion. For if the thesis is implausible the conclusion will be reputable, so that the premisses secured by the questioner should all be reputable, and more reputable than this proposed conclusion, if the less familiar is to be inferred through the more familiar. Consequently, if any of the questions put to him is not of this character, the answerer should not grant it. If, on the other hand, the thesis is reputable without qualification, clearly the conclusion will be implausible without qualification. Accordingly, the answerer should admit all views that seem to be the case and, of those that do not, all that are less implausible than the conclusion. For then he will be thought to have argued sufficiently well. Likewise, too, if the thesis is neither implausible nor reputable; for then, too, anything that appears to be true should be granted, and, of the views that do not seem true, any that are more reputable than the conclusion; for in that case the result will be that the arguments will be more reputable. If, then, the view laid down by the answerer is reputable or implausible without qualification, then the views that are accepted without qualification must be taken as the standard of comparison; whereas if the view laid down is not reputable or implausible without qualification, but only to the answerer, then he must judge with reference to himself what seems or does not seem, and must grant or refuse to grant the point asked accordingly. If, again, the answerer is defending some one else's opinion, then clearly it will be the latter's judgement to which he must have regard in granting or denying the various points. This is why those who introduce others' opinions—e.g. that good and evil are the same thing, as Heraclitus says—refuse to admit that contraries do not belong at the same time to the same thing; not because they do not themselves believe this, but because on Heraclitus' principles one has to say so. The same thing is done also by those who take on the defence of one another's theses; their aim being to speak as would the man who stated the thesis.

6 · It is clear, then, what the aims of the answerer should be, whether the position he lays down is reputable either without qualification or to some definite person. Now every question asked is bound to be either reputable or implausible or neither, and is also bound to be either relevant to the argument or irrelevant; if then it seems to be true and is irrelevant, the answerer should grant it and remark that it seems to be true; if it does not seem to be true and is irrelevant, he should grant it but add a comment that it does not seem to be true, in order to avoid the appearance of being a simpleton. If it is relevant and seems to be true, he should admit that it seems to be true but say that it lies too close to the original proposition, and that if it is granted the problem proposed collapses. If the axiom is relevant but too implausible, the answerer, while admitting that if it is granted the conclusion sought follows, should yet protest that the proposition is too silly. If it is neither implausible nor reputable, then, if it is irrelevant to the argument, it may be granted without restriction; if, however, it is relevant, the answerer should add the comment that, if it is granted, the original problem collapses. For then the answerer will not be held to be personally accountable for what happens to him, if he grants the several points with his eyes open, and the questioner will be able to draw his inference, seeing that all the premisses that are more reputable than the conclusion are granted him. Those who try to deduce from premisses more implausible than the conclusion clearly do not deduce correctly; hence, when men ask these things, they ought not to be granted.

7 · The questioner should be met in a like manner also in the case of terms used obscurely and in several ways. For the answerer, if he does not understand, is always permitted to say 'I do not understand', and he is not compelled to reply 'Yes' or 'No' to a question which may mean different things. Clearly, then, in the first place, if what is said is not clear, he ought not to hesitate to say that he does not understand it; for often people encounter some difficulty from assenting to questions that are not clearly put. If he understands the question and yet it covers many senses, then supposing what it says to be universally true or false, he should give it an unqualified assent or denial; if, on the other hand, it is partly true and partly false, he should add a comment that it bears different senses, and that in one it is true, in the other false; for if he leaves this distinction till later, it becomes uncertain whether originally he perceived the ambiguity. If he does not foresee the ambiguity, but assents to the question having in view the one sense of the words, then, if the questioner takes it in the other sense, he should say, 'That was not what I had in view when I admitted it; I meant the other sense'—for if a name or account covers more than one thing, disputes easily arise. If, however, the question is both clear and simple, he should answer either 'Yes' or 'No'.

8 · Every deductive proposition either is one of the constituent elements in the deduction, or else goes to establish one of these (and you can always tell when it is secured in order to establish something else by the fact of a number of similar questions being put; for people for the most part secure the universal by means either of induction or of likeness); accordingly the particular propositions should all be admitted, if they are true and reputable; but against the universal one should try to bring some objection; for to bring the argument to a standstill without an objection, either real or apparent, shows ill-temper. If, then, a man refuses to grant the universal when supported by many instances, although he has no objection, he obviously shows ill-temper. If, moreover, he cannot even attempt a counter-proof that it is not true, far more likely is he to be thought ill-tempered. (Although even that is not enough; for we often hear arguments that are contrary to common opinions, whose solution is yet difficult, e.g. the argument of Zeno that it is impossible to move or to traverse the stadium; but still, this is no reason for omitting to assert the opposites of these views.) If, then, a man refuses to admit the proposition without having either an objection or some counter-argument to bring against it, clearly he is ill-tempered, for ill-temper in argument consists in answering in ways other than the above, so as to wreck the reasoning.

9 · Before maintaining either a thesis or a definition the answerer should try his hand at attacking it by himself; for clearly his business is to oppose those positions from which questioners demolish what he has laid down.

He should beware of maintaining an implausible hypothesis: and this it may be in two ways; for it may be one which results in absurd statements (e.g. suppose anyone were to say that everything is in motion or that nothing is); and also there are those which a bad character would choose, and which are opposed to men's wishes (e.g. that pleasure is the good, and that to do injustice is better than to suffer it). For people then hate him, supposing him to maintain them not for the sake of argument but because he really thinks them.

10 · When arguments reason to a false conclusion the right solution is to demolish the point on which the falsity depends; for the demolition of any random point is no solution, even if the point demolished is false. For the argument may contain many falsehoods, e.g. suppose someone assumes that he who sits, writes and that Socrates is sitting; for from these it follows that Socrates is writing. Now we may demolish the proposition that Socrates is sitting, and still be no nearer a solution of the argument. 'Yet the axiom is false'. But it is not on that that the falsity of the argument depends; for supposing that anyone should happen to be sitting and not writing, it would be impossible in such a case to apply the same solution. Accordingly, it is not this that needs to be demolished, but rather that he who sits, writes; for not everyone who sits writes. He, then, who has demolished the point on which the falsity depends, has given the solution of the argument completely. Anyone who knows that it is on such and such a point that the argument depends, knows the solution of it, just as in the case of a figure falsely drawn. For it is not enough to object, even if the point demolished is a falsehood, but the reason of the falsity should also be demonstrated; for then it will be clear whether the man makes his objection with his eyes open or not.

There are four possible ways of preventing a man from working his argument to a conclusion. It can be done either by demolishing the point on which the falsity that comes about depends, or by stating an objection directed against the questioner—for often when a solution has not as a matter of fact been brought, yet the questioner is rendered thereby unable to pursue the argument any farther. Thirdly, one may object to the questions asked; for it may happen that what the questioner wants does not follow from the questions he has asked because he has asked them badly, whereas if something additional is granted the conclusion comes about. If, then, the questioner is unable to pursue his argument farther, the objection will be directed against the questioner; if he can do so, then it will be against his questions. The fourth and worst kind of objection is that which is directed to the time allowed for discussion; for some people bring objections of a kind which would take longer to answer than the length of the discussion in hand.

There are then, as we said, four ways of making objections; but of them the first alone is a solution: the others are just hindrances and stumbling-blocks to prevent the conclusions.

11 · Criticism of an argument when taken in itself and when presented in the form of questions, is not the same. For often the failure to carry through the argument correctly in discussion is due to the person questioned, because he will not grant the steps of which a correct argument might have been made against his thesis; for it is not in the power of the one side only to effect properly a result that depends on both alike. Accordingly it sometimes becomes necessary to attack the

speaker and not his thesis, when the answerer lies in wait for the points that are contrary to the questioner and becomes abusive as well: when people lose their tempers in this way, their argument becomes contentious, not dialectical. Moreover, since arguments of this kind are held not for the sake of instruction but for purposes of practice and examination, clearly one has to deduce not only true conclusions, but also false ones, and not always through true premisses, but sometimes through false as well. For often, when a true proposition is put forward, the dialectician is compelled to demolish it; and then false propositions have to be put forward. Sometimes also when a false proposition is put forward, it has to be demolished by means of false propositions; for it is possible for a man to believe what is not the case more firmly than the truth. Accordingly, if the argument is made to depend on something that he holds, he will be persuaded rather than helped. He, however, who would rightly convert anyone to a different opinion should do so in a dialectical and not in a contentious manner, just as a geometrician should reason geometrically, whether his conclusion is false or true (what kind of deductions are dialectical has already been said).[41] The principle that a man who hinders the common business is a bad partner, clearly applies to an argument as well; for in arguments as well there is a common aim in view—except with mere contestants, for these cannot both reach the same goal; for more than one cannot win. It makes no difference whether he effects this as answerer or as questioner; for both he who asks contentious questions is a bad dialectician, and also he who in answering fails to grant the obvious answer or to accept whatever question the questioner wishes to put. What has been said, then, makes it clear that criticism is not to be passed in a like manner upon the argument in itself and upon the questioner; for it may very well be that the argument is bad, but that the questioner has argued with the answerer in the best possible way—for when men lose their tempers, it may perhaps be impossible to make one's deductions just as one would wish: we have to do as we can.

Inasmuch as it is indeterminate when people are claiming the admission of contrary things, and when they are claiming what originally they set out to prove—for often when they are talking by themselves they say contrary things, and admit afterwards what they have previously denied; for which reason they often assent, when questioned, to contrary things and to what originally had to be proved—the argument is sure to become vitiated. The responsibility, however, for this rests with the answerer, because he refuses to grant some things and grants others of that sort. It is, then, clear that criticism is not to be passed in a like manner upon questioners and upon their arguments.

In itself an argument is liable to five kinds of criticism. The first is when neither the proposed conclusion nor indeed any conclusion at all is drawn from the questions asked, and when most, if not all, of the premisses on which the conclusion rests are false or implausible, when, moreover, neither withdrawals nor additions nor both together can bring the conclusion about. The second is if the deduction, though constructed from the premisses, and in the manner, described above, is irrelevant to the thesis. The third is if certain additions would bring a deduction

[41] See $100^{a}22$.

about but yet these additions would be weaker than those that were put as questions, and less reputable than the conclusion. Again, supposing certain withdrawals could effect the same; for sometimes people secure more premisses than are necessary, so that it is not through them that the deduction comes about. Moreover, suppose the premisses are more implausible and less convincing than the conclusion, or if, though true, they require more labour to demonstrate than the problem.

One must not demand that for every problem the deductions should be equally reputable and convincing; for it is a direct result of the nature of things that some subjects of inquiry shall be easier and some harder, so that if a man concludes from opinions that are as reputable as the case admits, he has argued correctly. Clearly, then, the argument is not open to the same criticism when taken in relation to the proposed conclusion and when taken by itself. For there is nothing to prevent the argument being open to reproach in itself, and yet commendable in relation to the problem, or again, vice versa, being commendable in itself, and yet open to reproach in relation to the problem, whenever there are many propositions both reputable and true whereby it could easily be proved. It is possible also that an argument, even though brought to a conclusion, may sometimes be worse than one which is not so concluded, whenever the premisses of the former are silly, while the problem is not so; whereas the latter requires some additional premisses which are reputable and true, and moreover does not rest as an argument on these additions. With those which bring about a true conclusion by means of false premisses, it is not fair to find fault; for a false conclusion must of necessity always be deduced from false premisses, but a true conclusion may sometimes be deduced from *false* premisses; as is clear from the *Analytics*.[42]

Whenever by the argument stated something is demonstrated, but that something is other than what is wanted and has no bearing whatever on the conclusion, then there is no deduction as to the latter; and if there appears to be, it will be a sophism, not a demonstration. A philosopheme is a demonstrative deduction; an epichireme is a dialectical deduction; a sophism is a contentious deduction; an aporeme is a deduction that reasons dialectically to a contradiction.

If something were to be proved from premisses both of which seem true, but not to the same degree, it may very well be that what is proved seems more true than either. If, on the other hand, the one seems true and the other neither, or if the one seems true the other does not, then, if they are equally balanced the conclusion will be also; if, on the other hand, the one preponderates, the conclusion too will follow suit.

It is also a fault in deduction when a man proves something through a long chain of steps, when he might employ fewer steps and those already included in his argument: suppose him to be showing (e.g.) that one opinion is more properly so called from another, and suppose him to postulate that a thing-itself is most properly called that thing and that there genuinely exists an object of opinion in itself, so that it is more properly called an object of opinion than the particular

[42]See *Prior Analytics* II 2.

objects of opinion; now what is called such-and-such relative to what is more properly called so-and-so is more properly called such-and-such; and there exists a genuine opinion-in-itself, which will be more precise than the particular opinions. Now it has been postulated both that a genuine opinion-in-itself exists, and that a thing-in-itself is most properly called that thing; therefore this opinion will be more precise. Wherein lies the viciousness of the reasoning? Simply in that it conceals the ground on which the argument depends.

12 · An argument is clear in one, and that the most ordinary, sense, if it is so brought to a conclusion as to make no further questions necessary; in another sense, and this is the type most usually advanced, when the propositions assumed necessitate the conclusion, and the argument is concluded through premisses that are themselves conclusions; moreover, it is so also if it claims less than some very reputable views.[43]

An argument is called false in four senses: first, when it appears to be brought to a conclusion, and is not really so—what is called a contentious deduction. Again, when it comes to a conclusion but not to the conclusion proposed—which happens principally in the case of *reductio ad impossibile*. Or when it comes to the proposed conclusion but not according to the mode of inquiry appropriate to the case, as happens when a non-medical argument is taken to be a medical one, or one which is not geometrical for a geometrical argument, or one which is not dialectical for dialectical, whether the result reached is true or false. Again, if the conclusion is reached through false premisses: of this type the conclusion is sometimes false, sometimes true; for while a false conclusion is always the result of false premisses, a true conclusion may be drawn from premisses that are *not* true, as was said above as well.

Falsity in argument is due to a mistake of the arguer rather than of the argument; yet it is not always the fault of the arguer either, but only when he is not aware of it; for we often accept in itself in preference to many true ones an argument which demolishes some true proposition, if it does so from premisses as far as possible generally accepted. For an argument of that kind does demonstrate other truths; for one of the premisses laid down ought never to be there at all, and this will then be demonstrated. If, however, a true conclusion were to be reached through premisses that are false and utterly childish, the argument is worse than many arguments that lead to a false conclusion—though an argument which leads to a false conclusion may also be of this type. Clearly then the first thing to ask in regard to the argument in itself is whether it reaches a conclusion; the second, whether the conclusion is true or false; the third, on what kind of premisses does it depend. For if it depends on false but reputable premisses, the argument is dialectical; if on true but implausible premisses, it is bad; if they are both false and also entirely implausible, clearly it is bad, either without qualification or else in relation to the particular matter in hand.

[43]Reading ἐλλείπει σφόδρα ἐνδόξων.

13 · Of the ways in which a questioner may postulate the point at issue and postulate contraries the true account has been given in the *Analytics*[44]; but an account on the level of opinion must be given now.

People appear to postulate the point at issue in five ways: the first and most obvious being if any one postulates the actual point requiring to be proved; this is easily detected when put in so many words; but it is more apt to escape detection in the case of synonyms, and where a name and an account mean the same thing. A second way occurs whenever anyone postulates universally something which he has to demonstrate in a particular case: suppose (e.g.) he were trying to prove that the knowledge of contraries is one, and were to claim that the knowledge of opposites in general is one—for then he seems to be postulating, along with a number of other things, that which he ought to have proved by itself. A third way is if anyone were to postulate in particular cases what he has undertaken to prove universally: e.g. if he undertook to show that the knowledge of contraries is always one, and postulated it of certain pairs of contraries; for he seems to be postulating independently and by itself what, together with a number of other things, he ought to have proved. Again, if he divides up the problem and postulates its parts (supposing e.g. that he had to prove that medicine is a science of what leads to health and to disease, and were to claim first the one, then the other); or if he postulates the one or the other of a pair of statements that necessarily follow one other (e.g. if he had to prove that the diagonal is incommensurable with the side, and were to postulate that the side is incommensurable with the diagonal).

The ways in which people assume contraries are equal in number to those in which they postulate the point at issue. For it would happen, firstly, if any one were to postulate opposites, affirmation and negation; secondly, if he were to postulate the contrary terms of an antithesis, e.g. that the same thing is good and evil; thirdly, suppose anyone were to claim something universally and then proceed to postulate its contradictory in some particular case, e.g. if having assumed that the knowledge of contraries is one, he were to claim that the knowledge of what makes for health or for disease is different; or suppose him, after postulating the latter view, to try to secure universally the contradictory statement. Again, suppose a man postulates the contrary of what necessarily comes about through the premisses laid down—even without postulating the opposites themselves but postulating two premisses such that the opposite contradiction will follow from them. The securing of contraries differs from postulating the point at issue in this way: in the latter case the mistake lies in regard to the conclusion (for it is looking at the conclusion that we say that the point at issue has been postulated); whereas contrary views lie in the propositions, viz. in a certain relation which they bear to one another.

14 · The best way to secure training and practice in arguments of this kind is in the first place to get into the habit of converting the arguments. For in this way we shall be better equipped for dealing with the proposition stated, and from a few cases we shall know thoroughly several arguments. For conversion is taking the

[44]See *Prior Analytics* II 16.

reverse of the conclusion together with the remaining propositions asked and so demolishing one of those that were conceded; for it follows necessarily that if the conclusion is untrue, some one of the propositions is demolished, seeing that, given all of them, the conclusion was bound to follow. In dealing with any thesis, be on the look-out for a line of argument both pro and con; and on discovering it at once set about looking for the solution of it; for in this way you will soon find that you have trained yourself at the same time in both asking questions and answering them. If we cannot find any one else to argue with, we should argue with ourselves. Select, moreover, arguments relating to the same thesis and range them side by side; for this produces a plentiful supply of arguments for carrying a point by force, and in refutation also it is of great service, whenever one is well stocked with arguments pro and con—for then you find yourself on your guard against contrary statements. Moreover, as contributing to knowledge and to philosophic wisdom the power of discerning and holding in one view the results of either of two hypotheses is no mean instrument; for it then only remains to make a right choice of one of them. For a task of this kind a certain natural ability is required: in fact real natural ability just is the power rightly to choose the true and shun the false. Men of natural ability can do this; for by a right liking or disliking for whatever is proposed to them they rightly select what is best.

It is best to know thoroughly arguments upon those problems which are of most frequent occurrence, and particularly in regard to those theses which are primary; for in discussing these answerers frequently give up in despair. Moreover, get a good stock of definitions; and have those of reputable and primary ideas at your fingertips; for it is through these that deductions are effected. You should try, moreover, to master the heads under which other[45] arguments mostly tend to fall. For just as in geometry it is useful to be practised in the elements, and in arithmetic having the multiplication table up to ten at one's fingers' ends makes a great difference to one's knowledge of the multiples of other numbers too, likewise also in arguments it is a great advantage to be well up in regard to first principles, and to have a thorough knowledge of propositions by heart. For just as in a person with a trained memory, a memory of things themselves is immediately caused by the mere mention of their 'places', so these habits too will make a man readier in reasoning, because he has his premisses classified before his mind's eye, each under its number. It is better to commit to memory a proposition of general application than an argument; for it is not very difficult to get a supply of first principles and hypotheses.

Moreover, you should get into the habit of turning one argument into several, and conceal your procedure as darkly as you can: this kind of effect is best produced by keeping as far as possible away from topics akin to the subject of the argument. This can be done with arguments that are entirely universal, e.g. that there cannot be one knowledge of more than one thing—for that is the case with both relative terms and contraries and co-ordinates.

Records of discussions should be made in a universal form, even though one

[45]Reading οἱ ἄλλοι λόγοι.

has argued only some particular case; for this will enable one to turn a single argument into several. (A like rule applies in rhetoric as well to enthymemes.) For yourself, however, you should as far as possible avoid universalizing your deductions. You should, moreover, always examine arguments to see whether they rest on principles of general application; for all particular arguments reason universally as well, and a particular demonstration always contains a universal demonstration, because it is impossible to deduce at all without using universals.

You should display your training in inductive reasoning against a young man, in deductive against an expert. You should try, moreover, to secure from those skilled in deduction their premisses, from inductive reasoners their parallel cases; for this is the thing in which they are respectively trained. In general, too, from your exercises in argumentation you should try to carry away either a deduction on some subject or a solution or a proposition or an objection, or whether some one put his question properly or improperly (whether it was yourself or some one else) and the point which made it the one or the other. For this is what gives one ability, and the object of training is to acquire ability, especially in regard to propositions and objections. For it is the skilled propounder and objector who is, speaking generally, a dialectician. To formulate a proposition is to form a number of things into one (for the conclusion to which the argument leads must be taken generally, as a single thing), whereas to formulate an objection is to make one thing into many (for the objector either distinguishes or demolishes, partly granting, partly denying the statements proposed).

Do not argue with every one, nor practise upon the man in the street; for there are some people with whom any argument is bound to degenerate. For against anyone who is ready to try all means in order to seem not to be beaten, it is indeed fair to try all means of bringing about one's conclusion; but it is not good form. Therefore the best rule is, not lightly to engage with the man in the street, or bad argument is sure to result. For you see how in practising together people cannot refrain from contentious argument.

It is best also to have ready-made arguments relating to those problems in which a very small stock will furnish us with arguments serviceable on a very large number of occasions. These are those that are universal, and those in regard to which[46] it is rather difficult to produce material from everyday experience.

[46]Reading πρὸς οὓς πορίζεσθαι.

SOPHISTICAL REFUTATIONS

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1 · Let us now discuss sophistical refutations, i.e. what appear to be refutations but are really fallacies instead. We will begin in the natural order with the first.

That some deductions are genuine, while others seem to be so but are not, is evident. This happens with arguments, as also elsewhere, through a certain likeness between the genuine and the sham. For physically some people are in a vigorous condition, while others merely seem to be so by blowing and rigging themselves out like the tribal choruses; and some people are beautiful thanks to their beauty, while others seem to be so, by dint of embellishing themselves. So it is, too, with inanimate things; for of these, too, some are really silver and others gold, while others are not and merely seem to be such to our sense; e.g. things made of litharge and tin seem to be of silver, while those made of yellow metal look golden. In the same way both deduction and refutation are sometimes genuine, sometimes not, though inexperience may make them appear so—for inexperienced people obtain only, as it were, a distant view of these things. For a deduction rests on certain statements such that they involve necessarily the assertion of something other than what has been stated, through what has been stated; a refutation is a deduction to the contradictory of the given conclusion. Now some of them do not really achieve this, though they seem to do so for a number of reasons; and of these the most prolific and usual is the argument that turns upon names. It is impossible in a discussion to bring in the actual things discussed: we use their names as symbols instead of them; and we suppose that what follows in the names, follows in the things as well, just as people who calculate suppose in regard to their counters. But the two cases are not alike. For names are finite and so is the sum-total of accounts, while things are infinite in number. Inevitably, then, the same account and a single name signify several things. Accordingly just as, in counting, those who are not clever in manipulating their counters are taken in by the experts, in the same way in arguments too those who are not well acquainted with the force of names misreason both in their own discussions and when they listen to others. For this reason, then, and for others to be

TEXT: W. D. Ross, OCT, Oxford, 1958

mentioned later, there are both deductions and refutations that appear to be genuine but are not really so. Now for some people it is better worth while to seem to be wise, than to be wise without seeming to be (for the art of the sophist is the semblance of wisdom without the reality, and the sophist is one who makes money from an apparent but unreal wisdom); for them, then, it is clearly necessary to seem to accomplish the task of a wise man rather than to accomplish it without seeming to do so. To reduce it to a single point of contrast, it is the business of one who knows a thing, himself to avoid falsities in the subjects which he knows and to be able to show up the man who makes them; and of these accomplishments the one depends on the faculty to produce an argument, and the other upon the faculty to exact one. Those, then, who would be sophists are bound to study the class of arguments aforesaid; for it is worth their while; for a faculty of this kind will make a man seem to be wise, and this is the purpose they actually have in view.

Clearly, then, there exists a class of arguments of this kind, and it is at this kind of ability that those aim whom we call sophists. Let us now go on to discuss how many kinds there are of sophistical arguments, and how many in number are the elements of which this faculty is composed, and how many branches there actually are of this inquiry, and the other factors that contribute to this art.

2 · Of arguments used in discussion there are four classes: didactic, dialectical, examinational, and contentious arguments. Didactic arguments are those that deduce from the principles appropriate to each subject and not from the opinions held by the answerer (for the learner must be convinced); dialectical arguments are those that deduce from reputable premisses, to the contradictory of a given thesis; examinational arguments are those that deduce from premisses which are accepted by the answerer and which any one who claims to possess knowledge of the subject is bound to know (in what manner, has been explained elsewhere);[1] contentious arguments are those that deduce or appear to deduce to a conclusion from premisses that appear to be reputable but are not so. The subject of demonstrative arguments has been discussed in the *Analytics*, while that of dialectic arguments and examinational arguments has been discussed elsewhere:[2] let us now proceed to speak of the arguments used in competitions and contests.

3 · First we must grasp the number of aims entertained by those who argue as competitors and rivals. These are five in number: refutation, falsity, paradox, solecism, and fifthly to reduce the opponent in the discussion to babbling (i.e. to constrain him to repeat himself a number of times); or it is to produce the appearance of each of these things without the reality. For they choose if possible plainly to refute the other party, or as the second best to show that he is saying something false, or as a third best to lead him into paradox, or fourthly to reduce him to solecism, i.e. to make the answerer, in consequence of the argument, use some barbarous mode of expression; or, as a last resort, to make him repeat himself.

[1] See *Topics* VIII 5.
[2] I.e. in the *Topics*.

4 · There are two styles of refutation; for some depend on the language used, while some are independent of language. Those ways of producing the illusion which depend on language are six in number: they are homonymy, ambiguity, combination, division, accent, form of expression. Of this we may assure ourselves both by induction and by deduction—among others, a deduction showing that this is the number of ways in which we might fail to mean the same thing by the same names or accounts. Arguments such as the following depend upon homonymy. 'Those who know grasp things; for it is those who know their letters who grasp what is dictated to them.'[3] For to grasp is homonymous; it is to understand by the use of knowledge, and also to acquire knowledge. Again, 'Evils are good; for what must be is good, and evils must be.' For what must be has a double meaning: it means what is inevitable, as often is the case with evils (for evil of some kind is inevitable), while on the other hand we say of good things as well that they must be. Moreover, 'The same man is both seated and standing and he is both sick and in health; for it is he who stood up who is standing, and he who was recovering who is in health; but it is the seated man who stood up, and the sick man who was recovering.' For 'The sick man does so and so', or 'has so and so done to him' is not single in meaning: sometimes it means the man who is sick now, sometimes the man who was sick formerly. Of course, the man who was recovering was the sick man, who really was sick at the time; but the man who is in health is not sick at the same time: he is the sick man in the sense not that he is sick now, but that he was sick formerly. Examples such as the following depend upon ambiguity: 'I wish that you the enemy may capture.' And 'He who knows that, that knows'; for by this phrase one may signify as the knower either him who knows or that which is known. Also, 'There must be sight of what one sees; one sees the pillar; *ergo* the pillar has sight'. Also, 'What you profess to be, that you profess to be; you profess a stone to be; *ergo* you profess to be a stone.' Also, 'Speaking of the silent is possible'; for 'speaking of the silent' also has a double meaning: it may mean that the speaker is silent or that the things of which he speaks are so. There are three varieties of these homonymies and ambiguities: one when either the account or the name properly signifies more than one thing, e.g. mole and bank; one when by custom we use them so; thirdly when words that have a simple sense taken alone have more than one meaning in combination; e.g. 'knowing letters'. For each word, both 'knowing' and 'letters', may have a single meaning; but both together have more than one—either that the letters themselves have knowledge or that some one else has it of them.

Ambiguity and homonymy, then, take these forms. Upon combination there depend instances such as the following: 'A man can walk while sitting, and can write while not writing'. For the meaning is not the same if one divides the words and if one combines them in saying that walking while sitting is possible. The same applies to the latter phrase, too, if one combines the words 'to write while not writing'; for then it means that he has the power to write and not to write at once; whereas if one does not combine them, it means that when he is not writing he has the power to

[3]Aristotle's Greek ambiguities rarely translate neatly into English ambiguities: on this and the following pages the translation sometimes presents a stilted but fairly literal version of the Greek, and sometimes offers English parallels to Aristotle's examples.

write. Also, 'He knows now if he has learnt his letters.'[4] Moreover, 'One single thing if you can carry many you can carry too'.

Upon division depend the propositions that 5 is 2 and 3, and even and odd, and that the greater is equal (for it is that amount and more besides). For the same phrase would not be thought always to have the same meaning when divided and when combined, e.g. 'I made thee a slave free', and 'God-like Achilles left fifty a hundred men'.

An argument depending upon accent is not easy to construct in unwritten discussion; in written discussions and in poetry it is easier. Thus (e.g.) some people emend Homer against those who criticize as absurd his expression *τὸ μὲν οὗ καταπύθεται ὄμβρῳ*. For they solve the difficulty by a change of accent, pronouncing the *ου* with an acute accent.[5] Also, in the passage about Agamemnon's dream, they say that Zeus did not himself say 'We grant him the fulfilment of his prayer',[6] but that he bade the dream grant it. Instances such as these, then, turn upon the accentuation.

Others come about owing to the form of expression used, when what is really different is expressed in the same form, e.g. a masculine thing by a feminine termination, or a feminine thing by a masculine, or a neuter by either a masculine or a feminine; or, again, when a quality is expressed by a termination proper to quantity or vice versa, or what is active by a passive word, or a state by an active word, and so forth with the other divisions previously[7] laid down. For it is possible to use an expression to denote what does not belong to the class of actions at all as though it did so belong. Thus (e.g.) 'flourishing' is a word which in the form of its expression is like 'cutting' or 'building'; yet the one denotes a certain quality—i.e. a certain condition—while the other denotes a certain action. In the same manner also in the other instances.

Refutations, then, that depend upon language are drawn from these commonplace rules. Of fallacies that are independent of language there are seven kinds: one that which depends upon accident; secondly the use of an expression without qualification or not without qualification but with some qualification of respect, or place, or time, or relation; thirdly that which depends upon ignorance of what refutation is; fourthly that which depends upon the consequent; fifthly that which depends upon assuming the point at issue; sixthly stating as cause what is not the cause; seventhly the making of more than one question into one.

5 · Fallacies, then, that depend on accident occur whenever any attribute is claimed to belong in a like manner to a thing and to its accident. For since the same thing has many accidents there is no necessity that all the same attributes should belong to all of a thing's predicates and to their subject as well. Thus (e.g.), if

[4] Reading ἐμάνθανεν and omitting ἃ ἐπίσταται.

[5] They emend *οὗ* to *οὐ*, 'Part of which decays in the rain' to 'It does not decay in the rain' (*Iliad* XXIII 328).

[6] Agamemnon's dream occurs at *Iliad* II 1–35; but in our texts the phrase Aristotle cites appears not there but at XXI 297.

[7] See *Topics* I 9.

Coriscus is different from a man, he is different from himself: for he is a man; or if he is different from Socrates, and Socrates is a man, then, they say, you have admitted that Coriscus is different from a man, because it is an accident of the person from whom you said that he is different that he is a man.

Those that depend on whether an expression is used without qualification or in a certain respect and not strictly, occur whenever an expression used in a particular sense is taken as though it were used without qualification, e.g. 'If what is not is an object of opinion, then what is not is'; for it is not the same thing to be something and to be without qualification. Or again, 'What is, is not, if it is not a particular kind of being, e.g. if it is not a man.' For it is not the same thing not to be something and not to be without qualification: it looks as if it were, because of the closeness of the expression, i.e. because to be something is but little different from to be, and not to be something from not to be. Likewise also with any argument that turns upon the point whether an expression is used in a certain respect or used without qualification. Thus e.g. 'Suppose an Indian to be black all over, but white in respect of his teeth; then he is both white and not white.' Or if both characters belong in a particular respect, then, they say, contrary attributes belong at the same time. This kind of thing is in some cases easily seen by anyone, e.g. suppose a man were to assume that the Ethiopian is black, and were then to ask whether he is white in respect of his teeth; thus if he is white in that respect, he might think, as he ended his questioning reductively, that he had argued that he was both black and not black. But in some cases it often passes undetected, viz. in all cases where, whenever something is said to hold in a certain respect, it would seem to follow that it holds without qualification as well; and also in cases where it is not easy to see which of the attributes ought to be rendered strictly. A situation of this kind arises, where both the opposite attributes belong alike; for then it seems that one must agree that both or neither belongs without qualification: e.g. if a thing is half white and half black, is it white or black?

Those which arise because it has not been defined what a deduction is and what a refutation is,[8] come about because something is left out in their definition. For to refute is to contradict one and the same attribute—not the name, but the object and one[9] that is not synonymous but the same—and to confute it from the propositions granted, necessarily, without including in the reckoning the original point to be proved, in the same respect and relation and manner and time in which it was asserted. (A false assertion about anything has to be defined in the same way.) Some people, however, omit some one of the said conditions and give a merely apparent refutation, showing (e.g.) that the same thing is both double and not double—for two is double of one, but not double of three. Or, it may be, they show that it is both double and not double of the same thing, but not that it is so in the same respect—for it is double in length but not double in breadth. Or, it may be, they show it to be both double and not double of the same thing and in the same

[8]Omitting ἀλλὰ (ἄλλως, Ross) after ἔλεγχος.
[9]Omitting ὀνόματος.

respect and manner, but not that it is so at the same time; and therefore their refutation is merely apparent. One might force this fallacy into the group dependent on language.

Those that depend on the assumption of the point at issue, occur in the same way, and in as many ways, as it is possible to postulate the point at issue; they appear to refute because men lack the power to keep their eyes at once upon what is the same and what is different.

The refutation which depends upon the consequent arises because people suppose that the relation of consequence is convertible. For whenever, if this is the case, that necessarily is the case, they then suppose also that if the latter is the case, the former necessarily is the case. This is also the source of the deceptions that attend opinions based on sense-perception. For people often supposed bile to be honey because honey is attended by a yellow colour; and since after rain the ground is wet, we suppose that if the ground is wet, it has been raining; whereas that does not necessarily follow. In rhetoric demonstrations from signs are based on consequences. For when orators wish to show that a man is an adulterer, they take hold of some consequence—that the man is smartly dressed, or that he is observed to wander about at night. There are, however, many people of whom these things are true, while the charge in question is untrue. It happens like this also in deductive reasoning; e.g. Melissus' argument that the universe is infinite, assumes that the universe has not come to be (for from what is not nothing could possibly come to be) and that what has come to be has done so from a first beginning. If, therefore, the universe has not come to be, it has no first beginning, and is therefore infinite. But this does not necessarily follow; for if what has come to be always has a first beginning, it does not follow that what has a first beginning has come to be; any more than it follows that if a man in a fever is hot, a man who is hot must be in a fever.

The refutation which depends upon treating as cause what is not a cause, occurs whenever what is not a cause is inserted in the argument, as though the refutation depended upon it. This kind of thing happens in deductions *ad impossibile;* for in these we are bound to demolish one of the premisses. If, then, it is reckoned in among the questions that are necessary to establish the resulting impossibility, it will often be thought that the refutation depends upon it. E.g. the soul and life are not the same; for if coming-to-be is contrary to perishing, then a particular form of perishing will have a particular form of coming-to-be as its contrary: now death is a particular form of perishing and is contrary to life; life, therefore, is a coming-to-be, and to live is to come-to-be. But this is impossible; accordingly, the soul and life are not the same. Now this has not been deduced; for the impossibility results even if one does not say that life is the same as the soul, but merely says that life is contrary to death, which is a form of perishing, and that perishing has coming-to-be as its contrary. Arguments of that kind, then, though not non-deductive without qualification, are non-deductive in relation to the proposed conclusion. And the questioners themselves often fail quite as much to see a point of that kind.

Such, then, are the arguments that depend upon the consequent and upon false cause. Those that depend upon the making of two questions into one occur whenever the plurality is undetected and a single answer is returned as if to a single question.
168a1 Now, in some cases, it is easy to see that there is more than one, and that an answer[10] is not to be given, e.g. 'Does the earth consist of sea, or the sky?' But in some cases it is less easy, and then people treat the question as one, and either confess their defeat by failing to answer the question, or are exposed to an apparent refutation. Thus 'Is he and is he a man?' Then if any one hits him and him, he will strike a man, not men. Or again, where some are good and some bad, are they all good or not good? For whichever he says, it is possible that he might be thought to expose himself to an apparent refutation or to make an apparently false statement; for to say that something is good which is not good, or not good which is good, is to make a false statement. Sometimes, however, additional premisses may actually give rise to a genuine refutation; e.g. suppose a man were to grant that one thing and a number of things can alike be called white and naked and blind. For if a thing that cannot see though nature designed it to see is blind, then things that cannot see though nature designed them to do so will be blind. Whenever, then, one thing can see while another cannot, they will either both be able to see or else both be blind; which is impossible.

6 · We should either divide apparent proofs and refutations as above, or else refer them all to ignorance of what refutation is, and make that our starting-point; for it is possible to analyse all the aforesaid modes of fallacy into breaches of the definition of a refutation. In the first place, we may see if they are non-deductive; for the conclusion ought to result from the premisses laid down, so that we state it necessarily and do not merely seem to. Next we should also take the definition bit by bit. For of the fallacies that consist in language, some depend upon a double meaning, e.g. homonymy and the account[11] and similarity of form (for we habitually speak of everything as though it were a certain 'this'— while fallacies of combination and division and accent arise because the account or the name as altered is not the same. But this too should be the same, just as the thing should be, if a refutation or deduction is to be effected; e.g. if the point concerns a doublet, then you should deduce about a doublet, not about a cloak. For the former conclusion also would be true, but it has not been deduced; we need a further question to show that doublet means the same thing, in order to satisfy any one who asks the reason why.

Fallacies that depend on accident are clear once deduction has been defined. For the same definition ought to hold good of refutation too, except that a mention of the contradictory is here added; for a refutation is a deduction of the contradictory. If, then, there is no deduction as regards an accident of anything, there is no refutation. For supposing, when these things are the case, that must necessarily be, and that is white, there is no necessity for it to be white on account of

[10]Omitting μίαν (inserted by Wallies).
[11]ὁ λόγος is apparently used here to mean ambiguity: see 169a22.

the deduction. So, if the triangle has its angles equal to two right-angles, and it happens to be a figure, or a primitive or a principle, it is not proved that a figure or a principle or a primitive has this character. For the demonstration proves the point about it not *qua* figure or *qua* primitive, but *qua* triangle. Likewise also in other cases. If, then, a refutation is a sort of deduction, an argument depending on an accident will not be a refutation. It is, however, just in this that the experts and men of science generally suffer refutation at the hand of the unscientific; for the latter meet the scientists with deductions depending on accidents; and the scientists for lack of the power to draw distinctions either say 'Yes' to their questions, or else are thought to have said 'Yes', although they have not.[12]

Those that depend upon whether something is said in a certain respect only or said without qualification occur because the affirmation and the denial are not concerned with the same point. For of white in a certain respect the negation is not white in a certain respect, while of white without qualification it is not white, without qualification. If, then, a man treats the admission that a thing is white in a certain respect as though it were said to be white without qualification, he does not effect a refutation, but merely appears to do so owing to ignorance of what refutation is.

The clearest cases of all, however, are those that were previously described as depending upon the definition of a refutation; and this is also why they were given their name.[13] For the appearance of a refutation is produced because of the omission in the definition, and if we divide fallacies in the above manner, we ought to set 'defect in definition' as a common mark upon them all.

Those that depend upon the assumption of the original point and upon stating as the cause what is not the cause, are clear through the definition. For the conclusion ought to come about because these things are so, and this does not happen where the premisses are not causes of it; and again it should come about without taking into account the original point, and this is not the case with those arguments which depend upon postulating the original point.

Those that depend upon the consequent are a branch of accident; for the consequent is an accident, only it differs from the accident in this, that you may secure an admission of the accident in the case of one thing only (e.g. the identity of a yellow thing and honey and of a white thing and a swan), whereas the consequent always involves more than one thing; for we claim that things that are the same as one and the same thing are also the same as one another, and this is the ground of a refutation dependent on the consequent. (But this is not always true, e.g. suppose that they are the same accidentally; for both snow and the swan are the same as something white.) Or again, as in Melissus' argument, a man assumes that to have been generated and to have a beginning are the same thing, or to become equal and to assume the same magnitude. For because what has been generated has a beginning, he claims also that what has a beginning has been generated, and argues as though both what has been generated and what is finite were the same because

[12]Reading δόντας.

[13]They are called παραλογισμοί because they occur παρὰ τοῦ λόγου τὴν ἔλλειψιν.

each has a beginning. Likewise also in the case of things that are made equal he assumes that if things that assume one and the same magnitude become equal, then also things that become equal assume one magnitude: i.e. he assumes the consequent. Inasmuch, then, as a refutation depending on accident consists of ignorance of what a refutation is, clearly so also does a refutation depending on the consequent. We shall have further to examine this in another way as well.[14]

Those fallacies that depend upon the making of several questions into one consist in our failure to articulate the account of a proposition. For a proposition predicates a single thing of a single thing. For the same definition applies to one single thing only and to the thing without qualification, e.g. to man and to one single man only; and likewise also in other cases. If, then, a single proposition is one which claims a single thing of a single thing, a proposition, without qualification, will be the putting of a question of that kind. Now since a deduction starts from propositions and a refutation is a deduction, a refutation, too, will start from propositions. If, then, a proposition predicates a single thing of a single thing, it is obvious that this fallacy too consists in ignorance of what a refutation is; for in it what is not a proposition appears to be one. If, then, the answerer has returned an answer as though to a single question, there will be a refutation; while if he has returned one not really but apparently, there will be an apparent refutation. All the types of fallacy,[15] then, fall under ignorance of what a refutation is, those dependent on language because the contradiction, which is the proper mark of a refutation, is merely apparent, and the rest because of the definition of a deduction.

7 · The error comes about in the case of arguments that depend on homonymy and the account[16] because we are unable to distinguish the various senses (for some terms it is not easy to distinguish, e.g. one, being, and sameness), while in those that depend on combination and division, it is because we suppose that it makes no difference whether the phrase is combined or divided, as is indeed the case with most phrases. Likewise also with those that depend on accent; for the lowering or raising of the pitch upon a phrase seems not to alter its meaning—with any phrase, or not with many. With those that depend on the form it is because of the likeness of expression. For it is hard to distinguish what kind of things are signified by the same and what by different kinds of expression (for a man who can do this is practically next door to the understanding of the truth, and knows best how to assent) because we suppose every predicate of anything to be an individual thing, and we understand it as being one thing; for it is to that which is one and to substances that individuality and being seem especially to belong. For this reason, too, this type of fallacy is to be ranked among those that depend on language; in the first place, because the error is effected the more readily when we are inquiring into a problem in company with others than when we do so by ourselves (for an inquiry with another person is carried on by means of speech, whereas an inquiry by oneself

[14]See Chh. 24 and 28.
[15]Reading τρόποι for τόποι.
[16]See 168a25.

is carried on quite as much by means of the object itself); secondly a man is liable to err, even when inquiring by himself, when he takes speech as the basis of his inquiry; moreover the error arises out of the likeness, and the likeness arises out of the language. With those fallacies that depend upon accident, error comes about because we cannot distinguish what is the same and what is different, what is one and what many, or what kinds of predicate have all the same accidents as their subject. Likewise also with those that depend on the consequent; for the consequent is a branch of accident. Moreover, in many cases it seems and it is claimed that if this is inseparable from that, so also is that from this. With those that depend upon deficiency in the account of a refutation, and with those that depend upon the difference between a qualified and an unqualified statement, the error consists in the smallness of the difference involved; for we treat the limitation to the particular thing or respect or manner or time as adding nothing to the meaning, and so grant the statement universally. Likewise also in the case of those that assume the original point, and those of false cause, and all that treat a number of questions as one; for in all of them the error lies in the smallness of the difference; for our failure to be quite precise in our definition of propositions and of deductions is due to the aforesaid reason.

8 · Since we know on how many points apparent deductions depend, we know also on how many sophistical deductions and refutations may depend. By a sophistical refutation and deduction I mean not only a deduction or refutation which appears to be valid but is not, but also one which, though it is valid, only appears to be appropriate to the thing in question. These are those which fail to refute in respect of the object and which prove the answerer to be ignorant, which was the function of the art of examination. Now the art of examining is a branch of dialectic; and this may deduce a false conclusion because of the ignorance of the answerer. Sophistic refutations on the other hand, even though they deduce the contradictory of his thesis, do not make clear whether he is ignorant; for even men of knowledge are entangled by these arguments.

That we know them by the same line of inquiry is clear; for the same considerations which make it appear to an audience that the conclusion was deduced by way of the questions, would make the answerer think so as well, so that false deductions will occur through all or some of these means; for what a man has not been asked but thinks he has granted, he would also grant if he were asked. Of course, in some cases the moment we add the missing question, we also show up the falsity, e.g. in fallacies that depend on language and on solecism. If then fallacious arguments for the contradictory of a thesis depend on their appearing to refute, it is clear that the considerations on which both deductions of false conclusions and apparent refutation depend must be the same in number. Now an apparent refutation depends upon the elements involved in a genuine one; for the failure of one or other of these must make the refutation merely apparent, e.g. that which depends on the failure of the conclusion to follow from the argument (the argument *ad impossibile*) and that which treats two questions as one and so depends upon a flaw in the proposition, and that which depends on the substitution of an accident for an essential attribute, and—a branch of the last—that which depends upon the consequent; moreover, the conclusion may follow not in fact but only verbally; then, instead of proving the contradictory universally and in the same respect and relation and manner, the fallacy may be dependent on some limit of extent or on one or other of these qualifications; moreover, there is the assumption of the original point, in violation of the principle of not reckoning in the original point. Thus we should have the number of considerations on which fallacies depend; for they could not depend on more, but all will depend on the points aforesaid.

A sophistical refutation is a refutation not without qualification but relatively to someone; and so is a deduction, in the same way. For unless that which depends upon homonymy assumes that the term has a single meaning, and that which depends on similarity of form assumes that terms signify nothing but individuals, and the rest in the same way, they will be neither refutations nor deductions, either without qualification or relatively to the answerer; whereas if they do assume these things, they will be, relatively to the answerer; but they will not be without qualification; for they have not secured a statement that does have a single meaning, but only one that appears to have, and that only from this particular man.

9 · The number of considerations on which depend the refutations of those who are refuted, we ought not to try to grasp without a knowledge of everything that is. This, however, is not the province of any single study; for possibly the sciences are infinite in number, so that obviously demonstrations may be infinite too. Now refutations may be true as well as false; for whenever it is possible to demonstrate something, it is also possible to refute the man who maintains the contradictory of the truth; e.g. if a man has stated that the diagonal is commensurate with the side of the square, one might refute him by demonstrating that it is incommensurate. Accordingly, we shall have to have scientific knowledge of everything; for some refutations depend upon the principles of geometry and the conclusions that follow from these, others upon those of medicine, and others upon those of the other sciences. For the matter of that, false refutations likewise belong to the number of the infinite; for in respect of every art there is false deduction, e.g. in respect of geometry there is a geometrical one, and in respect of medicine a medical. By in respect of the art, I mean in respect of its principles. Clearly, then, it is not of all refutations, but only of those that depend upon dialectic that we need to grasp the commonplace rules; for these are common to every art and faculty. And as regards the refutation that is in respect of one or other of the particular sciences it is the task of that particular scientist to examine whether it is merely apparent without being real, and, if it is real, what is the reason for it; whereas it is the business of dialecticians so to examine the refutation that proceeds from common principles and falls under no particular study. For if we grasp the starting-points of the reputable deductions on any subject we grasp those of the refutations. For a
170b1 refutation is a deduction of the contradictory, so that either one or two deductions of the contradictory constitute a refutation. We grasp, then, the number of consider-

ations on which all such depend; and if we grasp this, we grasp their solutions as well; for the objections to these are the solutions of them. We also grasp the number of considerations on which those refutations depend, that are merely apparent—apparent, I mean, not to everybody, but to people of a certain stamp; for it is an indefinite task if one is to inquire how many are the considerations that make them apparent to the man in the street. Accordingly it is clear that the dialectician's business is to be able to grasp on how many considerations depends the formation, through common principles, of a refutation that is either real or apparent, i.e. either dialectical or apparently dialectical, or suitable for an examination.

10 · It is no true distinction between arguments which some people draw when they say that some arguments are directed against the word, and others against the thought; for it is absurd to suppose that some arguments are directed against the word and others against the thought, and that they are not the same. For what is failure to direct an argument against the thought except what occurs whenever a man does not use the word in the sense about which the person being questioned thought he was being questioned when he made the concession? And this is the same thing as to direct the argument against the word. On the other hand, it is directed against the thought whenever a man uses the word in the sense which the answerer had in mind when he made the concession. If now anyone (i.e. both the questioner and the person questioned), in dealing with a word with more than one meaning, were to suppose it to have one meaning—as e.g. it may be that being and one have many meanings, and yet both the answerer answers and the questioner puts his question supposing it to be one, and the argument is to the effect that all things are one—will this discussion be directed any more against the word than against the thought of the person questioned? If, on the other hand, someone supposes the word to have many meanings, it is clear that such a discussion will not be directed against the thought. For direction against the word and against the thought applies primarily to those arguments which have several meanings, but secondarily to any argument whatsoever; for the fact of being directed against the thought depends not on the argument, but on the special attitude of the answerer towards the points he concedes. Next, all of them may be directed to the word. For to be directed against the word is in this doctrine not to be directed against the thought. For if not all are directed against either word or thought, there will be certain other arguments directed neither against the word nor against the thought, whereas they say that all must be one or the other, and divide them all as directed either against the word or against the thought, while others (they say) there are none. But in point of fact those that depend on the word are a branch of those deductions that depend on a multiplicity of uses. For the absurd statement has actually been made that the description 'dependent on the word' describes all the arguments that depend on language; whereas some of these are fallacies not because the answerer adopts a particular attitude towards them, but because the argument itself involves the asking of a question such as bears more than one use.

It is altogether absurd to discuss refutation without first discussing deduction; 171a1
for a refutation is a deduction, so that one ought to discuss deduction before

describing false refutation; for a refutation of that kind is a merely apparent deduction of the contradictory of a thesis. Accordingly, the reason of the falsity will be either in the deduction or in the contradiction (for mention of the contradiction must be added), while sometimes it is in both, if the refutation is merely apparent. In the argument that speaking of the silent is possible it lies in the contradiction, not in the deduction; in the argument that one can give what one does not possess, it lies in both; in the argument that Homer's poem is a figure through its being a cycle it lies in the deduction. An argument that does not fail in either respect is a true deduction.

But, to return to the point whence our argument digressed, are mathematical reasonings directed against the thought, or not? And if any one thinks 'triangle' to be a word with many meanings, and granted it in some different sense from the figure which was proved to contain two right angles, has the questioner here directed his argument against the thought of the former or not?

Moreover, if the name bears many senses, while the answerer does not understand or suppose it to have them, surely the questioner here has directed his argument against his thought. Or how else ought he to put his question except by suggesting a distinction—suppose one's question to be 'Is speaking of the silent possible or not?' or 'Is the answer "No" in one sense, but "Yes" in another?' If, then, any one were to answer that it was not possible in any sense and the other were to argue that it was, has not his argument been directed against the thought of the answerer? Yet his argument is supposed to be one of those that depend on the word. There is not, then, any definite kind of arguments that is directed against the thought. Some arguments are, indeed, directed against the word; but these do not include all apparent refutations, let alone all refutations. For there are also apparent refutations which do not depend upon language, e.g. those that depend upon accident, and others.

If anyone requires that one should actually draw the distinction, and say, 'By "speaking of the silent" I mean, in one sense this and in the other sense that', surely to require *this* is in the first place absurd (for sometimes the question does not seem to have several uses, and you cannot possibly draw a distinction which you do not think to be there); in the second place, what else but this will *didactic* argument be? For it will make manifest the state of the case to one who has never considered, and does not know or suppose that there is any other use. For what is there to prevent the same thing also happening to us in cases where there is no[17] double use? 'Are the units in four equal to the twos? Observe that some twos[18] are contained in one way, some in another.' Also, 'Is the knowledge of contraries one or not? Observe that some contraries are known, while others are unknown.' Thus the man who makes
171b1 this requirement seems to be unaware of the difference between didactic and dialectical argument, and of the fact that while he who argues didactically should not ask questions but make things clear himself, the other should merely ask questions.

[17]Ross accidentally omits μή.
[18]Retaining δυάδες.

11 · Moreover, to require a 'Yes' or 'No' answer is the business not of a man who is proving something, but of one who is holding an examination. For the art of examining is a branch of dialectic and has in view not the man who has knowledge, but the ignorant pretender. Now the man who regards the common principles with their application to the particular matter in hand is a dialectician, while the man who only appears to do this is a sophist. Now one form of contentious and sophistical deduction is a merely apparent deduction, on subjects on which dialectic is the proper method of examination, even if its conclusion is true (for it misleads us in regard to the cause); also there are those fallacies which do not belong to the line of inquiry proper to the particular subject, but seem to belong to the art in question. For false diagrams of geometrical figures are not contentious (for the fallacies belong to the subject of the art)—any more than is any false diagram illustrating a truth—e.g. Hippocrates' figure of the squaring of the circle by means of the lunules. But Bryson's method of squaring the circle, even if the circle is thereby squared, is still sophistical because it does not conform to the subject in hand. So, then, any merely apparent deduction about these things is a contentious argument, and any deduction that merely appears to conform to the subject in hand, even if it is a genuine deduction, is a contentious argument; for it is merely apparent in its conformity to the subject-matter, so that it is deceptive and unfair. For just as unfairness in a contest is a definite type of fault, and is a kind of foul fighting, so the art of contentious reasoning is foul fighting in disputation; for in the former case those who are resolved to win at all costs snatch at everything, and so in the latter case do contentious reasoners. Those, then, who do this in order to win the mere victory are thought to be contentious and quarrelsome persons, while those who do it to win a reputation with a view to making money are sophistical. For sophistry is, as we said, a kind of art of money-making from a merely apparent wisdom, and this is why they aim at a merely apparent demonstration; and quarrelsome persons and sophists both employ the same arguments, but not with the same motives; and the same argument will be sophistical and contentious, but not in the same respect; rather, it will be contentious in so far as its aim is an apparent victory, while in so far as its aim is an apparent wisdom, it will be sophistical—for the art of sophistry is a certain appearance of wisdom without the reality. The contentious arguer stands in somewhat the same relation to the dialectician as the drawer of false diagrams to the geometrician; for he argues fallaciously from the same principles as the dialectician, just as the drawer of a false diagram uses the same principles as the geometrician. But whereas the latter is not a contentious reasoner, because he bases his false diagram on the principles and conclusions that fall under the art of geometry, the argument which is subordinate to the principles of dialectic will yet clearly be contentious as regards other subjects. Thus, e.g., though the squaring of the circle by means of the lunules is not contentious, Bryson's solution is contentious; and the former argument cannot be adapted to any subject except geometry, because it proceeds from principles that are proper to geometry, whereas the latter can be adapted as an argument against the many people who do not know what is or is not possible in each particular context—for it will apply to them all. Or

there is the method whereby Antiphon squared the circle. Or again, an argument which denied that it was better to take a walk after dinner, because of Zeno's argument, would not be a proper argument for a doctor, because Zeno's argument is of general application. If, then, the relation of the contentious arguer to the dialectician were exactly like that of the drawer of false diagrams to the geometrician, a contentious argument upon the aforesaid subjects could not have existed. But, as it is, the dialectical argument is not concerned with any definite genus, nor does it prove anything, nor is it of the same type as a universal argument. For all beings are not contained in any one kind, nor, if they were, could they possibly fall under the same principles. Accordingly, no art that is a method of proving the nature of anything proceeds by asking questions; for it does not permit a man to grant whichever he likes of the two alternatives in the question; for they will not both of them yield a deduction. Dialectic, on the other hand, does proceed by questioning, whereas if it were concerned to prove things, it would have refrained from putting questions, even if not about everything, at least about the primitives and the appropriate principles. For suppose the answerer not to grant these, it would then no longer have had any grounds from which to argue any longer against the objection. Dialectic is at the same time a mode of examination as well. For the art of examination is not an accomplishment of the same kind as geometry, but one which a man may possess, even though he has not knowledge. For it is possible even for one without knowledge to hold an examination of one who is without knowledge, if the latter grants him points taken not from things that he knows or from the proper principles but from the consequences which a man may know without knowing the art in question (but which if he does not know, he is bound to be ignorant of the art). So then clearly the art of examining does not consist in knowledge of any definite subject. For this reason, too, it deals with everything; for every art employs certain common principles too. Hence everybody, including even amateurs, makes use in a way of dialectic and the practice of examining; for all undertake to some extent a test of those who profess to know things. What serves them here is the general principles; for they know these themselves just as well as the scientist, even if in what they say they seem to go wildly astray. All, then, are engaged in refutation; for they take a hand as amateurs in the same task with which dialectic is concerned professionally; and he is a dialectician who examines by the help of a theory of deduction. Now there are many identical principles which are true of everything, though they are not such as to constitute a particular nature, i.e. a particular kind of being, but are like negations, while other principles are not of this kind but are proper; accordingly it is possible from these general principles to hold an examination on everything, and that there should be a definite art of so doing, and, moreover, an art which is not of the same kind as those which prove. This is why the contentious reasoner does not stand in the same condition in all respects as the drawer of a false diagram; for the contentious reasoner will not argue fallaciously from any definite class of principles, but will deal with every class.

These, then, are the types of sophistical refutations; and that it belongs to the dialectician to study these, and to be able to effect them, is not difficult to see; for the investigation of propositions comprises the whole of this study.

12 · So much, then, for apparent refutations. As for showing that the answerer is saying something false, and drawing his argument into something implausible—for this was the second item of the sophist's programme—in the first place, then, this is best brought about by a certain manner of inquiring and through the question. For to put the question without framing it with reference[19] to any definite subject is a good bait for these purposes; for people are more inclined to make mistakes when they talk at large, and they talk at large when they have no definite subject before them. Also the putting of several questions, even though the position against which one is arguing is definite, and the requirement that he shall say only what he thinks, create abundant opportunity for drawing him into implausibility or falsity, and also, whether to any of these questions he replies 'Yes' or replies 'No', for leading[20] him on to statements against which one is well off for a line of attack. Nowadays, however, men are less able to play foul by these means than they were formerly; for people rejoin with the question, 'What has that to do with the original subject?' It is, too, an elementary rule for eliciting some falsity or implausibility that one should never put a thesis directly, but say that one puts it from the wish for information; for the pretext gives room for an attack.

A rule specially appropriate for showing up a falsity is the sophistic rule that one should draw the answerer on to the kind of statements against which one is well supplied with arguments: this can be done both properly and improperly, as was said before.[21]

Again, to draw a paradoxical statement, look and see to what school the person arguing with you belongs, and then question him as to some point wherein their doctrine is paradoxical to most people; for with every school there is some point of that kind. It is an elementary rule in these matters to have a collection of the theses of the various schools among your propositions. The solution appropriate here, too, is to show that the paradox does not come about because of the argument: whereas this is what your opponent always really wants.

Moreover, argue from men's wishes and their professed opinions. For people do not wish the same things as they say they wish: they say what will look best, whereas they wish what appears to be to their interest; e.g. they say that a man ought to die nobly rather than to live in pleasure, and to live in honest poverty rather than in dishonourable riches; but they wish the opposite. Accordingly, a man who speaks according to his wishes must be led into stating his professed opinions, while he who speaks according to these must be led into admitting those that are hidden away; for in either case they are bound to introduce a paradox; for they will speak contrary either to their professed or to their hidden opinions.

The widest range of commonplace argument for leading men into paradoxical statement is that which depends on the standards of nature and of convention: it is thus that both Callicles is portrayed as arguing in the *Gorgias*, and that all the men of old supposed the result to come about; for nature (they said) and convention are

[19]Retaining πρός.
[20]Retaining ἄγειν.
[21]See *Topics* 111^{b}32.

opposites, and justice is a fine thing by a conventional standard, but not by that of nature. Accordingly, the man whose statement agrees with the standard of nature you should meet by the standard of convention, but the man who agrees with convention by leading him to the facts of nature; for in both ways paradoxical statements will be made. In their view the standard of nature was the truth, while that of convention was the opinion held by the majority. So that it is clear that they, too, used to try either to refute the answerer or to make him make paradoxical statements, just as the men of to-day do as well.

Some questions are such that in both forms the answer is implausible; e.g. 'Ought one to obey the wise or one's father?' and 'Ought one to do what is expedient or what is just?' and 'Is it preferable to suffer injustice or to do an injury?' You should lead people, then, into views opposite to the majority and to the wise: if anyone speaks as do the expert reasoners, lead him into opposition to the majority, while if he speaks as do the majority, then into opposition to the wise. For some say that of necessity the happy man is just, whereas it is implausible to the many that a king should not be happy. To lead a man into implausibility of this sort is the same as to lead him into the opposition of the standards of nature and convention; for convention represents the opinion of the majority, whereas the wise speak according to the standard of nature and the truth.

13 · Paradoxes, then, you should seek to elicit by means of these commonplace rules. Now as for making any one babble, we have already said what we mean by to babble.[22] This is the object in view in all arguments of the following kind: if it is all the same to state a word and to state its account, double and double of half are the same; if then double is double of half, it will be double of half of half. And if, instead of 'double', double of half is again put, then the same expression will be repeated three times, double of half of half of half. Also 'Desire is of the pleasant, isn't it?' But desire is appetition for the pleasant; accordingly, desire is appetition for the pleasant for the pleasant.

All arguments of this kind occur in dealing with any relative terms which not only have relative genera, but are also themselves relative, and are rendered in relation to one and the same thing (as e.g. appetition is appetition for something, and desire is desire for something, and double is double of something, i.e. double of half); also in dealing with any terms which, though they are not relative terms at all, yet have their substance, viz. the things of which they are the states or affections or what not, indicated as well in their definition, they being predicated of these things. Thus e.g. odd is a number containing a middle; but there are odd numbers; therefore there are numbers numbers containing a middle. Also, if snubness is a concavity of the nose, and there are snub noses, there are concave noses noses.

People sometimes appear to produce this result, without really producing it, because they do not add the question whether double, just by itself, has any meaning or not, and if so, whether it has the same meaning, or a different one; but they draw their conclusion straight away. Still it seems, inasmuch as the word is the same, to have the same meaning as well.

[22]See 165^b16.

14 · We have said before what kind of thing solecism is.[23] It is possible both to commit it, and to seem to do so without doing so, and to do so without seeming to do so. Suppose, as Protagoras used to say, that *μῆνις* ('wrath') and *πήληξ* ('helmet') are masculine: according to him a man who calls wrath a 'destructress' (*οὐλομένην*) commits a solecism, though he does not seem to do so to other people, whereas he who calls it a 'destructor' (*οὐλόμενον*) commits no solecism though he seems to do so. It is clear, then, that one could produce this affect by art as well; and for this reason many arguments seem to deduce a solecism which do not really do so, as happens in the case of refutations.

Almost all apparent solecisms depend upon occasions when the inflection denotes neither a masculine nor a feminine object but a neuter. For 'he' signifies a masculine, and 'she' a feminine; but 'this', though meant to signify a neuter, often also signifies one or other of the former: e.g. 'What is this?' —Calliope, a log, Coriscus. Now in the masculine and feminine the inflections are all different, whereas in the neuter some are and some are not. Often, then, when 'this' has been granted, people reason as if 'him' had been said; and likewise also they substitute one inflection for another. The fallacy comes about because 'this' is a common form of several inflections; for 'this' signifies sometimes 'he' and sometimes 'him'. It should signify them alternately: when combined with 'is' it should be 'he', while with 'being' it should be 'him': e.g. 'He is', 'being him'. It happens in the same way in the case of feminine names as well, and in the case of the so-called 'chattels' that have feminine or masculine designations. For only those names which end in *ο* and *ν*, have the designation proper to a chattel, e.g. *ξύλον*, *σχοινίον*; those which do not end so have that of a masculine or feminine object, though some of them we apply to chattels: e.g. *ἀσκός* is a masculine name, and *κλίνη* a feminine. For this reason in cases of this kind as well there will be a difference of the same sort between 'is' and 'being'. Also, solecism resembles in a certain way those refutations which are said to depend on the like expression of unlike things. For, just as there we come upon a material solecism, so here we come upon a verbal; for man is both an object and also a word, and so is white.

It is clear, then, that for solecisms we must try to construct our argument out of the aforesaid inflections.

These, then, are the types of contentious arguments, and the subdivisions of those types, and the methods for conducting them aforesaid. But it makes no little difference if the materials for putting the question are arranged in a certain manner with a view to concealment, as in the case of dialectical arguments. Following then upon what we have said, this must be discussed first.

15 · With a view then to refutation, one resource is length—for it is difficult to keep several things in view at once; and to secure length the elementary rules that have been stated before should be employed. Another resource is speed; for when people are left behind they look ahead less. Moreover, there is anger and contentiousness; for when agitated everybody is less able to take care of himself. Elementary rules for producing anger are to make a show of the wish to play foul,

[23] See 165b20.

and to be altogether shameless. Moreover there is the putting of one's questions alternately, whether one has more than one argument leading to the same conclusion, or whether one has arguments to show both that something is so, and that it is not so; for the result is that he has to be on his guard at the same time either against more than one line, or against contrary lines, of argument. In general, all the methods described before[24] of producing concealment are useful also for purposes of contentious argument; for the object of concealment is to avoid detection, and the object of this is to deceive.

To counter those who refuse to grant whatever they suppose to help one's argument, one should put the question negatively, as though desirous of the opposite answer, or at any rate as though one put the question without prejudice; for when it is obscure what answer one wants to secure, people are less refractory. Also when, in dealing with particulars, a man grants the individual case, when the induction is done you should often not put the universal as a question, but take it for granted and use it; for sometimes people themselves suppose that they have granted it, and also appear to the audience to have done so—for they remember the induction and assume that the questions could not have been put for nothing. In cases where there is no term to indicate the universal, still you should avail yourself of the resemblance to suit your purpose; for resemblance often escapes detection. Also, with a view to obtaining the proposition, you ought to put it in your question side by side with its contrary. E.g. if it were necessary to secure the admission that a man should obey his father in everything, ask 'Should a man obey his parents in everything, or disobey them in everything?'; and 'Should one agree that many times many is many or few?' (for then, if compelled to choose, one will be more inclined to think it many). For the placing of their contraries close beside them makes things look smaller and bigger, and worse and better to men.

A strong appearance of having been refuted is often produced by the most highly sophistical of all the unfair tricks of questioners, when without deducing anything, instead of putting their final proposition as a question, they state it as a conclusion, as though they had deduced it—'Therefore so-and-so is not true'.

It is also a sophistical trick, when a paradox has been laid down, to require, when the accepted view has been originally proposed that the answerer shall answer what he thinks about it, and to put one's question on matters of that kind in the form 'Do you think that . . . ?' For then, if the question is taken as one of the premisses of one's argument, either a refutation or a paradox is bound to result: if he grants the view, a refutation; if he refuses to grant it or even to admit it is accepted, an implausibility; if he refuses to grant it, but admits that it is accepted, something very like a refutation results.

Moreover, just as in rhetorical arguments, so also in those aimed at refutation, you should examine the discrepancies of the answerer's position either with his own statements, or with those of persons whom he admits to say and do aright, and also with those of people who are supposed to bear that kind of character, or who are like them, or with those of the majority or of all men. Also just as answerers, too, often, when they are in process of being refuted draw a distinction, if their refutation is

[24]See *Topics* $155^{b}26$-$157^{a}5$.

just about to take place, so questioners also should resort to this from time to time to counter objectors, pointing out, supposing that against one sense of the words the objection holds, but not against the other, that they have taken it in the latter sense, as e.g. Cleophon does in the *Mandrobulus*.[25] They should also break off their argument and cut short their other lines of attack, while in answering, if a man perceives this being done beforehand, he should put in his objection and have his say first. One should also lead attacks sometimes against positions other than the one stated, excluding it if one cannot find lines of attack against the view laid down, as Lycophron did when set to deliver a eulogy upon the lyre. To counter those who demand 'Against what are you directing your effort?,' since one is thought bound to state the reason, while, on the other hand, some ways of stating it make the defence too easy, you should state as your aim only the general result that always happens in refutations, namely the contradiction of his thesis—viz. that your effort is to deny what he has affirmed, or to affirm what he denied: don't say that you are trying to show that the knowledge of contraries is, or is not, the same.[26] One must not ask one's conclusion in the form of a proposition. Some things should not even be put as questions at all but used as though granted.

16 · We have now dealt with the sources of questions, and the methods of questioning in contentious disputations; next we have to speak of answering, and of how solutions should be made, and of what requires them, and of what use is served by arguments of this kind. 175ᵃ1

The use of them, then, is, for philosophy, two-fold. For in the first place, since for the most part they depend upon the expression, they put us in a better condition for seeing in how many ways any term is used, and what kind of resemblances and what kind of differences occur between things and between their names. In the second place they are useful for one's own personal researches; for the man who is easily committed to a fallacy by someone else, and does not perceive it, is likely to incur this fate himself also on many occasions. Thirdly and lastly, they further contribute to one's reputation, viz. the reputation of being well trained in everything, and not inexperienced in anything; for that a party to arguments should find fault with them and yet cannot definitely point out their weakness, creates a suspicion, making it seem as though it were not the truth of the matter but inexperience that put him out of temper.

Answerers may clearly see how to meet arguments of this kind, if our previous account was right of the sources whence fallacies came, and if we adequately distinguished the forms of dishonesty in putting questions. But it is not the same thing to take an argument in one's hand and then to see and solve its faults, as it is to be able to meet it quickly while being subjected to questions; for what we know, we often do not know in a different context. Moreover, just as in other things speed or slowness is enhanced by training, so it is with arguments too, so that supposing we are unpractised, even though a point is clear to us, we are often too late for the right

[25] Probably a dialogue by Speusippus.

[26] The text and the punctuation of this long sentence are in many places uncertain.

moment. Sometimes too it happens as with diagrams; for there we can sometimes analyse the figure, but not construct it again: so too in refutations, though we know on what the connexion of the argument depends, we still are at a loss to split the argument apart.

17 · First then, just as we say that we ought sometimes to choose to deduce something in a reputable fashion rather than in truth, so also we have sometimes to solve arguments rather in a reputable fashion than according to the truth. For it is a general rule in fighting contentious persons, to treat them not as refuting, but as merely appearing to refute; for we say that they don't really *deduce* anything, so that our object in correcting them must be to dispel the appearance of it. For if refutation is a non-homonymous contradiction arrived at from certain premisses, there will be no need to draw distinctions against ambiguity and homonymy; for they do not effect a deduction. The only motive for drawing further distinctions is that the conclusion reached looks like a refutation. What, then, we have to beware of, is not being refuted, but seeming to be, because of course the asking of ambiguities and of questions that turn upon homonymy, and all the other tricks of that kind, both conceal a genuine refutation and make it uncertain who is refuted and who is not. For since one has the right at the end, when the conclusion is drawn, to say that he has not denied what one has stated except homonymously, no matter how precisely he may have addressed his argument to the very same point as oneself, it is not clear whether one has been refuted; for it is not clear whether at the moment one is speaking the truth. If, on the other hand, one had drawn a distinction, and questioned him on the homonymy or the ambiguity, the refutation would not have been a matter of uncertainty. Also what contentious arguers (less so nowadays than formerly) aim at would have been achieved, namely that the person questioned should answer either 'Yes' or 'No'; whereas nowadays the improper forms in which questioners put their questions compel the party questioned to add something to his answer in correction of the faultiness of the proposition as put; for certainly, if the questioner distinguishes his meaning adequately, the answerer is bound to reply either 'Yes' or 'No'.

If anyone is going to suppose that an argument which turns upon homonymy is a refutation, it will be impossible for an answerer to escape being refuted in a sense; for in the case of visible objects one is bound of necessity to deny the term he has asserted, and to assert what he has denied. For the remedy which some people have for this is quite unavailing. They say, not that Coriscus is both musical and unmusical, but that *this* Coriscus is musical and *this* Coriscus unmusical. But this will not do, for to say that *this* Coriscus is unmusical, or musical, and to say *this* Coriscus is so, is to use the same expression; and this he is both affirming and denying at once. 'But perhaps they do not mean the same'. Well, nor did the name in the former case: so where is the difference? If, however, he is to use in the one case the simple title Coriscus, while in the other he is to add the prefix one or this, he commits an absurdity; for the latter is no more applicable to the one than to the other; for to whichever he adds it, it makes no difference.

All the same, since if a man does not distinguish the senses of an ambiguity, it is not clear whether he has been refuted or has not been refuted, and since in arguments the right to distinguish them is granted, it is evident that to grant the question without drawing any distinction and without qualification is a mistake, so that the *argument*—even if not the man himself—looks as though it has been refuted. It often happens, however, that, though they see the ambiguity, people hesitate to draw such distinctions, because of the dense crowd of persons who propose questions of the kind, in order that they may not be thought to be ill-tempered at every turn; then again, though they would never have supposed that that was the point on which the argument turned, they often find themselves faced by a paradox. Accordingly, since the right of drawing the distinction is granted, one should not hesitate, as has been said before.[27]

If people never made two questions into one question, the fallacy that turns upon homonymy and ambiguity would not have come about, but either genuine refutation or none. For what is the difference between asking whether Callias and Themistocles are musical, and what one might have asked if the pair of them, though different, had had its own single name? For if the term applied means more than one thing, he has asked more than one question. If then it is not right to demand to be given without qualification a single answer to two questions, it is evident that it is not proper to give an unqualified answer to any homonymous question, not even if the predicate is true of all the subjects, as some claim that one should. For this is exactly as though he had asked 'Are Coriscus and Callias at home or not at home?', supposing them to be both in or both out; for in both cases there is a number of propositions; for though the simple answer is true, that does not make the question one. For it is possible for it to be true to say 'Yes' or 'No' without qualification to countless different questions; but still one should not answer them with a single answer; for that is the death of argument. Rather, it is as though different things had actually had the same name applied to them. If then, one should not give a single answer to two questions, it is evident that we should not say 'Yes' or 'No' in the case of homonyms; for the remark is simply a remark, not an answer at all, although among disputants such remarks are demanded, because they do not see what the consequence is.

As we said, then, inasmuch as some things seem to be refutations though they are not, in the same way also some things will seem to be solutions, though they are not. Now these, we say, must sometimes be advanced rather than the true solutions in contentious reasonings and in meeting ambiguity. The proper answer in saying what one thinks is to say 'Granted'; for in that way the likelihood of being refuted on a side issue is minimized. If, on the other hand, one is compelled to say something paradoxical, one should then be most careful to add that it seems so; for in that way one avoids the impression of being either refuted or paradoxical. Since it is clear what is meant by postulating the point at issue, and people think that they must at all costs overthrow the premisses that lie near the conclusion, and that some must not be conceded because he is postulating the point at issue, so whenever any one

[27]See *Topics* VIII 7.

claims from us a point such as is bound to follow as a consequence from our thesis, but is false or paradoxical, we must plead the same; for the necessary consequences are generally held to be a part of the thesis itself. Moreover, whenever the universal has been secured not under a definite name, but by a comparison of instances, one should say that the questioner assumes it not in the sense in which it was granted nor in which he proposed it; for this too is a point upon which a refutation often depends.

If one is debarred from these defences one must pass to the argument that the conclusion has not been properly proved, approaching it in the light of the given classification.[28]

In the case, then, of names that are used literally one is bound to answer either without qualification or by drawing a distinction: it is the tacit understandings implied in our statements, e.g. in answer to questions that are not put clearly but truncatedly, upon which refutation depends. For example, 'Is what belongs to Athenians the property of Athenians?' Yes. 'And so it is likewise in other cases. But man belongs to the animal kingdom, doesn't he?' Yes. 'Then man is the property of the animal kingdom'. For we say that man belongs to the animal kingdom because he is an animal, just as we say that Lysander belongs to the Spartans, because he is a Spartan. It is evident, then, that where what is put forward is not clear, one must grant it without qualification.

Whenever of two things it seems that if the one is true the other is true of necessity, whereas, if the other is true, the first is not true of necessity, one should, if asked which of them is true, grant the smaller one; for the larger the number of premisses, the harder it is to deduce a conclusion from them. If, again, he tries to secure that one thing has a contrary while another has not, then if what he says is true, you should say that each has a contrary, only for the one there is no established name.

Since, again, in regard to some of the views they express, most people would say that anyone who did not admit them was telling a falsehood, while they would not say this in regard to some, e.g. to any matters whereon opinion is divided (for most people have no distinct view whether the soul of animals is destructible or immortal), accordingly wherever it is uncertain in which of two senses the premiss proposed is usually meant—whether as maxims are (for people call both true opinions and general assertions maxims), or like 'the diagonal of a square is incommensurate with its side'; and moreover[29] whenever opinions are divided as to the truth, we then have subjects of which it is very easy to change the terminology undetected. For because of the uncertainty in which of the two senses the premiss contains the truth, one will not be thought to be playing any trick, while because of the division of opinion, one will not be thought to be telling a falsehood; for the change will make the position irrefutable.

Moreover, whenever one foresees any question coming, one should put in one's objection and have one's say beforehand; for by doing so one is likely to embarrass the questioner most effectually.

[28] I.e. the classification of fallacies.
[29] Retaining ἔτι (ἐστι Ross).

18 · Inasmuch as a proper solution is an exposure of a false deduction, showing on what kind of question the falsity depends, and since false deduction has a double use—for it is used either if a false conclusion has been deduced, or if there is only an apparent deduction and no real one—there must be both the kind of solution just described, and also the correction of a merely apparent deduction, so as to show upon which of the questions the appearance depends. Thus it comes about that one solves arguments that are properly deduced by demolishing them, whereas one solves merely apparent arguments by drawing distinctions. Again, inasmuch as of arguments that are properly deduced some have a true and others a false conclusion, those that are false in respect of their conclusion it is possible to solve in two ways; for it is possible both by demolishing one of the premisses asked, and by proving that the conclusion is not the real state of the case; those, on the other hand, that are false in respect of their propositions can be solved only by a demolition of one of them; for the conclusion is true. So that those who wish to solve an argument should in the first place look and see if it is deduced or is not deduced; and next, whether the conclusion is true or false, in order that we may effect the solution either by drawing some distinction or by demolishing something, and demolishing it either in this way or in that, as was laid down before. There is a very great deal of difference between solving an argument when being subjected to questions and when not; for to foresee traps is difficult, whereas to see them at one's leisure is easier.

19 · Of the refutations, then, that depend upon homonymy and ambiguity some contain some question with more than one meaning, while others contain a conclusion bearing a number of uses: e.g. in the argument that speaking of the silent is possible, the conclusion has a double meaning, while in the argument that he who knows does not understand what he knows one of the questions contains an ambiguity. Also that which has a double use is true in one context but not in another; it means something that is and something that is not.

Whenever, then, the many senses lie in the conclusion no refutation takes place unless he secures as well the contradiction of the conclusion he means to prove; e.g. in the argument that seeing of the blind is possible; for without the contradiction there was no refutation. Whenever, on the other hand, the many senses lie in the questions, there is no necessity to begin by denying the double premiss; for this was not the goal of the argument but only its support. At the start, then, one should reply with regard to an ambiguity, whether of a word or of a phrase, in this manner, that in one sense it is so, and in another not so, as e.g. that speaking of the silent is in one sense possible but in another not possible; also that in one sense one should do what must be done, but not in another (for what must be bears a number of uses). If, however, the ambiguity escapes one, one should correct it at the end by making an addition to the question: 'Is speaking of the silent possible'? 'No, but to speak of this man while he is silent is possible'. Also, in cases which contain the ambiguity in their premisses, one should reply in like manner: 'Do people then not understand what they know?' 'Yes, but not those who know it in the manner described'; for it is not the same thing to say that those who know cannot understand what they know, and to say that those who know something in this particular manner cannot do so. In general, too, even if he deduces without qualification, one should contend that what he has negated is not the fact which one has asserted but only its name; and that therefore there is no refutation.

20 · It is evident also how one should solve those refutations that depend upon division and combination; for if the expression means something different when divided and when combined, as soon as one's opponent draws his conclusion one should take the expression in the contrary way. All such arguments as the following depend upon the combination or division of the words: 'Was he being beaten with that with which you saw him being beaten?' and 'Did you see him being beaten with that with which he was being beaten?' This has also in it an element of
177b1 ambiguity in the questions, but it really depends upon combination. For what depends upon the division of the words is not really a double meaning (for the expression when divided is not the same)—except in the way that *ὅρος* and *ὀρός*,[30] said with the accent, mean something different. In writing, indeed, a word is the same whenever it is written with the same letters and in the same manner—and even there people nowadays put marks at the side to show the pronunciation—but the spoken words are not the same. Accordingly an expression that depends upon division is not an ambiguous one. It is evident also that not all refutations depend upon ambiguity as some people say they do.

The answerer, then, must divide the expression; for to see a man being beaten with my eyes is not the same as to say I saw a man being beaten with my eyes. Also there is the argument of Euthydemus proving—'Then you know now in Sicily that there are triremes in Piraeus?'; and again, 'Can a good man who is a cobbler be bad?—But a good man may be a bad cobbler; therefore a good cobbler will be bad'. Again, 'Things the knowledge of which is good, are good things to learn, aren't they?—But knowledge of evil is good; therefore evil is a good thing to know. —But evil is both evil and a thing to learn, so that evil is an evil thing to learn—but knowledge of evils is good'. Again, 'Is it true to say in the present moment that you are born?—Then you are born in the present moment'. Or does the expression as divided have a different meaning? for it is true to say now that you are born, but not 'You are born now'. Again, 'Could you do what you can, and as you can?—But when not harping, you have the power to harp; therefore you could harp when not harping'. But he has not the power to do this—to harp while not harping; but when he is not doing it, he has the power to do it.

Some people solve this in another way. For, they say, if he has granted that he can do anything in the way he can, still it does not follow that he can harp when not harping; for it has not been granted that he will do anything in every way in which he can; and it is not the same thing to do a thing in the way he can and to do it in every way in which he can. But evidently they do not solve it properly; for of arguments that depend upon the same point the solution is the same, whereas this will not fit all cases of the kind nor yet all ways of putting the questions: it is valid against the questioner, but not against his argument.

[30]Reading *ὀρός* (Uhlig).

21 · Accentuation gives rise to no arguments, either as written or as spoken, except perhaps some few that might come about; e.g. the following argument. 'Is *οὗ καταλύεις* a house?' 'Yes.' 'Is then *οὐ καταλύεις* the negation of *καταλύεις*?' 'Yes'. 'But you said that *οὗ καταλύεις* is a house; therefore the house is a negation.' How one should solve this, is clear: for the word does not mean the same when spoken with an acuter and when spoken with a graver accent.

22 · It is clear also how one must meet those fallacies that depend on the identical expression of things that are not identical, seeing that we are in possession of the kinds of predications. For the one man, say, has granted, when asked, that a term denoting a substance does not belong as an attribute, while the other has proved that some attribute belongs which is in the category of relation or of quantity, but is thought to denote a substance because of its expression; e.g. in the following argument: 'Is it possible to be doing and to have done the same thing at the same time?' 'No'. 'But it is surely possible to be seeing and to have seen the same thing at the same time and in the same respect'. 'Is any mode of passivity a mode of activity?' 'No'. 'But "he is cut", "he is burnt", "he is struck by some sensible object" are alike in expression and all denote some form of passivity? And again "to say", "to run", "to see" are like one another in expression; but to see is surely a form of being struck by a sensible object; therefore it is at the same time a form of passivity and of activity'. Now if in that case anyone, after granting that it is not possible to do and to have done the same thing at the same time, were to say that it is possible to see and to have seen, still he has not yet been refuted, if he says that to see is not a form of doing but of passivity; for this question is required as well, though he is supposed by the listener to have already granted it, when he granted that to cut is to do something, and to have cut to have done something, and so on with the other things that have a like expression. For the listener adds the rest by himself, thinking the meaning to be alike; whereas really the meaning is not alike, though it appears to be so because of the expression. The same thing happens here as happens in cases of homonymy; for in dealing with homonyms the tyro in argument supposes that the fact and not the name which he affirmed has been denied; whereas there still wants the question whether in mentioning the homonym he had a single thing in view—for if he grants that that was so, the refutation will be effected.

Like the above are also the following arguments. It is asked if a man has lost what he once had and afterwards has not—for a man will no longer have ten dice even though he has only lost one. No: rather it is that he has lost what he had before and has not now; but there is no necessity for him to have lost as much or[31] as many things as he has not now. So then, he asks the questions as to what he has, and draws the conclusion as to what number—for ten is a number. If then he had asked to begin with, whether a man no longer having the number of things he once had has lost that number, no one would have granted it, but would have said 'Either that number or some of them'. Also there is the argument that a man may give what he has not got; for he has not got only one die. But he has given, not what he had not

[31]Reading *ὅσον δὲ μὴ ἔχει ἢ ὅσα*.

got, but in a manner in which he had not got it, viz. just the one. For the word 'only' does not signify a particular substance or quality or quantity, but a manner of
178b1 relation, i.e. that it is not coupled with any other. It is therefore just as if he had asked 'Could a man give what he has not got?' and, on being given the answer 'No', were to ask if a man could give a thing quickly when he had not got it quickly, and, on this being granted, were to deduce that a man could give what he had not got. It is quite evident that he has not deduced his point; for to give quickly is not to give a thing, but to give in a certain manner; and a man could certainly give a thing in a manner in which he has not got it, e.g. he might have got it with pleasure and give it with pain.

Like these are also all arguments of the following kind: Could a man strike a blow with a hand which he has not got, or see with an eye which he has not got?—For he has not got only one eye. Some people solve this case by saying that a man who has more than one eye, or more than one of anything else, also has only one. Others solve it as they solve the argument that what a man has, he has received; for this man gave only one vote; and the other, they say, has only one vote from him. Others, again, proceed by demolishing straightaway the proposition asked, and admitting that it is quite possible to have what one has not received; e.g. to have received sweet wine, but then, owing to its going bad in the course of receipt, to have it sour. But, as was said also above, all these persons direct their solutions against the man, not against his argument. For if this were a solution, then, suppose anyone to grant the opposite, he could find no solution, just as happens in other cases; e.g. suppose the solution to be 'So-and-so is partly so and partly not', then, if you grant it without any qualification, the conclusion follows. If, on the other hand, the conclusion does not follow, then that could not be the solution; and what we say in regard to the foregoing examples is that, even if all the premisses are granted, still no deduction is effected.

Moreover, the following too belong to this group of arguments. 'If something is in writing did some one write it?—But it is now in writing that you are seated—a false statement, though it was true at the time when it was written; therefore the statement that was written is at the same time false and true'. But this is fallacious; for the falsity or truth of a statement or opinion indicates not a substance but a quality (for the same account applies to the case of an opinion as well). Again, 'Is what a learner learns what he learns?—But suppose some one learns what is slow fast'. Then his words denote not what the learner learns but how he learns it. Also, 'Does a man tread upon what he walks through?—But he walks through a whole day'. But the words denote not what he walks through, but when he walks—just as when anyone uses the words 'to drink a cup' he denotes not what he drinks, but what he drinks from. Also, 'Is it either by learning or by discovery that a man knows what he knows?—But if of a pair of things he has discovered one and learned the other, the pair is not known to him by either method'. But it holds of each thing, not of everything. Again, there is the argument that there is a third man distinct from man and from individual men. But 'man', and indeed every general predicate, signifies not an individual, but some quality, or quantity or relation, or something of that sort. Likewise also in the case of 'Coriscus' and 'Coriscus the musician'—are they 179a1 the same or different? For the one signifies an individual and the other a quality, so that it cannot be isolated; though it is not isolation which creates the third man, but the admission that it is an individual. For what man is cannot be an individual, as Callias is. Nor does it make any difference if one says that the element he has isolated is not an individual but a quality; for there will still be the one beside the many, e.g. 'Man'. It is evident then that one must not grant that what is a common predicate applying to a class universally is an individual, but must say that it signifies either a quality, or a relation, or a quantity, or something of that kind.

23 · It is a general rule in dealing with arguments that depend on language that the solution always follows the opposite of the point on which the argument turns: e.g. if the argument depends upon combination, then the solution consists in division; if upon division, then in combination. Again, if it depends on an acute accent, the solution is a grave accent; if on a grave accent, it is an acute. If it depends on homonymy, one can solve it by using the opposite word; e.g. if you find yourself calling something inanimate, despite your previous denial that it was so, show in what sense it is animate; if you have declared it to be inanimate and he has deduced that it is animate, say how it is inanimate. Likewise also in the case of ambiguity. If the argument depends on likeness of expression, the opposite will be the solution. 'Could a man give what he has not got?' No, not what he has not got; but he could give it in a way in which he has not got it, e.g. one die by itself. 'Does a man know either by learning or by discovery each thing that he knows, singly?' Yes, but not the things that he knows. Also a man treads, perhaps, on anything he walks through, but not on the time he walks through. Likewise also in the case of the other examples.

24 · In dealing with arguments that depend on accident, one and the same solution meets all cases. For since it is indeterminate when an attribute should be ascribed to an object, in cases where it belongs to its accident, and since in some cases it is agreed and people admit that it belongs, while in others they deny that it need belong, we should therefore, as soon as the conclusion has been drawn, say in answer to them all alike, that there is no necessity for such an attribute to belong. One must, however, be prepared to adduce an example. All arguments such as the following depend upon accident. 'Do you know what I am going to ask you?' 'Do you know the man who is approaching', or 'the man in the mask?' 'Is the statue your work of art?' or 'Is the dog your father?' 'Is the product of a small number with a small number a small number?' For it is evident in all these cases that there is no necessity for what is true of the accident to be true of the object as well. For only to things that are indistinguishable and one in substance does it seem that all the same attributes belong; whereas in the case of a good thing, to be good is not the same as to be going to be the subject of a question; nor in the case of a man approaching, or 179b1 wearing a mask, is to be approaching the same thing as to be Coriscus, so that if I know Coriscus, but do not know the man who is approaching, it still isn't the case

that I both know and do not know the same man; nor, again, if this is mine and is also a work of art, is it therefore my work of art, but my property or thing or something else. The solution is the same in the other cases as well.

Some solve these by demolishing the question; for they say that it is possible to know and not to know the same thing, only not in the same respect; accordingly, when they don't know the man who is coming towards them, but do know Coriscus, they assert that they do know and don't know the same object, but not in the same respect. But first, as we have already remarked,[32] the correction of arguments that depend upon the same point ought to be the same, whereas this one will not hold if one adopts the same principle in regard not to knowing something, but to being, or to being in a certain state (e.g. it is a father, and is also yours); for if in some cases this is true (and it is possible to know and not to know the same thing), yet with that case the solution stated has nothing to do. There is nothing to prevent the same argument from having a number of flaws; but it is not the exposition of any flaw that constitutes a solution; for it is possible for a man to prove that a false conclusion has been deduced, but not to prove on what it depends, e.g. in the case of Zeno's argument to prove that motion is impossible. So that even if anyone were to try to establish that this is impossible,[33] he still is mistaken, even if he has deduced it ten thousand times over. For this is no solution; for a solution is an exposition of a false deduction, showing on what its falsity depends. If then he has not made a deduction, whether he is trying to establish a true proposition or a false one,[34] to point this out is a solution. The present suggestion may very well apply in some cases; but in these cases, at any rate, not even this would seem to be so; for he knows both that Coriscus is Coriscus and that the approaching figure is approaching. To know and not to know the same thing is thought to be possible, when e.g. one knows that he is white, but does not realize that he is musical; for in that way he does know and not know the same thing, though not in the same respect. But as to the approaching figure and Coriscus he knows both that it is approaching and that it is Coriscus.

A like mistake to that of those whom we have mentioned is that of those who solve the argument that every number is a small number; for if, when the conclusion is not deduced, they pass this over and say that a true conclusion has been deduced, on the ground that every number is both great and small, they make a mistake.

Some people also use the principle of ambiguity to solve the aforesaid deductions, e.g. that he is your father, or son, or slave. Yet it is evident that if the appearance of a refutation depends upon a plurality of uses, the word or the expression in question ought to bear a number of literal senses, whereas no one speaks of someone as being his child in the literal sense, if he is the child's master, but the combination depends upon accident. 'Is he yours?' 'Yes'. 'And is he a child?—Then the child is yours', because he happens to be both yours and a child; but he is not your child.[35]

[32]See 177^{b}31.
[33]Reading *ἀδύνατον* (*δυνατόν* Ross).
[34]Reading *εἴτ᾽ ἀληθὲς εἴτε ψεῦδος*.
[35]Retaining the MSS order.

There is also the argument that what is of evil is good; for wisdom is a knowledge of evils. But that this is of so-and-so does not have a number of uses: it means that it is so-and-so's property. But if it does have a number of uses (for we do say that man is of the animal kingdom, though not their property; and also anything related to evils in a way expressed as being of one is on that account of evil, though it is not of evil), then it seems to depend on whether the term is used relatively or without qualification. Yet it is no doubt possible to find an ambiguity in the phrase 'What is of evil is good' but not with regard to the argument in question, but rather if there is a good slave of the wicked; though perhaps not even there—for a thing may be good and be of so-and-so without being at the same time good of so-and-so. Nor is the saying that man is of the animal kingdom a phrase with a number of uses; for a phrase does not have a number of uses merely if we express it elliptically; for we express 'Give me the Iliad' by quoting half a line of it, e.g. 'Give me "Sing, goddess, of the wrath. . ."'[36]

25 · Those arguments which depend upon an expression that holds properly of a particular thing, or in a particular respect, or place, or manner, or relation, and not without qualification, should be solved by considering the conclusion in relation to its contradictory, to see if any of these things can possibly have happened to it. For it is impossible for contraries and opposites and an affirmative and a negative to belong to the same thing without qualification; there is, however, nothing to prevent each from belonging in a particular respect or relation or manner, or to prevent one of them from belonging in a particular respect and the other without qualification. So that if this one belongs without qualification and that one in a particular respect, there is as yet no refutation. This is a feature one has to find in the conclusion by examining it in comparison with its contradictory.

All arguments of the following kind have this feature: 'Is it possible for what is not to be?—But it *is* something, despite its not being'. Likewise also, what is will not be; for it will not be some particular being. 'Is it possible for the same man at the same time to be a keeper and a breaker of his oath?' 'Can the same man at the same time both obey and disobey the same man?' Or are being something and being not the same? (For it is not the case that what is not, even if it is something, is without qualification.) Nor if a man keeps his oath in this particular instance or in this particular respect, is he bound also to be a keeper of oaths (for he who swears that he will break his oath, and then breaks it, keeps this particular oath only; he is not a keeper of his oath); nor is the disobedient man obedient, though he obeys one particular command. The argument is similar for the problem whether the same man can at the same time say what is false and what is true; but it appears to be a troublesome question because it is not easy to see whether it is saying what is true or saying what is false which should be stated without qualification. There is, however, nothing to prevent him from being a liar without qualification, but truthful in some particular respect or relation, or there being truth in some of the things he says,

[36]The arguments discussed in this paragraph turn on the various functions of the genitive case in Greek: they have no natural translation into an uninflected language.

though he himself is not truthful. Likewise also in cases of relation and place and time. For all arguments of the following kind depend upon this. 'Is health, or wealth, a good thing?—But to the fool who does not use it aright it is not a good thing; therefore it is both good and not good'. 'Is health, or political power, a good thing?[37]—But sometimes it is not particularly good; therefore the same thing is both good and not good to the same man'. But there is nothing to prevent a thing, though good without qualification, being not good to a particular man, or being good to a particular man, and yet not good now or here. 'Is that which the prudent man would not wish, an evil?—But he would not wish to lose the good; therefore the good is an evil'. But it is not the same thing to say that the good is an evil and to lose the good is an evil. Similarly with the argument of the thief: for it is not the case that if the thief is an evil thing, acquiring things is also evil; what he wishes, therefore, is not what is evil but what is good; for to acquire is good. Also, disease is an evil thing, but not to get rid of disease. 'Is the just preferable to the unjust, and what takes place justly to what takes place unjustly?—But to be put to death unjustly is preferable'. 'Is it just that each should have his own?—But whatever decisions a man comes to on the strength of his own opinion, even if it is false, are valid in law; therefore the same result is both just and unjust'. Also, 'should one decide in favour of him who says what is just, or of him who says what is unjust?—But it is just for the injured party to say fully the things he has suffered; and these were unjust'. But because to suffer a thing unjustly is preferable, unjust ways are not therefore preferable to just; but just ways are preferable without qualification, though in this particular case the unjust may very well be better than the just. Also, to have one's own is just, while to have what is another's is not just; all the same, the decision in question may very well be a just decision, whatever it is that the opinion of the man who gave the decision supports; for because it is just in this particular case or in this particular manner, it is not also just without qualification. Likewise also, though things are unjust, there is nothing to prevent the *speaking* of them being just; for if to speak of things is just, it does not follow that the things should be just, any more than if to speak of things is of use, the things must be of use. Likewise also in the case of what is just. So that it is not the case that if the things spoken of are unjust, the victory goes to him who speaks unjust things;[38] for he speaks of things that are just to speak of, though without qualification, i.e. to suffer, they are unjust.

181a1 26 · Refutations that depend on the definition of a refutation must, according to the plan sketched above,[39] be met by comparing together the conclusion with its contradictory, and ensuring that it involves the same attribute in the same respect and relation and manner and time. If this additional question is put at the start, you should not admit that it is impossible for the same thing to be both double and not double, but grant that it is possible, only not in such a way as was agreed to constitute a refutation. All the following arguments depend upon a

[37]Retaining ἀγαθόν (βέλτιον Ross).
[38]Retaining νικᾷ (νικᾶται Ross).
[39]See 167a21.

point of that kind. 'Does a man who knows that so-and-so is so-and-so, know the thing? and in the same way for ignorance?—But one who knows that Coriscus is Coriscus might be ignorant of the fact that he is musical, so that he both knows and is ignorant of the same thing'. 'Is a thing four cubits long greater than a thing three cubits long?—But a thing might grow from three to four cubits in length; now what is greater is greater than a less; accordingly the thing in question will be both greater and less than itself in the same respect'.

27 · As to refutations that depend on postulating and assuming the original point, if it is obvious, one should not grant it, even though it is reputable and he is telling the truth. But if it escapes one, then, thanks to the badness of arguments of that kind, one should make one's error recoil upon the questioner, and say that he has brought no argument; for a refutation must be proved independently of the original point. Secondly, one should say that the point was granted under the impression that he intended not to use it as a premiss, but to reason against it, in the opposite way from that adopted in refutations on side issues.

28 · Also, those refutations that draw their conclusion through the consequent you should show up in the course of the argument itself. The mode in which consequents follow is two-fold, either as the universal follows on its particular, as (e.g.) animal follows man (for the claim is made that if this is found with that, then that also is found with this); or else by way of the opposites (for if this follows that, the opposite will follow the opposite). On this latter claim the argument of Melissus depends; for he claims that if that which has come to be has a beginning, that which has not come to be has none, so that if the heavens have not come to be, they are infinite. But that is not so; for the sequence is vice versa.

29 · In the case of refutations whose reasoning depends on some addition, look and see if upon its subtraction the impossibility follows none the less; and then the answerer should point this out, and say that he granted the addition not because he really thought it, but for the sake of the argument, whereas the questioner has not used it for the purpose of his argument at all.

30 · To meet those refutations which make several questions into one, one should draw a distinction between them straightaway at the start. For a question is single if it has a single answer, so that one must not affirm or deny several things of one thing, nor one thing of many, but one of one. But just as in the case of homonyms, an attribute belongs sometimes to both, and sometimes to neither, so that a simple answer does one no harm despite the fact that the question is not simple, so it is in these cases too. Whenever, then, the several attributes belong to the one subject, or the one to the many, the man who gives a simple answer encounters no obstacle even though he has committed this mistake; but whenever an attribute belongs to one subject but not to the other, or a number of attributes belong to a number of subjects, he does. And in one sense both belong to both, while in another sense, again, they do not; so that one must beware of this. Thus (e.g.) in

the following arguments: 'If one thing is good and another evil, it is true to call them good and evil, and likewise to call them neither good nor evil (for each of them has not each character), so that the same thing will be both good and evil and neither good nor evil'. Also, if everything is the same as itself and different from anything else, inasmuch as they are the same not as other things but as themselves, and also different from themselves, the same things must be both the same as and different from themselves. Moreover, 'if what is good becomes evil while what is evil becomes good, then they must both become two. But of two unequal things each is equal to itself, so that they are both equal and unequal to themselves'.

Now these refutations fall into the province of other solutions as well; for 'both' and 'all' have more than one meaning, so that one does not affirm and deny the same thing, except verbally; and this is not what we meant by a refutation. But it is clear that if there is not a single question on a number of points, but the answerer has affirmed or denied one attribute only of one subject only, the impossibility will not come to pass.

31 · With regard to those which draw one into repeating the same thing a number of times, it is clear that one must not grant that predications of relative terms have any meaning in abstraction by themselves, e.g. double apart from double of half, merely on the ground that it figures in it. For ten figures in ten minus one and do in not do, and generally the affirmation in the negation; but for all that, if someone says that this is not white, he does not say that it is white. Double, perhaps, has not even any meaning at all, any more than half; and even if it has a meaning, yet it has not the same meaning as in the combination. Nor is knowledge the same thing in a specific branch of it (suppose it, e.g., to be medical knowledge) as it is in general; for in general it is knowledge of the knowable. In the case of terms that are predicated of the terms through which they are defined, you should say that the term defined is not the same in abstraction as it is in the whole phrase. For 'concave' has a general meaning which is the same in the case of a snub nose, and of a bandy leg, but when added, in the one case to nose, in the other to leg, nothing prevents it from meaning different things; for in the former connexion it means snub and in the latter bandy; and it makes no difference whether you say snub nose or concave nose. Moreover, the expression must not be granted in the nominative case; for it is a falsehood. For snubness is not a concave nose but something (e.g. an affection) belonging to a nose; hence, there is no absurdity in supposing that the snub nose is a nose possessing the concavity that belongs to a nose.

32 · With regard to solecisms, we have previously said[40] what it is that appears to bring them about; the method of their solution will be clear in the course of the arguments themselves. Solecism is the result aimed at in all arguments of the following kind: 'Is a thing truly that which (*τοῦτο ὅ*) you truly call it?—But you call something a stone (*λίθον*); so it is a stone (*λίθον*)'. But calling something a stone is

[40]See 165b20ff. The solecisms Aristotle discusses have no exact English counterparts, for they depend on the inflected nature of Greek.

not saying that which (ὅ) it is, but that which (ὄν) it is, not that (τοῦτο) but that (τοῦτον). Now if someone were to ask 'Is a thing that which (τοῦτον ὄν) you truly call it?' he would not seem to be speaking Greek, any more than if he asked 'Is a thing that which (οὗτος ἦν) you call it?' But if you talk in this way of a log, or of whatever has neither feminine nor masculine signification, there is no difference; and for that reason there is no solecism—e.g. 'A thing is that which you call it, and you call it a log; therefore it is a log'. But 'stone' and 'that (οὗτος)' have masculine designations. Now if someone asks 'Is he (οὗτος) she?', and then again 'Well, isn't he (οὗτος) Coriscus?', and then were to say, 'Then he is she', he has not deduced the solecism, even if 'Coriscus' does signify a 'she', if the answerer does not grant this: this point must be put as an additional question. But if neither is it the fact nor does he grant it, then he has not proved his case either in fact or as against the person he has been questioning. In like manner, then, in the above instance 'that (τοῦτο)' must mean the stone.[41] If, however, this neither is so nor is granted, the conclusion must not be stated; though it follows apparently, because the case of the word, that is really unlike, appears to be like. 'Is it true to say that this is what you call it by name?—But you call it by the name of a shield; therefore this is of a shield'. But 'this' means not of a shield but a shield: of a shield would be the meaning of of this. Nor again if he is what you call him by name, while the name you call him by is Cleon's, is he therefore Cleon's; for he is not Cleon's—for what was said was that he, not his, is what I call him by name. For the question, if put in the latter way, would not even be Greek. 'Do you know this?—But this is he; therefore you know he'. But 'this' has not the same meaning in 'Do you know this?' as in 'This is he'; in the first it stands for an accusative, in the second for a nominative case. 'When you have understanding of anything, do you understand it?—But you have understanding of a stone; therefore you understand of a stone.' But the one phrase is in the genitive, 'of a stone', while the other is in the accusative, 'a stone'[42]; and what was granted was that you understand that, not of that, of which you have understanding, 182b1
so that you understand not of a stone, but the stone.

Thus that arguments of this kind do not deduce a solecism but merely appear to do so, and both why they so appear and how you should meet them, is clear from what has been said.

33 · We must also observe that of all the arguments aforesaid it is easier with some to see why and where the reasoning leads the hearer astray, while with others it is more difficult, though often they are the same arguments as the former. For we must call an argument the same if it depends upon the same point; but the same argument is apt to be thought by some to depend on diction, by others on accident, and by others on something else, because each of them, when worked with different terms, is not equally clear. Accordingly, just as in fallacies that depend on homonymy, which seem to be the silliest form of fallacy, some are clear even to the man in the street (for humorous phrases nearly all depend on diction; e.g. 'The man

[41]Reading τοῦτο for οὗτος.
[42]Reading τούτου for οὗ, and τοῦτον for τοῦτο.

got the cart down from the stand'; and 'Where are you bound?'—'To the yard arm'; and 'Which cow will calve before?' 'Neither, but both behind'; and 'Is the North wind clear?' 'No, indeed; for it has murdered the beggar and the merchant.' 'Is he a Goodenough-King?' 'No, indeed; a Rob-son': and so with the great majority of the rest as well), while others appear to elude the most expert (and it is a symptom of this that they often fight about words, e.g. whether the meaning of being and one is the same in all their applications or different; for some think that being and one mean the same; while others solve the argument of Zeno and Parmenides by asserting that one and being are used in a number of ways), likewise also as regards fallacies of accident and each of the other types, some of the arguments will be easier to see while others are more difficult; also to grasp to which class a fallacy belongs, and whether it is a refutation or not a refutation, is not equally easy in all cases.

An incisive argument is one which produces the greatest perplexity; for this is the one with the sharpest fang. Now perplexity is two-fold, one which occurs in deductions, respecting which of the propositions asked one is to demolish, and the other in contentious arguments, respecting the manner in which one is to express what is propounded. Therefore it is in deductions that the more incisive arguments produce the keenest inquiry. Now a deductive argument is most incisive if from premisses that are as generally accepted as possible it demolishes a conclusion that is as reputable as possible. For the one argument, if the contradictory is changed about, makes all the resulting deductions alike in character; for always from premisses that are reputable it will demolish a conclusion that is just as reputable; and therefore one is bound to feel perplexed. An argument, then, of this kind is the most incisive, viz. the one that puts its conclusion on all fours with the propositions asked; and second comes the one that argues from premisses, all of which are equally convincing; for this will produce an equal perplexity as to what kind of premiss, of those asked, one should demolish. Herein is a difficulty; for one must demolish something, but what one must demolish is uncertain. Of contentious arguments, on the other hand, the most incisive is the one which, in the first place, is characterized by an initial uncertainty whether it has been properly deduced or not; and also whether the solution depends on a false premiss or on the drawing of a distinction; while, of the rest, the second place is held by that whose solution clearly depends upon a distinction or a demolition, and yet it does not reveal clearly which it is of the premisses asked, whose demolition, or the drawing of a distinction within it, will bring the solution about, whether it is on the conclusion or on one of the premisses that this depends.

Now sometimes an argument which has not been properly deduced is silly, if the assumptions are extremely implausible or false; but sometimes it ought not to be held in contempt. For whenever some question is left out, of the kind that concerns both the subject and the nerve of the argument, the reasoning that has both failed to secure this as well, and also failed to deduce, is silly; but when what is omitted is some extraneous question, then it is by no means to be lightly despised, but the argument is quite respectable, though the questioner has not put his questions well.

Just as it is possible to bring a solution sometimes against the argument, at others against the questioner and his mode of questioning, and at others against neither of these, likewise also it is possible to marshal one's questions and deduction both against the thesis, and against the answerer and against the time, whenever the solution requires a longer time to examine than the period available for arguing to the solution.

34 · As to the number, then, and kind of sources whence fallacies arise in discussion, and how we are to prove that our opponent is saying something false and make him utter paradoxes; moreover, by the use of what materials solecism[43] is brought about, and how to question and what is the way to arrange the questions; moreover, as to the question what use is served by all arguments of this kind, and concerning the answerer's part, both as a whole in general, and in particular how to solve arguments and solecisms[44]—on all these things let the foregoing discussion suffice. It remains to recall our original proposal and to bring our discussion to a close with a few words upon it.

Our programme was, then, to discover some faculty of reasoning about any theme put before us from the most reputable premisses that there are. For that is the essential task of the art of dialectic and of examination. Inasmuch, however, as there is annexed to it,[45] on account of its affinity to the art of sophistry, that[46] it can conduct an examination not only dialectically but also with a show of knowledge, we therefore proposed for our treatise not only the aforesaid aim of being able to exact an account of any view, but also the aim of ensuring that in defending an argument we shall defend our thesis in the same manner by means of views as reputable as possible. The reason of this we have explained; for this was why Socrates used to ask questions and not to answer them—for he used to confess that he did not know. We have made clear, in the course of what precedes, the number both of the points with reference to which, and of the materials from which, this will be accomplished, and also from what sources we can become well supplied with these; we have shown, moreover, how to question or arrange the questioning as a whole, and the problems concerning the answers and solutions to be used against the deductions of the questioner. We have also cleared up the problems concerning all other matters that belong to the same inquiry into arguments. In addition to this we have been through the subject of fallacies, as we have already stated above.

That our programme has been adequately completed is clear. But we must not omit to notice what has happened in regard to this inquiry. For in the case of all discoveries the results of previous labours that have been handed down from others have been advanced bit by bit by those who have taken them on, whereas the original discoveries generally make an advance that is small at first though much more useful than the development which later springs out of them. For it may be that in everything, as the saying is, 'the first start is the main part'; and for this

[43]Reading σολοικισμός for συλλογισμός.
[44]Reading σολοικισμούς for συλλογισμούς.
[45]Retaining προσκατασκευάζεται.
[46]Retaining ὡς . . . δύναται.

reason it is the most difficult; for in proportion as it is most potent in its influence, so it is smallest in its compass and therefore most difficult to see—but when this is once discovered, it is easier to add and develop the remainder. This is in fact what has happened in regard to rhetorical speeches and to practically all the other arts; for those who discovered the beginnings of them advanced them in all only a little way, whereas the celebrities of to-day are the heirs (so to speak) of a long succession of men who have advanced them bit by bit, and so have developed them to their present form, Tisias coming next after the first founders, then Thrasymachus after Tisias, and Theodorus next to him, while several people have made their several contributions to it; and therefore it is not to be wondered at that the art has attained considerable dimensions. Of the present inquiry, on the other hand, it was not the case that part of the work had been thoroughly done before, while part had not. Nothing existed at all. For the training given by the paid professors of contentious arguments was like the practice of Gorgias. For he[47] used to hand out rhetorical speeches to be learned by heart, and they handed out speeches in the form of question and answer, which each supposed would cover most of the arguments on either side. And therefore the teaching they gave their pupils was rapid but unsystematic. For they used to suppose that they trained people by imparting to them not the art but its products, as though anyone professing that he would impart a form of knowledge to obviate any pain in the feet, were then not to teach a man the art of shoe-making or the sources whence he can acquire anything of the kind, but were to present him with several kinds of shoes of all sorts—for he has helped him to meet his need, but has not imparted an art to him. Moreover, on the subject of rhetoric there exists much that has been said long ago, whereas on the subject of deduction we had absolutely nothing else of an earlier date to mention, but[48] were kept at work for a long time in experimental researches. If, then, it seems to you after inspection that, such being the situation as it existed at the start, our investigation is in a satisfactory condition compared with the other inquiries that have been developed by tradition, there must remain for all of you, our students, the task of extending us your pardon for the shortcomings of the inquiry, and for the discoveries thereof your warm thanks.

[47]Reading ὁ μέν (Solmsen) for οἱ μέν.
[48]Reading ἄλλο λέγειν ἀλλά (λέγειν ἤ Ross).

PHYSICS

R. P. Hardie and R. K. Gaye

BOOK I

1 · When the objects of an inquiry, in any department, have principles, causes, or elements, it is through acquaintance with these that knowledge and understanding is attained. For we do not think that we know a thing until we are acquainted with its primary causes or first principles, and have carried our analysis as far as its elements. Plainly, therefore, in the science of nature too our first task will be to try to determine what relates to its principles.

The natural way of doing this is to start from the things which are more knowable and clear to us and proceed towards those which are clearer and more knowable by nature; for the same things are not knowable relatively to us and knowable without qualification. So we must follow this method and advance from what is more obscure by nature, but clearer to us, towards what is more clear and more knowable by nature.

Now what is to us plain and clear at first is rather confused masses, the elements and principles of which become known to us later by analysis. Thus we must advance from universals to particulars; for it is a whole that is more knowable to sense-perception, and a universal is a kind of whole, comprehending many things within it, like parts. Much the same thing happens in the relation of the name to the formula. A name, e.g. 'circle', means vaguely a sort of whole: its definition analyses this into particulars. Similarly a child begins by calling all men father, and all women mother, but later on distinguishes each of them.

2 · The principles in question must be either one or more than one. If one, it must be either motionless, as Parmenides and Melissus assert, or in motion, as the physicists hold, some declaring air to be the first principle, others water. If more than one, then either a finite or an infinite plurality. If finite (but more than one), then either two or three or four or some other number. If infinite, then either as Democritus believed one in kind, but differing in shape; or different in kind and even contrary.

A similar inquiry is made by those who inquire into the number of existents; for they inquire whether the ultimate constituents of existing things are one or

TEXT: W. D. Ross, OCT, Oxford, 1950

many, and if many, whether a finite or an infinite plurality. So they are inquiring whether the principle or element is one or many.

Now to investigate whether what exists is one and motionless is not a
185a1 contribution to the science of nature. For just as the geometer has nothing more to say to one who denies the principles of his science—this being a question for a different science or for one common to all—so a man investigating *principles* cannot argue with one who denies their existence. For if what exists is just one, and one in the way mentioned, there is a principle no longer, since a principle must be the principle of some thing or things.

To inquire therefore whether what exists is one in this sense would be like arguing against any other position maintained for the sake of argument (such as the Heraclitean thesis, or such a thesis as that what exists is one man) or like refuting a merely contentious argument—a description which applies to the arguments both of Melissus and of Parmenides: their premisses are false and their conclusions do not follow. Or rather the argument of Melissus is gross and offers no difficulty at all: accept one ridiculous proposition and the rest follows—a simple enough proceeding.

We, on the other hand, must take for granted that the things that exist by nature are, either all or some of them, in motion—which is indeed made plain by induction. Moreover, noone is bound to solve every kind of difficulty that may be raised, but only as many as are drawn falsely from the principles of the science: it is not our business to refute those that do not arise in this way; just as it is the duty of the geometer to refute the squaring of the circle by means of segments, but it is not his duty to refute Antiphon's proof. At the same time the holders of the theory of which we are speaking do incidentally raise physical questions, though nature is not their subject; so it will perhaps be as well to spend a few words on them, especially as the inquiry is not without scientific interest.

The most pertinent question with which to begin will be this: In what sense is it asserted that all things *are* one? For 'is' is used in many ways. Do they mean that all things are substance or quantities or qualities? And, further, are all things *one* substance—one man, one horse, or one soul—or quality and that one and the same—white or hot or something of the kind? These are all very different doctrines and all impossible to maintain.

For if *both* substance and quantity and quality are, then, whether these exist independently of each other or not, what exists will be many.

If on the other hand it is asserted that all things are quality or quantity, then, whether substance exists or not, an absurdity results, if indeed the impossible can properly be called absurd. For none of the others can exist independently except substance; for everything is predicated of substance as subject. Now Melissus says that what exists is infinite. It is then a quantity. For the infinite is in the category of
185b1 quantity, whereas substance or quality or affection cannot be infinite except accidentally, that is, if at the same time they are also quantities. For to define the infinite you must use quantity in your formula, but not substance or quality. If then what exists is both substance and quantity, it is two, not one; if only substance, it is not infinite and has no magnitude; for to have that it will have to be a quantity.

Again, 'one' itself, no less than 'is', is used in many ways, so we must consider in what way the word is used when it is said that the universe is one.

Now we say that the continuous is one or that the indivisible is one, or things are said to be one, when the account of their essence is one and the same, as liquor and drink.

If their One is one in the sense of continuous, it is many; for the continuous is divisible *ad infinitum*.

There is, indeed, a difficulty about part and whole, perhaps not relevant to the present argument, yet deserving consideration on its own account—namely, whether the part and the whole are one or more than one, and in what way they can be one or many, and, if they are more than one, in what way they are more than one. (Similarly with the parts of wholes which are not continuous.) Further, if each of the two parts is indivisibly one with the whole, the difficulty arises that they will be indivisibly one with each other also.

But to proceed: If their One is one as indivisible, nothing will have quantity or quality, and so what exists will not be infinite, as Melissus says—nor, indeed, limited, as Parmenides says; for though the limit is indivisible, the limited is not.

But if all things are one in the sense of having the same definition, like raiment and dress, then it turns out that they are maintaining the Heraclitean doctrine, for it will be the same thing to be good and to be bad, and to be good and to be not good, and so the same thing will be good and not good, and man and horse; in fact, their view will be, not that all things are one, but that they are nothing; and that to be of such-and-such a quality is the same as to be of such-and-such a quantity.

Even the more recent of the ancient thinkers were in a pother lest the same thing should turn out in their hands both one and many. So some, like Lycophron, were led to omit 'is', others to change the mode of expression and say 'the man has been whitened' instead of 'is white', and 'walks' instead of 'is walking', for fear that if they added the word 'is' they should be making the one to *be* many—as if 'one' and 'is' were always used in one and the same way. What is may be many either in definition (for example to be white is one thing, to be musical another, yet the same thing may be both, so the one is many) or by division, as the whole and its parts. On this point, indeed, they were already getting into difficulties and admitted that the one was many—as if there was any difficulty about the same thing being both one and many, provided that these are not opposites; for what is one may be either potentially one or actually one.

3 · If, then, we approach the thesis in this way it seems impossible for all things to be one. Further, the arguments they use to prove their position are not difficult to expose. For both of them reason contentiously—I mean both Melissus and Parmenides. [Their premisses are false and their conclusions do not follow. Or rather the argument of Melissus is gross and offers no difficulty at all: admit one ridiculous proposition and the rest follows—a simple enough proceeding.][1]

[1]The bracketed words are probably wrongly inserted from 185^a9–12.

The fallacy of Melissus is obvious. For he supposes that the assumption 'what has come into being always has a beginning' justifies the assumption 'what has not come into being has no beginning'. Then this also is absurd, that in every case there should be a beginning of the *thing*—not of the time and not only in the case of coming to be *simpliciter* but also in the case of qualitative change—as if change never took place all at once. Again, does it follow that what is, if one, is motionless? Why should it not move, the whole of it within itself, as parts of it do which are unities, e.g. this water? Again, why is qualitative change impossible? But, further, what is cannot be one in form, though it may be in what it is made of. (Even some of the physicists hold it to be one in the latter way, though not in the former.) Man obviously differs from horse in form, and contraries from each other.

The same kind of argument holds good against Parmenides also, besides any that may apply specially to his view: the answer to him being that *this* is not true and *that* does not follow. His assumption that 'is' is used in a single way only is false, because it is used in several. His conclusion does not follow, because if we take only white things, and if 'white' has a single meaning, none the less what is white will be many and not one. For what is white will not be one either in the sense that it is continuous or in the sense that it must be defined in only one way. Whiteness will be different from what has whiteness. Nor does this mean that there is anything that can exist separately, over and above what is white. For whiteness and that which is white differ in definition, not in the sense that they are things which can exist apart from each other. But Parmenides had not come in sight of this distinction.

It is necessary for him, then, to assume not only that 'is' has the same meaning, of whatever it is predicated, but further that it means what *just is* and what is *just one*. For an attribute is predicated of some subject, so that the subject to which 'is' is attributed will not be, as it is something different from being. Something, therefore, which is not will be. Hence what just is will not belong to anything else. For the subject cannot be a *being*, unless 'is' means several things, in such a way that each *is* something. But *ex hypothesi* 'is' means only one thing.

If, then, what just is is not attributed to anything, but other things are attributed to it, how does what just is mean what is rather than what is not? For suppose that what just is is also white, and that being white is not what just is (for being cannot even be attributed to white, since nothing is which is not what just is), it follows that what is white is not—and that not in the sense of not being something or other, but in the sense that it is not at all. Hence what just is is not; for it is true to say that it is white, and we found this to mean what is not. So 'white' must also mean what just is; and then 'is' has more than one meaning.

In particular, then, what is will not have magnitude, if it is what just is. For each of the two parts must *be* in a different way.

What just is is plainly divisible into other things which just are, if we consider the mere nature of a definition. For instance, if man is, what just is, animal and biped must also be what just is. For if not, they must be attributes—and if attributes, attributes either of man or of some other subject. But neither is possible.

For an attribute is either that which may or may not belong to the subject or that in whose definition the subject of which it is an attribute is involved. Thus sitting is an example of a separable attribute, while snubness contains the definition of nose, to which we attribute snubness. Further, the definition of the whole is not contained in the definitions of the contents or elements of the definitory formula; that of man for instance in biped, or that of white man in white. If then this is so, and if biped is supposed to be an attribute of man, it must be either separable, so that man might possibly not be biped, or the definition of man must come into the definition of biped—which is impossible, as the converse is the case.
If, on the other hand, we suppose that biped and animal are attributes not of man but of something else, and are not each of them what just is, then man too will be an attribute of something else. But we must assume that what just is is *not* the attribute of anything, and that the subject of which both biped and animal are predicated is the subject also of the complex. Are we then to say that the universe is composed of indivisibles?

Some thinkers did, in point of fact, give way to both arguments. To the 187a1
argument that all things are one if being means one thing, they conceded that what is not is; to that from bisection, they yielded by positing atomic magnitudes. But obviously it is not true that if being means one thing, and nothing can at the same time both be and not be, there will be nothing which is not; for even if what is not cannot *be* without qualification, there is no reason why it should not be something or other. To say that all things will be one, if there is nothing besides what is itself, is absurd. For who understands 'what is itself' to be anything but some particular thing? But if this is so, there is still nothing to prevent there being many beings, as has been said.

It is, then, clearly impossible for what is to be one in this sense.

4 · The physicists on the other hand have two modes of explanation.

The first set make the underlying body one—either one of the three[2] or something else which is denser than fire and rarer than air—then generate everything else from this, and obtain multiplicity by condensation and rarefaction. (Now these are contraries, which may be generalized into excess and defect. Compare Plato's 'Great and Small'—except that he makes these his matter, the one his form, while the others treat the one which underlies as matter and the contraries as differentiae, i.e. forms.)

The second set assert that the contrarieties are contained in the one and emerge from it by segregation, for example Anaximander and also all those who assert that what is is one and many, like Empedocles and Anaxagoras; for they too produce other things from their mixture by segregation. These differ, however, from each other in that the former imagines a cycle of such changes, the latter a single series. Anaxagoras again made both his homogeneous substances and his contraries infinite, whereas Empedocles posits only the so-called elements.

[2]I.e. water, air, fire.

The theory of Anaxagoras that the principles are infinite was probably due to his acceptance of the common opinion of the physicists that nothing comes into being from what is not. (For this is the reason why they use the phrase 'all things were together' and the coming into being of such and such a kind of thing is reduced to change of quality, while some spoke of combination and separation.) Moreover, the fact that the contraries come into being from each other led them to the conclusion. The one, they reasoned, must have already existed in the other; for since everything that comes into being must arise either from what is or from what is not, and it is impossible for it to arise from what is not (on this point all the physicists agree), they thought that the truth of the alternative necessarily followed, namely that things come into being out of existent things, i.e. out of things already present, but imperceptible to our senses because of the smallness of their bulk. So they assert that everything has been mixed in everything, because they saw everything arising out of everything. But things, as they say, appear different from one another and receive different names according to what is numerically predominant among the innumerable constituents of the mixture. For nothing, they say, is purely and entirely white or black or sweet, or bone or flesh, but the nature of a thing is held to be that of which it contains the most.

Now the infinite *qua* infinite is unknowable, so that what is infinite in multitude or size is unknowable in quantity, and what is infinite in variety of kind is unknowable in quality. But the principles in question are infinite both in multitude and in kind. Therefore it is impossible to know things which are composed of them; for it is when we know the nature and quantity of its components that we suppose we know a complex.

Further, if the parts of a whole may be indefinitely big or small (by parts I mean components into which a whole can be divided and which are actually present in it), it is necessary that the whole thing itself may also be of any size. Clearly, therefore, if it is impossible for an animal or plant to be indefinitely big or small, neither can its parts be such, or the whole will be the same. But flesh, bone, and the like are the parts of animals, and the fruits are the parts of plants. Hence it is obvious that neither flesh, bone, nor any such thing can be of indefinite size in the direction either of the greater or of the less.

Again, according to the theory all such things are already present in one another and do not come into being but are constituents which are separated out, and a thing receives its designation from its chief constituent. Further, anything may come out of anything—water by segregation from flesh and flesh from water. Hence, since every finite body is exhausted by the repeated abstraction of a finite body, it is evident that everything cannot subsist in everything else. For let flesh be extracted from water and again more flesh be produced from the remainder by repeating the process of separation; then, even though the quantity separated out will continually decrease, still it will not fall below a certain magnitude. If, therefore, the process comes to an end, everything will not be in everything else (for there will be no flesh in the remaining water); if on the other hand it does not, and further extraction is always possible, there will be an infinite multitude of finite equal parts in a finite quantity—which is impossible. Another proof may be added: since every body must diminish in size when something is taken from it, and flesh is quantitatively definite in respect both of greatness and smallness, it is clear that from the minimum quantity of flesh no body can be separated out; for the flesh left would be less than the minimum of flesh.

Again, in each of his infinite bodies there would be already present infinite flesh and blood and brain—having a distinct existence, however, from one another,[3] and no less real than the infinite bodies, and each infinite: which is contrary to reason.

The statement that complete separation never will take place is correct enough, though Anaxagoras is not fully aware of what it means. For affections are indeed inseparable. If then colours and states had entered into the mixture, and if separation took place, there would be something white or healthy which was nothing *but* white or healthy, i.e. was not the predicate of a subject. So his Mind absurdly aims at the impossible, if it is supposed to wish to separate them, and it is impossible to do so, both in respect of quantity and of quality—of quantity, because there is no minimum magnitude, and of quality, because affections are inseparable.

Nor is Anaxagoras right about the coming to be of homogeneous bodies. It is true there is a sense in which clay is divided into pieces of clay, but there is another in which it is not. Water and air are, and are generated, from each other, but not in the way in which bricks come from a house and again a house from bricks. And it is better to assume a smaller and finite number of principles, as Empedocles does.

All thinkers then agree in making the contraries principles, both those who describe the universe as one and unmoved (for even Parmenides treats hot and cold as principles under the names of fire and earth) and those too who use the rare and the dense. The same is true of Democritus also, with his plenum and void, both of which exist, he says, the one as being, the other as not being. Again he speaks of differences in position, shape, and order, and these are genera of which the species are contraries, namely, of position, above and below, before and behind; of shape, angular and angle-less, straight and round.

It is plain then that they all in one way or another identify the contraries with the principles. And with good reason. For first principles must not be derived from one another nor from anything else, while everything has to be derived from them. But these conditions are fulfilled by the primary contraries, which are not derived from anything else because they are primary, nor from each other because they are contraries.

But we must see how this can be arrived at as a reasoned result. Our first presupposition must be that in nature nothing acts on, or is acted on by, any other thing at random, nor may anything come from anything else, unless we mean that it does so accidentally. For how could white come from musical, unless musical

[3]Retaining the MS text; Ross reads: κεχωρισμένα μέντοι ἀπ' ἀλλήλων ⟨οὔ⟩ ('not, however, separated from one another').

happened to be an attribute of the not-white or of the black? No, white comes from 188b1 not-white—and not from *any* not-white, but from black or some intermediate. Similarly, musical comes to be from non-musical, but not from *any* thing other than musical, but from unmusical or any intermediate state there may be.

Nor again do things pass away into the first chance thing; white does not pass into musical (except, it may be, accidentally), but into not-white—and not into any chance thing which is not white, but into black or an intermediate; musical passes into not-musical—and not into any chance thing other than musical, but into unmusical or any intermediate state there may be.

The same holds of other things also: even things which are not simple but complex follow the same principle, but the opposite state has not received a name, so we fail to notice the fact. For what is in tune must come from what is not in tune, and *vice versa*; the tuned passes into untunedness—and not into *any* untunedness, but into the corresponding opposite. It does not matter whether we take attunement, order, or composition for our illustration; the principle is obviously the same in all, and in fact applies equally to the production of a house, a statue, or anything else. A house comes from certain things in a certain state of separation instead of conjunction, a statue (or any other thing that has been shaped) from shapelessness—each of these objects being partly order and partly composition.

If then this is true, everything that comes to be or passes away comes from, or passes into, its contrary or an intermediate state. But the intermediates are derived from the contraries—colours, for instance, from black and white. Everything, therefore, that comes to be by a natural process is either a contrary or a product of contraries.

Up to this point we have practically had most of the other writers on the subject with us, as I have said already; for all of them identify their elements, and what they call their principles, with the contraries, giving no reason indeed for the theory, but constrained as it were by the truth itself. They differ, however, from one another in that some assume contraries which are prior, others contraries which are posterior; some those more knowable in the order of explanation, others those more familiar to sense. For some make hot and cold, or again moist and dry, the causes of becoming; while others make odd and even, or again Love and Strife; and these differ from each other in the way mentioned.

Hence their principles are in one sense the same, in another different; different certainly, as indeed most people think, but the same inasmuch as they are 189a1 analogous; for all are taken from the same table of columns, some of the pairs being wider, others narrower in extent. In this way then their theories are both the same and different, some better, some worse; some, as I have said, take as their contraries what is more knowable in the order of explanation, others what is more familiar to sense. (The universal is knowable in the order of explanation, the particular in the order of sense; for explanation has to do with the universal, sense with the particular.) The great and the small, for example, belong to the former class, the dense and the rare to the latter.

It is clear then that our principles must be contraries.

6 · The next question is whether the principles are two or three or more in number.

One they cannot be; for there cannot be one contrary. Nor can they be innumerable, because, if so, what is will not be knowable; and in any one genus there is only one contrariety, and substance is one genus; also a finite number is sufficient, and a finite number, such as the principles of Empedocles, is better than an infinite multitude; for Empedocles professes to obtain all that Anaxagoras obtains from his innumerable principles. Again, some contraries are prior to others, and some arise from others—for example sweet and bitter, white and black—whereas the principles must always remain principles.

This will suffice to show that the principles are neither one nor innumerable.

Granted, then, that they are a limited number, it is plausible to suppose them more than two. For it is difficult to see how either density should be of such a nature as to act in any way on rarity or rarity on density. The same is true of any other pair of contraries; for Love does not gather Strife together and make things out of it, nor does Strife make anything out of Love, but both act on a third thing different from both. Some indeed assume more than one such thing from which they construct the world of nature.

Other objections to the view that it is not necessary to posit some other nature under the contraries may be added. We do not find that the contraries constitute the substance of any thing. But what is a first principle ought not to be predicated of any subject. If it were, there would be a principle of the supposed principle; for the subject is a principle, and prior presumably to what is predicated of it. Again, we hold that a substance is not contrary to another substance. How then can substance be derived from what are not substances? Or how can non-substance be prior to substance?

If then we accept both the former argument and this one, we must, to preserve both, posit some third thing, such as is spoken of by those who describe the universe 189b1
as one nature—water or fire or what is intermediate between them. What is intermediate seems preferable; for fire, earth, air, and water are already involved with pairs of contraries. There is, therefore, much to be said for those who make the underlying substance different from these four; of the rest, the next best choice is air, as presenting sensible differences in a less degree than the others; and after air, water. All, however, agree in this, that they differentiate their One by means of the contraries, such as density and rarity and more and less, which may of course be generalized, as has already been said, into excess and defect. Indeed this doctrine too (that the One and excess and defect are the principles of things) would appear to be of old standing, though in different forms; for the early thinkers made the two the active and the one the passive principle, whereas some of the more recent maintain the reverse.

To suppose then that the elements are three in number would seem, from these and similar considerations, a plausible view, as I said before. On the other hand, the view that they are more than three in number would seem to be untenable.

For one thing is sufficient to be acted on; but if we have four contraries, there will be two contrarieties, and we shall have to suppose an intermediate nature for each pair separately. If, on the other hand, the contrarieties, being two, can generate from each other, the second contrariety will be superfluous. Moreover, it is impossible that there should be more than one *primary* contrariety. For substance is a single genus of being, so that the principles can differ only as prior and posterior, *not* in genus; for in a single genus there is always a single contrariety, all the other contrarieties in it being held to be reducible to one.

It is clear then that the number of elements is neither one nor more than two or three; but whether two or three is, as I said, a question of considerable difficulty.

7 · We will now give our own account, approaching the question first with reference to becoming in its widest sense; for we shall be following the natural order of inquiry if we speak first of common characteristics, and then investigate the characteristics of special cases.

We say that 'one thing comes to be from another thing, and something from something different, in the case both of simple and of complex things. I mean the following. We can say the man becomes musical, or what is not-musical becomes musical, or the not-musical man becomes a musical man. Now what becomes in the first two cases—man and not-musical—I call *simple,* and what each becomes—musical—simple also. But when we say the not-musical man becomes a musical man, both what becomes and what it becomes are *complex.*

In some cases, we say not only this becomes so-and-so, but also from being this, it comes to be so-and-so (e.g.: from being not-musical he comes to be musical); but we do not say this in all cases, as we do not say from being a man he came to be musical but only the man became musical.

When a simple thing is said to become something, in one case it survives through the process, in the other it does not. For the man remains a man and is such even when he becomes musical, whereas what is not musical or is unmusical does not survive, either simply or combined with the subject.

These distinctions drawn, one can gather from surveying the various cases of becoming in the way we are describing that there must always be an underlying something, namely that which becomes, and that this, though always one numerically, in form at least is not one. (By 'in form' I mean the same as 'in account'.) For to be a man is not the same as to be unmusical. One part survives, the other does not: what is not an opposite survives (for the man survives), but not-musical or unmusical does not survive, nor does the compound of the two, namely the unmusical man.

We speak of 'becoming that from this' instead of 'this becoming that' more in the case of what does not survive the change—'becoming musical from unmusical', not 'from man'—but we sometimes use the latter form of expression even of what survives; we speak of a statue coming to be from bronze, not of the bronze becoming a statue. The change, however, from an opposite which does not survive is described in both ways, 'becoming that from this' or 'this becoming that'. We say both that the unmusical becomes musical, and that from unmusical he becomes musical. And so both forms are used of the complex, 'becoming a musical from an unmusical man', and 'an unmusical man becoming musical'.

Things are said to come to be in different ways. In some cases we do not use the expression 'come to be', but 'come to be so-and-so'. Only substances are said to come to be without qualification.

Now in all cases other than substance it is plain that there must be something underlying, namely, that which becomes. For when a thing comes to be of such a quantity or quality or in such a relation, time,[4] or place, a subject is always presupposed, since substance alone is not predicated of another subject, but everything else of substance.

But that substances too, and anything that can be said to be without qualification, come to be from some underlying thing, will appear on examination. For we find in every case something that underlies from which proceeds that which comes to be; for instance, animals and plants from seed.

Things which come to be without qualification, come to be in different ways: by change of shape, as a statue; by addition, as things which grow; by taking away, as the Hermes from the stone; by putting together, as a house; by alteration, as things which turn in respect of their matter.

It is plain that these are all cases of coming to be from some underlying thing.

Thus, from what has been said, whatever comes to be is always complex. There is, on the one hand, something which comes to be, and again something which becomes that—the latter in two senses, either the subject or the opposite. By the opposite I mean the unmusical, by the subject, man; and similarly I call the absence of shape or form or order the opposite, and the bronze or stone or gold the subject.

Plainly then, if there are causes and principles which constitute natural objects and from which they primarily are or have come to be—have come to be, I mean, what each is said to be in its substance, not what each is accidentally—plainly, I say, everything comes to be from both subject and form. For the musical man is composed in a way of man and musical: you can analyse it into the definitions of its elements. It is clear then that what comes to be will come to be from these elements.

Now the subject is one numerically, though it is two in form. (For there is the man, the gold—in general, the countable matter; for it is more of the nature of a 'this', and what comes to be does not come from it accidentally; the privation, on the other hand, and the contrariety *are* accidental.) And the form is one—the order, the art of music, or any similar predicate.

There is a sense, therefore, in which we must declare the principles to be two, and a sense in which they are three; a sense in which the contraries are the principles—say for example the musical and the unmusical, the hot and the cold, the tuned and the untuned—and a sense in which they are not, since it is impossible

[4]Ross excises 'time'.

for the contraries to be acted on by each other. But this difficulty also is solved by the fact that what underlies is different from the contraries; for it is itself not a contrary. The principles therefore are, in a way, not more in number than the contraries, but as it were two; nor yet precisely two, since there is a difference of being, but three. For to be man is different from to be unmusical, and to be unformed from to be bronze.

We have now stated the number of the principles of natural objects which are subject to generation, and how the number is reached; and it is clear that there must be something underlying the contraries, and that the contraries must be two. (Yet in another way of putting it this is not necessary, as one of the contraries will serve to effect the change by its absence and presence.)

The underlying nature can be known by analogy. For as the bronze is to the statue, the wood to the bed, or the matter and[5] the formless before receiving form to any thing which has form, so is the underlying nature to substance, i.e. the 'this' or existent.

This then is one principle (though not one or existent in the same sense as the 'this'); one is the form or definition;[6] then further there is its contrary, the privation. In what sense these are two, and in what sense more, has been stated above. We explained first that only the contraries were principles, and later that something else underlay them, and that the principles were three; our last statement has elucidated the difference between the contraries, the mutual relation of the principles, and the nature of what underlies. Whether the form or what underlies is the substance is not yet clear. But that the principles are three, and in what sense, and the way in which each is a principle, is clear.

So much then for the question of the number and the nature of the principles.

8 · We will now proceed to show that the difficulty of the early thinkers, as well as our own, is solved in this way alone.

The first of those who studied philosophy were misled in their search for truth and the nature of things by their inexperience, which as it were thrust them into another path. So they say that none of the things that are either comes to be or passes out of existence, because what comes to be must do so either from what is or from what is not, both of which are impossible. For what is cannot come to be (because it *is* already), and from what is not nothing could have come to be (because something must be underlying). So too they exaggerated the consequence of this, and went so far as to deny even the *existence* of a plurality of things maintaining that only what is itself is. Such then was their opinion, and such the reason for its adoption.

Our explanation on the other hand is that for something to come to be from what is or from what is not, or what is not or what is to do something or have something done to it or become some particular thing, are in one way no different

[5]Ross omits 'the matter and'.
[6]Reading *μία τὸ εἶδος ἢ ὁ λόγος* (Bonitz).

from a doctor doing something or having something done to him, or being or becoming something from being a doctor. These expressions may be taken in two ways, and so too, clearly, may 'from what is', and 'what is acts or is acted on'. A doctor builds a house, not *qua* doctor, but *qua* housebuilder, and turns gray, not *qua* doctor, but *qua* dark-haired. On the other hand he doctors or fails to doctor *qua* doctor. But we are using words most appropriately when we say that a doctor does something or undergoes something, or becomes something from being a doctor, if he does, undergoes, or becomes *qua* doctor. Clearly then also to come to be so-and-so from what is not means '*qua* what is not'.

It was through failure to make this distinction that those thinkers gave the matter up, and through this error that they went so much farther astray as to suppose that nothing else comes to be or exists apart from what is itself, thus doing away with all becoming.

We ourselves are in agreement with them in holding that nothing can be said without qualification to come from what is not. But nevertheless we maintain that a thing may come to be from what is not in a qualified sense, i.e. accidentally. For a thing comes to be from the privation, which in its own nature is something which is not—this not surviving as a constituent of the result. Yet this causes surprise, and it is thought impossible that something should come to be in the way described from what is not.

In the same way we maintain that nothing comes to be from what is, and that what is does not come to be except accidentally. In that way, however, it does, just as animal might come to be from animal, and an animal of a certain kind from an animal of a certain kind. Thus, suppose a dog to come to be from a dog, or a horse from a horse. The dog would then, it is true, come to be from animal (as well as from an animal of a certain kind) but not as *animal*, for that is already there. But if anything is to become an animal, *not* accidentally, it will not be from animal; and if what is, not from what is—nor from what is not either, for it has been explained that by 'from what is not' we mean *qua* what is not.

Note further that we do not subvert the principle that everything either is or is not.

This then is one way of solving the difficulty. Another consists in pointing out that the same things can be spoken of in terms of potentiality and actuality. But this has been done with greater precision elsewhere.[7]

So, as we said, the difficulties which constrain people to deny the existence of some of the things we mentioned are now solved. For it was this reason which also caused some of the earlier thinkers to turn so far aside from the road which leads to coming to be and passing away and change generally. If they had come in sight of this nature, all their ignorance would have been dispelled.

9 · Others, indeed, have apprehended the nature in question, but not adequately.

[7]See *Metaphysics* Δ 7, and Θ.

In the first place they allow that a thing may come to be without qualification from what is not, accepting on this point the statement of Parmenides. Secondly, they think that if it is one numerically, it must have also only a single potentiality—which is a very different thing.

Now we distinguish matter and privation, and hold that one of these, namely the matter, accidentally is not, while the privation in its own nature is not; and that the matter is nearly, in a sense *is*, substance, while the privation in no sense is. They, on the other hand, identify their Great and Small alike with what is not, and that whether they are taken together as one or separately. Their triad is therefore of quite a different kind from ours. For they got so far as to see that there must be some underlying nature, but they make it one—for even if one philosopher[8] makes a dyad of it, which he calls Great and Small, the effect is the same; for he overlooked the other nature. For the one which persists is a joint cause, with the form, of what comes to be—a mother, as it were. But the other part of the contrariety may often seem, if you concentrate your attention on it as an evil agent, not to exist at all.

For admitting that there is something divine, good, and desirable, we hold that there are two other principles, the one contrary to it, the other such as of its own nature to desire and yearn for it. But the consequence of their view is that the contrary desires its own extinction. Yet the form cannot desire itself, for it is not defective; nor can the contrary desire it, for contraries are mutually destructive. The truth is that what desires the form is matter, as the female desires the male and the ugly the beautiful—only the ugly or the female not in itself but accidentally.

The matter comes to be and ceases to be in one sense, while in another it does not. As that which contains the privation, it ceases to be in its own nature; for what ceases to be—the privation—is contained within it. But as potentiality it does not cease to be in its own nature, but is necessarily outside the sphere of becoming and ceasing to be. For if it came to be, something must have existed as a primary substratum from which it should come and which should persist in it; but this is its own very nature, so that it will be before coming to be. (For my definition of matter is just this—the primary substratum of each thing, from which it comes to be, and which persists in the result, not accidentally.) And if it ceases to be it will pass into that at the last, so it will have ceased to be before ceasing to be.

The accurate determination of the first principle in respect of form, whether it is one or many and what it is or what they are, is the province of first philosophy; so these questions may stand over till then. But of the natural, i.e. perishable, forms we shall speak in the expositions which follow.

The above, then, may be taken as sufficient to establish that there are principles and what they are and how many there are. Now let us make a fresh start and proceed.

[8] I.e. Plato.

BOOK II

1 · Of things that exist, some exist by nature, some from other causes. By nature the animals and their parts exist, and the plants and the simple bodies (earth, fire, air, water)—for we say that these and the like exist by nature.

All the things mentioned plainly differ from things which are *not* constituted by nature. For each of them has within itself a principle of motion and of stationariness (in respect of place, or of growth and decrease, or by way of alteration). On the other hand, a bed and a coat and anything else of that sort, *qua* receiving these designations—i.e. in so far as they are products of art—have no innate impulse to change. But in so far as they happen to be composed of stone or of earth or of a mixture of the two, they *do* have such an impulse, and just to that extent—which seems to indicate that nature is a principle or cause of being moved and of being at rest in that to which it belongs primarily, in virtue of itself and not accidentally.

I say 'not accidentally', because (for instance) a man who is a doctor might himself be a cause of health to himself. Nevertheless it is not in so far as he is a patient that he possesses the art of medicine: it merely has happened that the same man is doctor and patient—and that is why these attributes are not always found together. So it is with all other artificial products. None of them has in itself the principle of its own production. But while in some cases (for instance houses and the other products of manual labour) that principle is in something else external to the thing, in others—those which may cause a change in themselves accidentally—it lies in the things themselves (but not in virtue of what they are).

Nature then is what has been stated. Things have a nature which have a principle of this kind. Each of them is a substance; for it is a subject, and nature is always in a subject.

The term 'according to nature' is applied to all these things and also to the attributes which belong to them in virtue of what they are, for instance the property of fire to be carried upwards—which is not a nature nor has a nature but is by nature or according to nature.

What nature is, then, and the meaning of the terms 'by nature' and 'according to nature', has been stated. *That* nature exists, it would be absurd to try to prove; for it is obvious that there are many things of this kind, and to prove what is obvious by what is not is the mark of a man who is unable to distinguish what is self-evident from what is not. (This state of mind is clearly possible. A man blind from birth might reason about colours.) Presumably therefore such persons must be talking about words without any thought to correspond.

Some identify the nature or substance of a natural object with that immediate constituent of it which taken by itself is without arrangement, e.g. the wood is the nature of the bed, and the bronze the nature of the statue.

As an indication of this Antiphon points out that if you planted a bed and the rotting wood acquired the power of sending up a shoot, it would not be a bed that would come up, but *wood* which shows that the arrangement in accordance with the rules of the art is merely an accidental attribute, whereas the substance is the other, which, further, persists continuously through the process.

But if the material of each of these objects has itself the same relation to something else, say bronze (or gold) to water, bones (or wood) to earth and so on, *that* (they say) would be their nature and substance. Consequently some assert earth, others fire or air or water or some or all of these, to be the nature of the things that are. For whatever any one of them supposed to have this character—whether one thing or more than one thing—this or these he declared to be the whole of substance, all else being its affections, states, or dispositions. Every such thing they held to be eternal (for it could not pass into anything else), but other things to come into being and cease to be times without number.

This then is one account of nature, namely that it is the primary underlying matter of things which have in themselves a principle of motion or change.

Another account is that nature is the shape or form which is specified in the definition of the thing.

For the word 'nature' is applied to what is according to nature and the natural in the same way as 'art' is applied to what is artistic or a work of art. We should not say in the latter case that there is anything artistic about a thing, if it is a bed only potentially, not yet having the form of a bed; nor should we call it a work of art. The same is true of natural compounds. What is potentially flesh or bone has not yet its own nature, and does not exist by nature, until it receives the form specified in the definition, which we name in defining what flesh or bone is. Thus on the second account of nature, it would be the shape or form (not separable except in statement) of things which have in themselves a principle of motion. (The combination of the two, e.g. man, is not nature but by nature.)

The form indeed is nature rather than the matter; for a thing is more properly said to be what it is when it exists in actuality than when it exists potentially. Again man is born from man but not bed from bed. That is why people say that the shape is not the nature of a bed, but the wood is—if the bed sprouted, not a bed but wood would come up. But even if the shape *is* art,[9] then on the same principle the shape of man is his nature. For man is born from man.

Again, nature in the sense of a coming-to-be proceeds towards nature. For it is not like doctoring, which leads not to the art of doctoring but to health. Doctoring must start from the art, not lead to it. But it is not in this way that nature is related to nature. What grows *qua* growing grows from something into something. Into what then does it grow? Not into that from which it arose but into that to which it tends. The shape then is nature.

Shape and nature are used in two ways. For the privation too is in a way form. But whether in unqualified coming to be there is privation, i.e. a contrary, we must consider later.

2 · We have distinguished, then, the different ways in which the term 'nature' is used.

[9] Reading τέχνη, with the MSS, for Ross' φύσις.

The next point to consider is how the mathematician differs from the student of nature; for natural bodies contain surfaces and volumes, lines and points, and these are the subject-matter of mathematics.

Further, is astronomy different from natural science or a department of it? It seems absurd that the student of nature should be supposed to know the nature of sun or moon, but not to know any of their essential attributes, particularly as the writers on nature obviously do discuss their shape and whether the earth and the world are spherical or not.

Now the mathematician, though he too treats of these things, nevertheless does not treat of them as the limits of a natural body; nor does he consider the attributes indicated as the attributes of such bodies. That is why he separates them; for in thought they are separable from motion, and it makes no difference, nor does any falsity result, if they are separated. The holders of the theory of Forms do the same, though they are not aware of it; for they separate the objects of natural science, which are less separable than those of mathematics. This becomes plain if one tries to state in each of the two cases the definitions of the things and of their attributes. Odd and even, straight and curved, and likewise number, line, and figure, do not involve motion; not so flesh and bone and man—*these* are defined like snub nose, not like curved.

Similar evidence is supplied by the more natural of the branches of mathematics, such as optics, harmonics, and astronomy. These are in a way the converse of geometry. While geometry investigates natural lines but not *qua* natural, optics investigates mathematical lines, but *qua* natural, not *qua* mathematical.

Since two sorts of thing are called nature, the form and the matter, we must investigate its objects as we would the essence of snubness, that is neither independently of matter nor in terms of matter only. Here too indeed one might raise a difficulty. Since there are two natures, with which is the student of nature concerned? Or should he investigate the combination of the two? But if the combination of the two, then also each severally. Does it belong then to the same or to different sciences to know each severally?

If we look at the ancients, natural science would seem to be concerned with the *matter*. (It was only very slightly that Empedocles and Democritus touched on form and essence.)

But if on the other hand art imitates nature, and it is the part of the same discipline to know the form and the matter up to a point (e.g. the doctor has a knowledge of health and also of bile and phlegm, in which health is realized and the builder both of the form of the house and of the matter, namely that it is bricks and beams, and so forth): if this is so, it would be the part of natural science also to know nature in both its senses.

Again, that for the sake of which, or the end, belongs to the same department of knowledge as the means. But the nature is the end or that for the sake of which. For if a thing undergoes a continuous change toward some end, that last stage[10] is actually that for the sake of which. (That is why the poet was carried away into

[10]Reading τοῦτο ἔσχατον.

making an absurd statement when he said 'he has the end for the sake of which he was born'. For not every stage that is last claims to be an end, but only that which is best.)

For the arts make their material (some simply make it, others make it serviceable), and we use everything as if it was there for our sake. (We also are in a sense an end. 'That for the sake of which' may be taken in two ways, as we said in our work *On Philosophy*.) The arts, therefore, which govern the matter and have knowledge are two, namely the art which uses the product and the art which directs the production of it. That is why the using art also is in a sense directive; but it differs in that it knows the form,[11] whereas the art which is directive as being concerned with production knows the matter. For the helmsman knows and prescribes what sort of form a helm should have, the other from what wood it should be made and by means of what operations. In the products of art, however, we make the material with a view to the function, whereas in the products of nature the matter is there all along.

Again, matter is a relative thing—for different forms there is different matter.

How far then must the student of nature know the form or essence? Up to a point, perhaps, as the doctor must know sinew or the smith bronze (i.e. until he understands the purpose of each);[12] and the student of nature is concerned only with things whose forms are separable indeed, but do not exist apart from matter. Man is begotten by man and by the sun as well. The mode of existence and essence of the separable it is the business of first philosophy to define.

3 · Now that we have established these distinctions, we must proceed to consider causes, their character and number. Knowledge is the object of our inquiry, and men do not think they know a thing till they have grasped the 'why' of it (which is to grasp its primary cause). So clearly we too must do this as regards both coming to be and passing away and every kind of natural change, in order that, knowing their principles, we may try to refer to these principles each of our problems.

In one way, then, that out of which a thing comes to be and which persists, is called a cause, e.g. the bronze of the statue, the silver of the bowl, and the genera of which the bronze and the silver are species.

In another way, the form or the archetype, i.e. the definition of the essence, and its genera, are called causes (e.g. of the octave the relation of 2:1, and generally number), and the parts in the definition.

Again, the primary source of the change or rest; e.g. the man who deliberated is a cause, the father is cause of the child, and generally what makes of what is made and what changes of what is changed.

Again, in the sense of end or that for the sake of which a thing is done, e.g. health is the cause of walking about. ('Why is he walking about?' We say: 'To be

[11] Omitting ἡ ἀρχιτεκτονική.
[12] Reading μέχρι του· τίνος γάρ (Jaeger).

healthy', and, having said that, we think we have assigned the cause.) The same is true also of all the intermediate steps which are brought about through the action of something else as means towards the end, e.g. reduction of flesh, purging, drugs, or surgical instruments are means towards health. All these things are for the sake of the end, though they differ from one another in that some are activities, others instruments.

This then perhaps exhausts the number of ways in which the term 'cause' is used.

As things are called causes in many ways, it follows that there are several causes of the same thing (not merely accidentally), e.g. both the art of the sculptor and the bronze are causes of the statue. These are causes of the statue *qua* statue, not in virtue of anything else that it may be—only not in the same way, the one being the material cause, the other the cause whence the motion comes. Some things cause each other reciprocally, e.g. hard work causes fitness and *vice versa*, but again not in the same way, but the one as end, the other as the principle of motion. Further the same thing is the cause of contrary results. For that which by its presence brings about one result is sometimes blamed for bringing about the contrary by its absence. Thus we ascribe the wreck of a ship to the absence of the pilot whose presence was the cause of its safety.

All the causes now mentioned fall into four familiar divisions. The letters are the causes of syllables, the material of artificial products, fire and the like of bodies, the parts of the whole, and the premisses of the conclusion, in the sense of 'that from which'. Of these pairs the one set are causes in the sense of what underlies, e.g. the parts, the other set in the sense of essence—the whole and the combination and the form. But the seed and the doctor and the deliberator, and generally the maker, are all sources whence the change or stationariness originates, which the others are causes in the sense of the end or the good of the rest; for that for the sake of which tends to be what is best and the end of the things that lead up to it. (Whether we call it good or apparently good makes no difference.)

Such then is the number and nature of the kinds of cause.

Now the modes of causation are many, though when brought under heads they too can be reduced in number. For things are called causes in many ways and even within the same kind one may be prior to another: e.g. the doctor and the expert are causes of health, the relation 2:1 and number of the octave, and always what is inclusive to what is particular. Another mode of causation is the accidental and its genera, e.g. in one way Polyclitus, in another a sculptor is the cause of a statue, because being Polyclitus and a sculptor are accidentally conjoined. Also the classes in which the accidental attribute is included; thus a man could be said to be the cause of a statue or, generally, a living creature. An accidental attribute too may be more or less remote, e.g. suppose that a pale man or a musical man were said to be the cause of the statue.

All causes, both proper and accidental, may be spoken of either as potential or as actual; e.g. the cause of a house being built is either a house-builder or a house-builder building.

Similar distinctions can be made in the things of which the causes are causes, e.g. of this statue or of a statue or of an image generally, of this bronze or of bronze or of material generally. So too with the accidental attributes. Again we may use a complex expression for either and say, e.g., neither 'Polyclitus' nor a 'sculptor' but 'Polyclitus, the sculptor'.

All these various uses, however, come to six in number, under each of which again the usage is twofold. It is either what is particular or a genus, or an accidental attribute or a genus of that, and these either as a complex or each by itself; and all either as actual or as potential. The difference is this much, that causes which are actually at work and particular exist and cease to exist simultaneously with their effect, e.g. this healing person with this being-healed person and that housebuilding man with that being-built house; but this is not always true of potential causes—the house and the housebuilder do not pass away simultaneously.

In investigating the cause of each thing it is always necessary to seek what is most precise (as also in other things): thus a man builds because he is a builder, and a builder builds in virtue of his art of building. This last cause then is prior; and so generally.

Further, generic effects should be assigned to generic causes, particular effects to particular causes, e.g. statue to sculptor, this statue to this sculptor; and powers are relative to possible effects, actually operating causes to things which are actually being effected.

This must suffice for our account of the number of causes and the modes of causation.

4 · But chance and spontaneity are also reckoned among causes: many things are said both to be and to come to be as a result of chance and spontaneity. We must inquire therefore in what manner chance and spontaneity are present among the causes enumerated, and whether they are the same or different, and generally what chance and spontaneity are.

Some people even question whether there are such things or not. They say that
196a1 nothing happens by chance, but that everything which we ascribe to chance or spontaneity has some definite cause, e.g. coming by chance into the market and finding there a man whom one wanted but did not expect to meet is due to one's wish to go and buy in the market. Similarly, in other so-called cases of chance it is always possible, they maintain, to find something which is the cause; but not chance, for if chance were real, it would seem strange indeed, and the question might be raised, why on earth none of the wise men of old in speaking of the causes of generation and decay took account of chance; whence it would seem that they too did not believe that anything is by chance. But there is a further circumstance that is surprising. Many things both come to be and are by chance and spontaneity, and although all know that each of them can be ascribed to some cause (as the old argument said which denied chance), nevertheless they all speak of some of these things as happening by chance and others not. For this reason they ought to have at least referred to the matter in some way or other.

Certainly the early physicists found no place for chance among the causes which they recognized—love, strife, mind, fire, or the like. This is strange, whether they supposed that there is no such thing as chance or whether they thought there is but omitted to mention it—and that too when they sometimes used it, as Empedocles does when he says that the air is not always separated into the highest region, but as it may chance. At any rate he says in his cosmogony that 'it happened to run that way at that time, but it often ran otherwise'.[13] He tells us also that most of the parts of animals came to be by chance.

There are some who actually ascribe this heavenly sphere and all the worlds to spontaneity. They say that the vortex arose spontaneously, i.e. the motion that separated and arranged the universe in its present order. This statement might well cause surprise. For they are asserting that chance is not responsible for the existence or generation of animals and plants, nature or mind or something of the kind being the cause of them (for it is not any chance thing that comes from a given seed but an olive from one kind and a man from another); and yet at the same time they assert that the heavenly sphere and the divinest of visible things arose spontaneously, having no such cause as is assigned to animals and plants. Yet if this is so, it is a fact which deserves to be dwelt upon, and something might well have been said about it. For besides the other absurdities of the statement, it is the more absurd that people should make it when they see nothing coming to be spontaneously in the heavens, but much happening by chance among the things which as they say are not due to chance; whereas we should have expected exactly the opposite.

Others there are who believe that chance is a cause, but that it is inscrutable to human intelligence, as being a divine thing and full of mystery.

Thus we must inquire what chance and spontaneity are, whether they are the same or different, and how they fit into our division of causes.

5 · First then we observe that some things always come to pass in the same way, and others for the most part. It is clearly of neither of these that chance, or the result of chance, is said to be the cause—neither of that which is by necessity and always, nor of that which is for the most part. But as there is a third class of events besides these two—events which all say are by chance—it is plain that there is such a thing as chance and spontaneity; for we know that things of this kind are due to chance and that things due to chance are of this kind.

Of things that come to be, some come to be for the sake of something, others not. Again, some of the former class are in accordance with intention, others not, but both are in the class of things which are for the sake of something. Hence it is clear that even among the things which are outside what is necessary and what is for the most part, there are some in connexion with which the phrase 'for the sake of something' is applicable. (Things that are for the sake of something include whatever may be done as a result of thought or of nature.) Things of this kind, then, when they come to pass accidentally are said to be by chance. For just as a thing is something either in virtue of itself or accidentally, so may it be a cause. For

[13]Frag. 53 Diels-Kranz.

instance, the housebuilding faculty is in virtue of itself a cause of a house, whereas the pale or the musical is an accidental cause. That which is *per se* cause is determinate, but the accidental cause is indeterminable; for the possible attributes of an individual are innumerable. As we said, then, when a thing of this kind comes to pass among events which are for the sake of something, it is said to be spontaneous or by chance. (The distinction between the two must be made later—for the present it is sufficient if it is plain that both are in the sphere of things done for the sake of something.)

Example: A man is engaged in collecting[14] subscriptions for a feast. He would have gone to such and such a place for the purpose of getting the money, if he had known. He actually went there for another purpose, and it was only accidentally that he got his money by going there;[15] and this was not due to the fact that he went there as a rule or necessarily, nor is the end effected (getting the money) a cause present in himself—it belongs to the class of things that are objects of choice and the result of thought. It is when these conditions are satisfied that the man is said to have gone by chance. If he had chosen and gone for the sake of this—if he always or normally went there when he was collecting payments—he would not be said to have gone by chance.

It is clear then that chance is an accidental cause in the sphere of those actions for the sake of something which involve choice. Thought, then, and chance are in the same sphere, for choice implies thought.

It is necessary, no doubt, that the causes of what comes to pass by chance be indefinite; and that is why chance is supposed to belong to the class of the indefinite and to be inscrutable to man, and why it might be thought that, in a way, nothing occurs by chance. For all these statements are correct, as might be expected. Things *do,* in a way, occur by chance, for they occur accidentally and chance is an accidental cause. But it is not the cause without qualification of anything; for instance, a housebuilder is the cause of a house; accidentally, a fluteplayer may be so.

And the causes of the man's coming and getting the money (when he did not come for the sake of that) are innumerable. He may have wished to see somebody or been following somebody or avoiding somebody, or may have gone to see a spectacle. Thus to say that chance is unaccountable is correct. For an account is of what holds always or for the most part, whereas chance belongs to a third type of event. Hence, since causes of this kind are indefinite, chance too is indefinite. (Yet in some cases one might raise the question whether *any* chance fact might be the cause of the chance occurrence, e.g. of health the fresh air or the sun's heat may be the cause, but having had one's hair cut *cannot;* for some accidental causes are more relevant to the effect than others.)

Chance is called good when the result is good, evil when it is evil. The terms 'good fortune' and 'ill fortune' are used when either result is of considerable magnitude. Thus one who comes within an ace of some great evil or great good is said to be fortunate or unfortunate. The mind affirms the presence of the attribute,

[14]Reading *κομιζόμενος*, with one MS, for Ross's *κομιζομένου*.
[15]Omitting *τοῦ κομίσασθαι ἕνεκα* (Bonitz).

ignoring the hair's breadth of difference. Further, it is with reason that good fortune is regarded as unstable; for chance is unstable, as none of the things which result from it can hold always or for the most part.

Both are then, as I have said, accidental causes—both chance and spontaneity—in the sphere of things which are capable of coming to pass not simply, nor for the most part and with reference to such of these as might come to pass for the sake of something.

6 · They differ in that spontaneity is the wider. Every result of chance is from what is spontaneous, but not everything that is from what is spontaneous is from chance.

Chance and what results from chance are appropriate to agents that are capable of good fortune and of action generally. Therefore necessarily chance is in the sphere of actions. This is indicated by the fact that good fortune is thought to be the same, or nearly the same, as happiness, and happiness to be a kind of action, since it is well-doing. Hence what is not capable of action cannot do anything by chance. Thus an inanimate thing or a beast or a child cannot do anything by chance, because it is incapable of choice; nor can good fortune or ill fortune be ascribed to them, except metaphorically, as Protarchus, for example, said that the stones of which altars are made are fortunate because they are held in honour, while their fellows are trodden under foot. Even these things, however, can in a way be affected by chance, when one who is dealing with them does something to them by chance, but not otherwise.

The spontaneous on the other hand is found both in the beasts and in many inanimate objects. We say, for example, that the horse came spontaneously, because, though his coming saved him, he did not come for the sake of safety. Again, the tripod fell spontaneously, because, though it stood on its feet so as to serve for a seat, it did not fall so as to serve for a seat.

Hence it is clear that events which belong to the general class of things that may come to pass for the sake of something, when they come to pass not for the sake of what actually results, and have an external cause, may be described by the phrase 'from spontaneity'. These spontaneous events are said to be from chance if they have the further characteristics of being the objects of choice and happening to agents capable of choice. This is indicated by the phrase 'in vain', which is used when one thing which is for the sake of another, does not result in it.[16] For instance, taking a walk is for the sake of evacuation of the bowels; if this does not follow after walking, we say that we have walked in vain and that the walking was vain. This implies that what is naturally for the sake of an end is in vain, when it does not effect the end for the sake of which it was the natural means—for it would be absurd for a man to say that he had bathed in vain because the sun was not eclipsed, since the one was not done for the sake of the other. Thus the spontaneous is even according to its derivation[17] the case in which the thing itself happens in vain. The stone that struck the man did not fall for the sake of striking him; therefore it fell

[16]Reading *τῷ ἕνεκα ἄλλου ἐκεῖνο οὗ* (Prantl).

[17]'The spontaneous': *τὸ αὐτόματον*; 'the thing itself happens in vain': *αὐτὸ μάτην γένηται*.

spontaneously, because it might have fallen by the action of an agent and for the sake of striking. The difference between spontaneity and what results by chance is greatest in things that come to be by nature; for when anything comes to be contrary to nature, we do not say that it came to be by chance, but by spontaneity. Yet strictly this too is different from the spontaneous proper; for the cause of the latter is external, that of the former internal.

We have now explained what chance is and what spontaneity is, and in what they differ from each other. Both belong to the mode of causation 'source of change', for either some natural or some intelligent agent is always the cause; but in this sort of causation the number of possible causes is infinite.

Spontaneity and chance are causes of effects which, though they might result from intelligence or nature, have in fact been caused by something accidentally. Now since nothing which is accidental is prior to what is *per se,* it is clear that no accidental cause can be prior to a cause *per se*. Spontaneity and chance, therefore, are posterior to intelligence and nature. Hence, however true it may be that the heavens are due to spontaneity, it will still be true that intelligence and nature will be prior causes of this universe and of many things in it besides.

7 · It is clear then that there are causes, and that the number of them is what we have stated. The number is the same as that of the things comprehended under the question 'why'. The 'why' is referred ultimately either, in things which do not involve motion, e.g. in mathematics, to the 'what' (to the definition of straight line or commensurable or the like); or to what initiated a motion, e.g. 'why did they go to war?—because there had been a raid'; or we are inquiring 'for the sake of what?'—'that they may rule'; or in the case of things that come into being, we are looking for the matter. The causes, therefore, are these and so many in number.

Now, the causes being four, it is the business of the student of nature to know about them all, and if he refers his problems back to all of them, he will assign the 'why' in the way proper to his science—the matter, the form, the mover, that for the sake of which. The last three often coincide; for the what and that for the sake of which are one, while the primary source of motion is the same in species as these. For man generates man—and so too, in general, with all things which cause movement by being themselves moved; and such as are not of this kind are no longer inside the province of natural science, for they cause motion not by possessing motion or a source of motion in themselves, but being themselves incapable of motion. Hence there are three branches of study, one of things which are incapable of motion, the second of things in motion, but indestructible, the third of destructible things.

The question 'why', then, is answered by reference to the matter, to the form, and to the primary moving cause. For in respect of coming to be it is mostly in this last way that causes are investigated—'what comes to be after what? what was the primary agent or patient?' and so at each step of the series.

Now the principles which cause motion in a natural way are two, of which one is not natural, as it has no principle of motion in itself. Of this kind is whatever causes movement, not being itself moved, such as that which is completely unchangeable, the primary reality, and the essence of a thing, i.e. the form; for this is the end or that for the sake of which. Hence since nature is for the sake of something, we must know this cause also. We must explain the 'why' in all the senses of the term, namely, that from this that will necessarily result ('from this' either without qualification or for the most part); that this must be so if that is to be so (as the conclusion presupposes the premisses); that this was the essence of the thing; and because it is better thus (not without qualification, but with reference to the substance in each case).

8 · We must explain then first why nature belongs to the class of causes which act for the sake of something; and then about the necessary and its place in nature, for all writers ascribe things to this cause, arguing that since the hot and the cold and the like are of such and such a kind, therefore certain things *necessarily* are and come to be—and if they mention any other cause (one friendship and strife, another mind), it is only to touch on it, and then good-bye to it.

A difficulty presents itself: why should not nature work, not for the sake of something, nor because it is better so, but just as the sky rains, not in order to make the corn grow, but of necessity? (What is drawn up must cool, and what has been cooled must become water and descend, the result of this being that the corn grows.) Similarly if a man's crop is spoiled on the threshing-floor, the rain did not fall for the sake of this—in order that the crop might be spoiled—but that result just followed. Why then should it not be the same with the parts in nature, e.g. that our teeth should come up of necessity—the front teeth sharp, fitted for tearing, the molars broad and useful for grinding down the food—since they did not arise for this end, but it was merely a coincident result; and so with all other parts in which we suppose that there is purpose? Wherever then all the parts came about just what they would have been if they had come to be for an end, such things survived, being organized spontaneously in a fitting way; whereas those which grew otherwise perished and continue to perish, as Empedocles says his 'man-faced oxprogeny' did.[18]

Such are the arguments (and others of the kind) which may cause difficulty on this point. Yet it is impossible that this should be the true view. For teeth and all other natural things either invariably or for the most part come about in a given way; but of not one of the results of chance or spontaneity is this true. We do not ascribe to chance or mere coincidence the frequency of rain in winter, but frequent rain in summer we do; nor heat in summer but only if we have it in winter. If then, it is agreed that things are either the result of coincidence or for the sake of something, and these cannot be the result of coincidence or spontaneity, it follows that they must be for the sake of something; and that such things are all due to nature even the champions of the theory which is before us would agree. Therefore action for an end is present in things which come to be and are by nature.

[18]Frag. 61 Diels-Kranz.

Further, where there is an end, all the preceding steps are for the sake of that. Now surely as in action, so in nature; and as in nature, so it is in each action, if nothing interferes. Now action is for the sake of an end; therefore the nature of things also is so. Thus if a house, e.g., had been a thing made by nature, it would have been made in the same way as it is now by art; and if things made by nature were made not only by nature but also by art, they would come to be in the same way as by nature. The one, then, is for the sake of the other; and generally art in some cases completes what nature cannot bring to a finish, and in others imitates nature. If, therefore, artificial products are for the sake of an end, so clearly also are natural products. The relation of the later to the earlier items is the same in both.

This is most obvious in the animals other than man: they make things neither by art nor after inquiry or deliberation. That is why people wonder whether it is by intelligence or by some other faculty that these creatures work,—spiders, ants, and the like. By gradual advance in this direction we come to see clearly that in plants too that is produced which is conducive to the end—leaves, e.g. grow to provide shade for the fruit. If then it is both by nature and for an end that the swallow makes its nest and the spider its web, and plants grow leaves for the sake of the fruit and send their roots down (not up) for the sake of nourishment, it is plain that this kind of cause is operative in things which come to be and are by nature. And since nature is twofold, the matter and the form, of which the latter is the end, and since all the rest is for the sake of the end, the form must be the cause in the sense of that for the sake of which.

Now mistakes occur even in the operations of art: the literate man makes a mistake in writing and the doctor pours out the wrong dose. Hence clearly mistakes
199b1 are possible in the operations of nature also. If then in art there are cases in which what is rightly produced serves a purpose, and if where mistakes occur there was a purpose in what was attempted, only it was not attained, so must it be also in natural products, and monstrosities will be failures in the purposive effort. Thus in the original combinations the 'ox-progeny', if they failed to reach a determinate end must have arisen through the corruption of some principle, as happens now when the seed is defective.

Further, seed must have come into being first, and not straightway the animals: what was 'undifferentiated first'[19] was seed.

Again, in plants too we find that for the sake of which, though the degree of organization is less. Were there then in plants also olive-headed vine-progeny, like the 'man-headed ox-progeny', or not? An absurd suggestion; yet there must have been, if there were such things among animals.

Moreover, among the seeds anything must come to be at random. But the person who asserts this entirely does away with nature and what exists by nature. For those things are natural which, by a continuous movement originated from an internal principle, arrive at some end: the same end is not reached from every principle; nor any chance end, but always the tendency in each is towards the same end, if there is no impediment.

[19]Empedocles, frag. 62 Diels-Kranz.

The end and the means towards it may come about by chance. We say, for instance, that a stranger has come by chance, paid the ransom, and gone away, when he does so as if he had come for that purpose, though it was not for that that he came. This is accidental, for chance is an accidental cause, as I remarked before. But when an event takes place always or for the most part, it is not accidental or by chance. In natural products the sequence is invariable, if there is no impediment.

It is absurd to suppose that purpose is not present because we do not observe the agent deliberating. Art does not deliberate. If the ship-building art were in the wood, it would produce the same results by nature. If, therefore, purpose is present in art, it is present also in nature. The best illustration is a doctor doctoring himself: nature is like that.

It is plain then that nature is a cause, a cause that operates for a purpose.

9 · As regards what is of necessity, we must ask whether the necessity is hypothetical, or simple as well. The current view places what is of necessity in the process of production, just as if one were to suppose that the wall of a house necessarily comes to be because what is heavy is naturally carried downwards and what is light to the top, so that the stones and foundations take the lowest place, with earth above because it is lighter, and wood at the top of all as being the lightest. Whereas, though the wall does not come to be *without* these, it is not *due* to these, except as its material cause: it comes to be for the sake of sheltering and guarding certain things. Similarly in all other things which involve that for the sake of which: the product cannot come to be without things which have a necessary nature, but it is not due to these (except as its material); it comes to be for an end. For instance, why is a saw such as it is? To effect so-and-so and for the sake of so-and-so. This end, however, cannot be realized unless the saw is made of iron. It is, therefore, necessary for it to be of iron, if we are to have a saw and perform the operation of sawing. What is necessary then, is necessary on a hypothesis, not as an end. Necessity is in the matter, while that for the sake of which is in the definition.

Necessity in mathematics is in a way similar to necessity in things which come to be through the operation of nature. Since a straight line is what it is, it is necessary that the angles of a triangle should equal two right angles. But not conversely; though if the angles are *not* equal to two right angles, then the straight line is not what it is either. But in things which come to be for an end, the reverse is true. If the end is to exist or does exist, that also which precedes it will exist or does exist; otherwise just as there, if the conclusion is not true, the principle will not be true, so here the end or that for the sake of which will not exist. For this too is itself a principle, but of the reasoning, not of the action. (In mathematics the principle is the principle of the reasoning only, as there is no action.) If then there is to be a house, such-and-such things must be made or be there already or exist, or generally the matter relative to the end, bricks and stones if it is a house. But the end is not due to these except as the matter, nor will it come to exist because of them. Yet if they do not exist at all, neither will the house, or the saw—the former in the absence of stones, the latter in the absence of iron—just as in the other case the principles will not be true, if the angles of the triangle are not equal to two right angles.

The necessary in nature, then, is plainly what we call by the name of matter, and the changes in it. Both causes must be stated by the student of nature, but especially the end; for that is the cause of the matter, not *vice versa;* and the end is that for the sake of which, and the principle starts from the definition or essence: as in artificial products, since a house is of such-and-such a kind, certain things must *necessarily* come to be or be there already, or since health is this, these things must necessarily come to be or be there already, so too if man is this, then these; if these, then those. Perhaps the necessary is present also in the definition. For if one defines the operation of sawing as being a certain kind of dividing, then this cannot come about unless the saw has teeth of a certain kind; and these cannot be unless it is of iron. For in the definition too there are some parts that stand as matter.

BOOK III

1 · Nature is a principle of motion and change, and it is the subject of our inquiry. We must therefore see that we understand what motion is; for if it were unknown, nature too would be unknown.

When we have determined the nature of motion, our task will be to attack in the same way the terms which come next in order. Now motion is supposed to belong to the class of things which are continuous; and the infinite presents itself first in the continuous—that is how it comes about that the account of the infinite is often used in definitions of the continuous; for what is infinitely divisible is continuous. Besides these, place, void, and time are thought to be necessary conditions of motion.

Clearly, then, for these reasons and also because the attributes mentioned are common to everything and universal, we must first take each of them in hand and discuss it. For the investigation of special attributes comes after that of the common attributes.

To begin then, as we said, with motion.

Some things are in fulfilment only, others in potentiality and in fulfilment—one being a 'this', another so much, another such and such, and similarly for the other categories of being. The term 'relative' is applied sometimes with reference to excess and defect, sometimes to agent and patient, and generally to what can move and what can be moved. For what can cause movement is relative to what can be moved, and *vice versa*.

There is no such thing as motion over and above the things. It is always with respect to substance or to quantity or to quality or to place that what changes changes. But it is impossible, as we assert, to find anything common to these which is neither 'this' nor quantity nor quality nor any of the other predicates. Hence neither will motion and change have reference to something over and above the things mentioned; for there *is* nothing over and above them.

Now each of these belongs to all its subjects in either of two ways: namely, substance—the one is its form, the other privation; in quality, white and black; in quantity, complete and incomplete. Similarly, in respect of locomotion, upwards and downwards or light and heavy. Hence there are as many types of motion or change as there are of being.

We have distinguished in respect of each class between what is in fulfilment and what is potentially; thus the fulfilment of what is potentially, as such, is motion—e.g. the fulfilment of what is alterable, as alterable, is alteration; of what is increasable and its opposite, decreasable (there is no common name for both), increase and decrease; of what can come to be and pass away, coming to be and passing away; of what can be carried along, locomotion.

That this is what motion is, is clear from what follows: when what is buildable, in so far as we call it such, is in fulfilment, it is being built, and that is building. Similarly with learning, doctoring, rolling, jumping, ripening, aging.

The same thing can be both potential and fulfilled, not indeed at the same time or not in the same respect, but e.g. potentially hot and actually cold. Hence such things will act and be acted on by one another in many ways: each of them will be capable at the same time of acting and of being acted upon. Hence, too, what effects motion as a natural agent can be moved: when a thing of this kind causes motion, it is itself also moved. This, indeed, has led some people to suppose that every mover is moved. But this question depends on another set of arguments, and the truth will be made clear later.[20] It *is* possible for a thing to cause motion, though it is itself incapable of being moved.

It is the fulfilment of what is potential when it is already fulfilled and operates not as itself but as movable, that is motion. What I mean by 'as' is this: bronze is potentially a statue. But it is not the fulfilment of bronze as *bronze* which is motion. For to be bronze and to be a certain potentiality are not the same. If they were identical without qualification, i.e. in definition, the fulfilment of bronze as bronze *would* be motion. But they are not the same, as has been said. (This is obvious in contraries. To be capable of health and to be capable of illness are not the same; for if they were there would be no difference between being ill and being well. Yet the 201ᵇ1
subject both of health and of sickness—whether it is humour or blood—is one and the same.)

We can distinguish, then, between the two—just as colour and visible are different—and clearly it is the fulfilment of what is potential as potential that is motion.

It is evident that this is motion, and that motion occurs just when the fulfilment itself occurs, and neither before nor after. For each thing is capable of being at one time actual, at another not. Take for instance the buildable: the actuality of the buildable as buildable is the process of building. For the actuality must be either this or the house. But when there is a house, the buildable is no longer there. On the other hand, it *is* the buildable which is *being* built. Necessarily, then, the actuality is the process of building. But building is a kind of motion, and the same account will apply to the other kinds also.

[20]See VIII 1–6.

2 · The soundness of this definition is evident both when we consider the accounts of motion that the others have given, and also from the difficulty of defining it otherwise.

One could not easily put motion and change in another genus—this is plain if we consider where some people put it: they identify motion with difference or inequality or not being; but such things are not necessarily moved, whether they are different or unequal or non-existent. Nor is change either to or from *these* rather than to or from their opposites.

The reason why they put motion into these genera is that it is thought to be something indefinite, and the principles in the second column[21] are indefinite because they are privative: none of them is either a 'this' or such or comes under any of the other categories. The reason why motion is thought to be indefinite is that is cannot be classed as a potentiality or as an actuality—a thing that is merely *capable* of having a certain size is not necessarily undergoing change, nor yet a thing that is *actually* of a certain size, and motion is thought to be a sort of *actuality*, but incomplete, the reason for this view being that the potential whose actuality it is is incomplete. This is why it is hard to grasp what motion is. It is necessary to class it with privation or with potentiality or with simple actuality, yet none of these seems possible. There remains then the suggested mode of definition, namely that it is a sort of actuality, or actuality of the kind described, hard to grasp, but not incapable of existing.

Every mover too is moved, as has been said—every mover, that is, which is capable of motion, and whose immobility is rest (for when a thing is subject to motion its immobility is rest). For to act on the movable as such is just to move it. But this it does by contact, so that at the same time it is also acted on. Hence motion is the fulfilment of the movable as movable, the cause being contact with what can move, so that the mover is also acted on. The mover will always transmit a form, either a 'this' or such or so much, which, when it moves, will be the principle and cause of the motion, e.g. the actual man begets man from what is potentially man.

3 · The solution of the difficulty is plain: motion is in the movable. It is the fulfilment of this potentiality by the action of that which has the power of causing motion; and the actuality of that which has the power of causing motion is not other than the actuality of the movable; for it must be the fulfilment of *both*. A thing is capable of causing motion because it *can* do this, it is a mover because it actually *does* it. But it is on the movable that it is capable of acting. Hence there is a single actuality of both alike, just as one to two and two to one are the same interval, and the steep ascent and the steep descent are one—for these are one and the same, although their definitions are not one. So it is with the mover and the moved.

This view has a dialectical difficulty. Perhaps it is necessary that there should be an actuality of the agent and of the patient. The one is agency and the other patiency; and the outcome and end of the one is an action, that of the other a passion. Since then they are both motions, we may ask: *in* what are they, if they are different?

[21]Compare the Pythagorean columns at *Metaphysics* A 5, $986^{a}25$.

Either both are in what is acted on and moved, or the agency is in the agent and the patiency in the patient. (If we ought to call the latter also 'agency', the word would be used in two senses.)

Now, in the latter case, the motion will be in the mover, for the same account will hold of mover and moved. Hence either *every* mover will be moved, or, though having motion, it will not be moved.

If on the other hand both are in what is moved and acted on—both the agency and the patiency (e.g. both teaching and learning, though they are two, in the learner), then, first, the actuality of each will not be present *in* each, and, a second absurdity, a thing will have two motions at the same time. How will there be two alterations of quality in *one* subject towards *one* form? The thing is impossible: the actualization will be one.

But (someone will say) it is contrary to reason to suppose that there should be one identical actualization of two things which are different in kind. Yet there will be, if teaching and learning are the same, and agency and patiency. To teach will be the same as to learn, and to act the same as to be acted on—the teacher will necessarily be learning everything that he teaches, and the agent will be acted on. It is not absurd that the actualization of one thing should be in another. Teaching is the activity of a person who can teach, yet the operation is performed in something—it is not cut adrift from a subject, but is of one thing in another.

There is nothing to prevent two things having one and the same actualization (not the same in being, but related as the potential is to the actual).

Nor is it necessary that the teacher should learn, even if to act and to be acted on are one and the same, provided they are not the same in respect of the account which states their essence (as raiment and dress), but are the same in the sense in which the road from Thebes to Athens and the road from Athens to Thebes are the same, as has been explained above. For it is not things which are in any way the same that have all their attributes the same, but only those to be which is the same. But indeed it by no means follows from the fact that teaching is the same as learning, that to learn is the same as to teach, any more than it follows from the fact that there is one distance between two things which are at a distance from each other, that being here at a distance from there and being there at a distance from here are one and the same. To generalize, teaching is not the same as learning, or agency as patiency, in the full sense, though they belong to the same subject, the motion; for the actualization of this in that and the actualization of that through the action of this differ in definition.

What then motion is, has been stated both generally and particularly. It is not difficult to see how each of its types will be defined—alteration is the fulfilment of the alterable as alterable (or, more scientifically, the fulfilment of what can act and what can be acted on, as such)—generally and again in each particular case, building, healing. A similar definition will apply to each of the other kinds of motion.

4 · The science of nature is concerned with magnitudes and motion and time, and each of these is necessarily infinite or finite, even if some things are not, e.g. a

quality or a point—it is not necessary perhaps that such things should be put under either head. Hence it is incumbent on the person who treats of nature to discuss the infinite and to inquire whether there is such a thing or not, and, if there is, what it is.

203a1 The appropriateness to the science of this problem is clearly indicated; for all who have touched on this kind of science in a way worth considering have formulated views about the infinite, and indeed, to a man, make it a principle of things.

Some, as the Pythagoreans and Plato, make the infinite a principle as a substance in its own right, and not as an accident of some other thing. Only the Pythagoreans place the infinite among the objects of sense (they do not regard number as separable from these), and assert that what is outside the heaven is infinite. Plato, on the other hand, holds that there is no body outside (the Forms are not outside, because they are nowhere), yet that the infinite is present not only in the objects of sense but in the Forms also.

Further, the Pythagoreans identify the infinite with the even. For this, they say, when it is cut off and shut in by the odd, provides things with the element of infinity. An indication of this is what happens with numbers. If the gnomons are placed round the one, and without the one, in the one construction the figure that results is always different, in the other it is always the same. But Plato has two infinites, the Great and the Small.

The physicists, on the other hand, all of them, regard the infinite as an attribute of a substance which is different from it and belongs to the class of the so-called elements—water or air or what is intermediate between them. Those who make them limited in number never make them infinite in amount. But those who make the elements infinite in number, as Anaxagoras and Democritus do, say that the infinite is continuous by contact—compounded of the homogeneous parts according to the one, of the seedmass of the atomic shapes according to the other.

Further, Anaxagoras held that any part is a mixture in the same way as the whole, on the ground of the observed fact that anything comes out of anything. For it is probably for this reason that he maintains that once upon a time all things were together. *This* flesh and *this* bone were together, and so of *any* thing; therefore *all* things—and at the same time too. For there is a principle of separation, not only for each thing, but for all. Each thing that comes to be comes to be from a similar body, and there is a coming to be of all things, though not, it is true, at the same time. Hence there must also be a principle of coming to be. One such source there is which he calls Mind, and Mind begins its work of thinking from some principle. So necessarily all things must have been together at a certain time, and must have begun to be moved at a certain time.

Democritus, for his part, asserts that no element arises from another element.
203b1 Nevertheless for him the common body is a principle of all things, differing from part to part in size and in shape.

It is clear then from these considerations that the inquiry concerns the student of nature. Nor is it without reason that they all make it a principle. We cannot say that the infinite exists in vain, and the only power which we can ascribe to it is that of a principle. For everything is either a principle or derived from a principle. But there cannot be a principle of the infinite, for that would be a limit of it. Further, as it is a principle, it is both uncreatable and indestructible. For there must be a point at which what has come to be reaches its end, and also a termination of all passing away. That is why, as we say, there is no principle of *this,* but it is this which is held to be the principle of other things, and to encompass all and to steer all, as those assert who do not recognize, alongside the infinite, other causes, such as Mind or Friendship. Further they identify it with the Divine, for it is deathless and imperishable as Anaximander says, with the majority of the physicists.

Belief in the existence of the infinite comes mainly from five considerations: From the nature of time—for it is infinite; From the division of magnitudes—for the mathematicians also use the infinite; again, if coming to be and passing away do not give out, it is only because that from which things come to be is infinite; again, because the limited always finds its limit in something, so that there must be no limit, if everything is always limited by something different from itself. Most of all, a reason which is peculiarly appropriate and presents the difficulty that is felt by everybody—not only number but also mathematical magnitudes and what is outside the heaven are supposed to be infinite because they never give out in our thought.

If what is outside is infinite it seems that body also is infinite, and that there is an infinite number of worlds. Why should there be body in one part of the void rather than in another? Grant only that mass is anywhere and it follows that it must be everywhere. Also, if void and place are infinite, there must be infinite body too; for in the case of eternal things what may be is.
But the problem of the infinite is difficult: many contradictions result whether we suppose it to exist or not to exist. If it exists, we have still to ask *how* it exists—as a substance or as the essential attribute of some entity? Or in neither way, yet none the less is there something which is infinite or some things which are infinitely many?

The problem, however, which specially belongs to the physicist is to investigate 204a1
whether there is a sensible magnitude which is infinite.

We must begin by distinguishing the various ways in which the term 'infinite' is used: in one way, it is applied to what is incapable of being gone through, because it is not its nature to be gone through (the way in which the voice is invisible); in another, to what admits of a traversal which cannot be completed, or which can only be completed with difficulty, or what naturally admits of a traversal but does not have a traversal or limit.

Further, everything that is infinite may be so in respect of addition or division or both.

5 · Now it is impossible that the infinite should be a thing which is in itself infinite, separable from sensible objects. If the infinite is neither a magnitude nor an aggregate, but is itself a substance and not an accident, it will be indivisible; for the

divisible must be either a magnitude or an aggregate. But if indivisible, then not infinite, except in the way in which the voice is invisible. But this is not the way in which it is used by those who say that the infinite exists, nor that in which we are investigating it, namely as that which cannot be gone through. But if the infinite is accidental, it would not be, *qua* infinite, an element in things, any more than the invisible would be an element of speech, though the voice is invisible.

Further, how can the infinite be itself something, unless both number and magnitude, of which it is an essential attribute, exist in that way? If they are not substances, *a fortiori* the infinite is not.

It is plain, too, that the infinite cannot be an actual thing and a substance and principle. For any part of it that is taken will be infinite, if it has parts; for to be infinite and the infinite are the same, if it is a substance and not predicated of a subject. Hence it will be either indivisible or divisible into infinites. But the same thing cannot be many infinites. (Yet just as part of air is air, so a part of the infinite would be infinite, if it is supposed to be a substance and principle.) Therefore the infinite must be without parts and indivisible. But this cannot be true of what is infinite in fulfilment; for it must be a definite quantity.

Suppose then that infinity belongs accidentally. But, if so, it cannot, as we have said, be described as a principle, but rather that of which it is an accident—the air or the even number.

Thus the view of those who speak after the manner of the Pythagoreans is absurd. With the same breath they treat the infinite as substance, and divide it into parts.

This discussion, however, involves the more general question whether the infinite can be present in mathematical objects and things which are intelligible and do not have extension. Our inquiry is limited to our special subject-matter, the objects of sense, and we have to ask whether there is or is not among them a body which is infinite in the direction of increase.

We may begin with a dialectical argument and show as follows that there is no such thing.

If 'bounded by a surface' is the definition of body there cannot be an infinite body either intelligible or sensible. Nor can number taken in abstraction be infinite; for number or that which has number is numerable. If then the numerable can be numbered, it would also be possible to go through the infinite.

If, on the other hand, we investigate the question more in accordance with principles appropriate to physics, we are led as follows to the same result.

The infinite can be either compound, or simple.

It will not be compound, if the elements are finite in number. For they must be more than one, and the contraries must always balance, and no *one* of them can be infinite. If one of the bodies falls in any degree short of the other in potency—suppose fire is finite in amount while air is infinite and a given quantity of fire exceeds in power the same amount of air in any ratio provided it is numerically definite—the infinite body will obviously prevail over and annihilate the finite body. On the other hand, it is impossible that *each* should be infinite. Body is what has extension in all directions and the infinite is what is boundlessly extended, so that the infinite body would be extended in all directions *ad infinitum*.

Nor can an infinite body be one and simple, whether it is, as some hold, a thing over and above the elements (from which they generate the elements) or is not thus qualified. There *are* some people who make this the infinite, and not air or water, in order that the other elements may not be annihilated by the element which is infinite. They have contrariety with each other—air is cold, water moist, fire hot; if one were infinite, the others by now would have ceased to be. As it is, they say, the infinite is different from them and is their source.

It is impossible, however, that there should be such a body; not because it is infinite—on that point a general proof can be given which applies equally to all, air, water, or anything else—but because there is no such sensible body, alongside the so-called elements. Everything can be resolved into the elements of which it is composed. Hence the body in question would have been present in our world here, alongside air and fire and earth and water; but nothing of the kind is observed.

Nor can fire or any other of the elements be infinite. For generally, and apart 205a1
from the question how any of them could be infinite, the universe, even, if it were limited, cannot either be or become one of them, as Heraclitus says that at some time all things become fire. (The same argument applies also to the one which the physicists suppose to exist alongside the elements: for everything changes from contrary to contrary, e.g. from hot to cold.)

In each case, we should consider along these lines whether it is or is not possible that it should be infinite. The following arguments give a general demonstration that it is not possible for there to be an infinite sensible body.

It is the nature of every kind of sensible body to be somewhere, and there is a place appropriate to each, the same for the part and for the whole, e.g. for the whole earth and for a single clod, and for fire and for a spark.

Suppose that the infinite sensible body is homogeneous. Then each will be either immovable or always being carried along. Yet neither is possible. For why downwards rather than upwards or in any other direction? I mean, e.g., if you take a clod, where will it be moved or where will it be at rest? For the place of the body akin to it is infinite. Will it occupy the whole place, then? And how? What then will be the nature of its rest and of its movement, or where will they be? It will either be at rest everywhere—then it will not be moved; or it will be moved everywhere—then it will not come to rest.

But if the universe has dissimilar parts, the proper places of the parts will be dissimilar also, and the body of the universe will have no unity except that of contact. Then, further, the parts will be either finite or infinite in variety of kind.

Finite they cannot be; for if the universe is to be infinite, some of them would have to be infinite, while the others were not, e.g. fire or water will be infinite. But such an element would destroy what is contrary to it.

But if the parts are *infinite* in number and simple, their proper places too will be infinite in number, and the same will be true of the elements themselves. If that is impossible, and the places are finite, the whole too must be finite; for the place and the body cannot but fit each other. Neither is the whole place larger than what can be filled by the body (and then the body would no longer be infinite), nor is the body larger than the place; for either there would be an empty space or a body whose nature it is to be nowhere. This indeed is the reason why none of the physicists made fire or earth the one infinite body, but either water or air or what is intermediate between them, because the abode of each of the two was plainly determinate, while the others have an ambiguous place between up and down.

205b1 Anaxagoras gives an absurd account of why the infinite is at rest. He says that the infinite itself is the cause of its being fixed. This because it is *in* itself, since nothing else contains it—on the assumption that wherever anything is, it is there by its own nature. But this is not true: a thing could be somewhere by compulsion, and not where it is its nature to be.

Thus however true it may be that the whole is not moved (for what is fixed by itself and is in itself must be immovable), yet we must explain *why* it is not its nature to be moved. It is not enough just to make this statement and then decamp. For it might be not moving because there is nowhere else for it to move, even though there is no reason why it should not be its nature to be moved. The earth is not carried along, and would not be carried along if it were infinite, provided it is held together by the centre. But it would not be because there was no other region in which it could be carried along that it would remain, but because this is its nature. Yet in this case also we may say that it fixes itself. If then in the case of the earth, supposed to be infinite, it is at rest, not for this reason, but because it has weight and what is heavy rests at the centre and the earth is at the centre, similarly the infinite also would rest in itself, not because it is infinite and fixes itself, but owing to some other cause.

It is clear at the same time that part of the infinite body ought to remain at rest. Just as the infinite remains at rest in itself because it fixes itself, so too any part of it you may take will remain in itself. The appropriate places of the whole and of the part are alike, e.g. of the whole earth and of a clod the appropriate place is the lower region; of fire as a whole and of a spark, the upper region. If, therefore, to be in itself is the place of the infinite, that also will be appropriate to the part. Therefore it will remain in itself.

In general, the view that there is an infinite body is plainly incompatible with the doctrine that there is a proper place for each kind of body, if every sensible body has either weight or lightness, and if a body has a natural locomotion towards the centre if it is heavy, and upwards if it is light. This would need to be true of the infinite also. But neither character can belong to it: it cannot be either as a whole, nor can it be half the one and half the other. For how should you divide it? or how can the infinite have the one part up and the other down, or an extremity and a centre?

Further, every sensible body is in place, and the kinds or differences of place are up-down, before-behind, right-left; and these distinctions hold not only in relation to us and by convention, but also in the whole itself. But in the infinite body
206a1 they cannot exist. In general, if it is impossible that there should be an infinite place, and if every body is in place, there cannot be an infinite body.

Surely what is in a place is somewhere, and what is somewhere is in a place. Just, then, as the infinite cannot be quantity—that would imply that it has a particular quantity, e.g. two or three cubits; quantity just means these—so a thing's being in a place means that it is somewhere, and that is either up or down or in some other of the six differences of position; but each of these is a limit.

It is plain from these arguments that there is no body which is actually infinite.

6 · But on the other hand to suppose that the infinite does not exist in any way leads obviously to many impossible consequences: there will be a beginning and an end of time, a magnitude will not be divisible into magnitudes, number will not be infinite. If, then, in view of the above considerations, neither alternative seems possible, an arbiter must be called in; and clearly there is a sense in which the infinite exists and another in which it does not.

Now things are said to exist both potentially and in fulfilment. Further, a thing is infinite either by addition or by division. Now, as we have seen, magnitude is not actually infinite. But by division it is infinite. (There is no difficulty in refuting the theory of indivisible lines.) The alternative then remains that the infinite has a potential existence.

But we must not construe potential existence in the way we do when we say that it is possible for this to be a statue—this will *be* a statue, but something infinite will not be in actuality. Being is spoken of in many ways, and we say that the infinite is in the sense in which we say it is day or it is the games, because one thing after another is always coming into existence. For of these things too the distinction between potential and actual existence holds. We say that there are Olympic games, both in the sense that they may occur and that they are actually occurring.

The infinite exhibits itself in different ways—in time, in the generations of man, and in the division of magnitudes. For generally the infinite has this mode of existence: one thing is always being taken after another, and each thing that is taken is always finite, but always different. [Again, 'being' is spoken of in several ways, so that we must not regard the infinite as a 'this', such as a man or a horse, but must suppose it to exist in the sense in which we speak of the day or the games as existing—things whose being has not come to them like that of a substance, but consists in a process of coming to be or passing away, finite, yet always different.][22]

But in spatial magnitudes, what is taken persists, while in the succession of 206b1
time and of men it takes place by the passing away of these in such a way that the source of supply never gives out.

In a way the infinite by addition is the same thing as the infinite by division. In a finite magnitude, the infinite by addition comes about in a way inverse to that of the other. For just as we see division going on *ad infinitum*, so we see addition being made in the same proportion to what is already marked off. For if we take a

[22]Ross excises the bracketed sentence as an alternative version of 206a18-29.

determinate part of a finite magnitude and add another part determined by the same ratio (not taking in the same amount of the original whole), we shall not traverse the given magnitude. But if we increase the ratio of the part, so as always to take in the same amount, we shall traverse the magnitude; for every finite magnitude is exhausted by means of any determinate quantity however small.

The infinite, then, exists in no other way, but in this way it does exist, potentially and by reduction. It exists in fulfillment in the sense in which we say 'it is day' or 'it is the games'; and potentially as matter exists, not independently as what is finite does.

By addition then, also, there is potentially an infinite, namely, what we have described as being in a sense the same as the infinite in respect of division. For it will always be possible to take something *ab extra*. Yet the sum of the parts taken will not exceed every determinate magnitude, just as in the direction of division every determinate magnitude is surpassed and there will always be a smaller part.

But in respect of addition there cannot even potentially be an infinite which exceeds every assignable magnitude, unless it is accidentally infinite in fulfillment, as the physicists hold to be true of the body which is outside the world, whose substance is air or something of the kind. But if there cannot be in this way a sensible body which is infinite in fulfilment, evidently there can no more be a body which is potentially infinite in respect of addition, except as the inverse of the infinite by division, as we have said. It is for this reason that Plato also made the infinites two in number, because it is supposed to be possible to exceed all limits and to proceed *ad infinitum* in the direction both of increase and of reduction. Yet though he makes the infinites two, he does not use them. For in the numbers the infinite in the direction of reduction is not present, as the monad is the smallest; nor is the infinite in the direction of increase, for he makes numbers only up to the decad.

The infinite turns out to be the contrary of what it is said to be. It is not what
207a1 has nothing outside it that is infinite, but what always has something outside it. This is indicated by the fact that rings also that have no bezel are described as infinite,[23] because it is always possible to take a part which is outside a given part. The description depends on a certain similarity, but it is not true in the full sense of the word. This condition alone is not sufficient: it is necessary also that the same part should never be taken twice. In the circle, the latter condition is not satisfied: it is true only that the next part is always different.

Thus something is infinite if, taking it quantity by quantity, we can always take something outside. On the other hand, what has nothing outside it is complete and whole. For thus we define the whole—that from which nothing is wanting, as a whole man or box. What is true of each particular is true of the whole properly speaking—the whole is that of which nothing is outside. On the other hand that from which something is absent and outside, however small that may be, is not 'all'. Whole and complete are either quite identical or closely akin. Nothing is complete which has no end and the end is a limit.

Hence Parmenides must be thought to have spoken better than Melissus. The

[23]Rings are ἄπειροι in the sense of having no ends (πέρατα).

latter says that the whole is infinite, but the former describes it as limited, 'equally balanced from the middle'.[24] For to connect the infinite with the universe and the whole is not like joining two pieces of string; for it is from this they get the dignity they ascribe to the infinite—its containing all things and holding the universe in itself—from its having a certain similarity to the whole. It is in fact the matter of the completeness which belongs to size, and what is potentially a whole, though not in fulfilment. It is divisible both in the direction of reduction and of the inverse addition. It is a whole and limited; not, however, in virtue of its own nature, but in virtue of something else. It does not contain, but, in so far as it is infinite, is contained. Consequently, also, it is unknowable, *qua* infinite; for the matter has no form. (Hence it is plain that the infinite stands in the relation of part rather than of whole. For the matter is part of the whole, as the bronze is of the bronze statue.) If it contains in the case of sensible things, in the case of intelligible things the great and the small ought to contain them. But it is absurd and impossible to suppose that the unknowable and indeterminate should contain and determine.

7 · It is reasonable that there should not be held to be an infinite in respect of addition such as to surpass every magnitude, but that there should be thought to be such an infinite in the direction of division. For the matter and the infinite are contained inside what contains them, while it is the form which contains. It is reasonable too to suppose that in number there is a limit in the direction of the minimum, and that in the other direction every amount is always surpassed. In magnitude, on the contrary, every magnitude is surpassed in the direction of smallness, while in the other direction there is no infinite magnitude. The reason is that what is one is indivisible whatever it may be, e.g. a man is one man, not many. Number on the other hand is a plurality of 'ones' and a certain quantity of them. Hence number must stop at the indivisible; for 'two' and 'three' are derivative terms, and so with each of the other numbers. But in the direction of largeness it is always possible to think of a large number; for the number of times a magnitude can be bisected is infinite. Hence this infinite is potential, never actual: the number of parts that can be taken always surpasses any definite amount. But this number is not separable, and its infinity does not persist but consists in a process of coming to be, like time and the number of time.

With magnitudes the contrary holds. What is continuous is divided *ad infinitum*, but there is no infinite in the direction of increase. For the size which it can potentially be, it can actually be. Hence since no sensible magnitude is infinite, it is impossible to exceed every definite magnitude; for if it were possible there would be something bigger than the heavens.

The infinite is not the same in magnitude and movement and time, in the sense of a single nature, but the posterior depends on the prior, e.g. movement is called infinite in virtue of the magnitude covered by the movement (or alteration or growth), and time because of the movement. (I use these terms for the moment. Later I shall explain what each of them means, and also why every magnitude is divisible into magnitudes.)

[24] Frag. 8, line 44, Diels-Kranz.

Our account does not rob the mathematicians of their science, by disproving the actual existence of the infinite in the direction of increase, in the sense of the untraversable. In point of fact they do not need the infinite and do not use it. They postulate only that a finite straight line may be produced as far as they wish. It is possible to have divided into the same ratio as the largest quantity another magnitude of any size you like. Hence, for the purposes of proof, it will make no difference to them whether the infinite is found among existent magnitudes.

In the four-fold scheme of causes, it is plain that the infinite is a cause in the sense of matter, and that its essence is privation, the subject as such being what is continuous and sensible. All the other thinkers, too, evidently treat the infinite as matter—that is why it is inconsistent in them to make it what contains, and not what is contained.

8 · It remains to go through the arguments which are supposed to support the view that the infinite exists not only potentially but as a separate thing. Some have no cogency; others can be met by fresh objections that are true.

In order that coming to be should not fail, it is not necessary that there should be a sensible body which is actually infinite. The passing away of one thing may be the coming to be of another, the universe being limited.

There is a difference between touching and being limited. The former is relative to something and is the touching of something (for everything that touches touches something), and further is an attribute of some one of the things which are limited. On the other hand, what is limited is not limited in relation to anything. Again, contact is not possible between any two things taken at random.

To rely on thinking is absurd; for then the excess or defect is not in the thing but in the thought. One might think that one of us is bigger than he is and magnify him *ad infinitum*. But it does not follow that he is bigger than the size we are, just because some one thinks he is, but only because he *is* the size he is. The thought is an accident.

Time indeed and movement are infinite, and also thinking; but the parts that are taken do not persist.

Magnitude is not infinite either in the way of reduction or of magnification in thought.

This concludes my account of the way in which the infinite exists, and of the way in which it does not exist, and of what it is.

BOOK IV

1 · The physicist must have a knowledge of place, too, as well as of the infinite—namely, whether there is such a thing or not, and the manner of its existence and what it is—both because all suppose that things which exist are *somewhere* (the non-existent is nowhere—where is the goat-stag or the sphinx?),

and because motion in its most general and proper sense is change of place, which we call 'locomotion'.

The question, what is place? presents many difficulties. An examination of all the relevant facts seems to lead to different conclusions. Moreover, we have inherited nothing from previous thinkers, whether in the way of a statement of difficulties or of a solution.

The existence of place is held to be obvious from the fact of mutual 208b1
replacement. Where water now is, there in turn, when the water has gone out as from a vessel, air is present; and at another time another body occupies this same place. The place is thought to be different from all the bodies which come to be in it and replace one another. What now contains air formerly contained water, so that clearly the place or space into which and out of which they passed was something different from both.

Further, the locomotions of the elementary natural bodies—namely, fire, earth, and the like—show not only that place is something, but also that it exerts a certain influence. Each is carried to its own place, if it is not hindered, the one up, the other down. Now these are regions or kinds of place—up and down and the rest of the six directions. Nor do such distinctions (up and down and right and left) hold only in relation to us. To *us* they are not always the same but change with the direction in which we are turned: that is why the same thing is often both right *and* left, up *and* down, before *and* behind. But in *nature* each is distinct, taken apart by itself. It is not every chance direction which is up, but where fire and what is light are carried; similarly, too, down is not any chance direction but where what has weight and what is made of earth are carried—the implication being that these places do not differ merely in position, but also as possessing distinct powers. This is made plain also by the objects studied by mathematics. Though they have no place, they nevertheless, in respect of their position relatively to us, have a right and left as these are spoken of merely in respect of relative position, not having by nature these various characteristics. Again, the theory that the void exists involves the existence of place; for one would define void as place bereft of body.

These considerations then would lead us to suppose that place is something distinct from bodies, and that every sensible body is in place. Hesiod too might be held to have given a correct account of it when he made chaos first. At least he says:

> First of all things came chaos to being, then broadbreasted earth,[25]

implying that things need to have space first, because he thought, with most people, that everything is somewhere and in place. If this is its nature, the power of place must be a marvellous thing, and be prior to all other things. For that without which nothing else can exist, while it can exist without the others, must needs be first; for 209a1
place does not pass out of existence when the things in it are annihilated.

True, but even if we suppose its existence settled, the question of what it is presents difficulty—whether it is some sort of 'bulk' of body or some entity other than that; for we must first determine its genus.

[25] *Theogony* 116.

Now it has three dimensions, length, breadth, depth, the dimensions by which all body is bounded. But the place cannot *be* body; for if it were there would be two bodies in the same place.

Further, if body has a place and space, clearly so too have surface and the other limits of body; for the same argument will apply to them: where the bounding planes of the water were, there in turn will be those of the air. But when we come to a point we cannot make a distinction between it and its place. Hence if the place of a point is not different from the point, no more will that of any of the others be different, and place will not be something different from each of them.

What in the world, then, are we to suppose place to be? If it has the sort of nature described, it cannot be an element or composed of elements, whether these be corporeal or incorporeal; for while it has size, it has not body. But the elements of sensible bodies are bodies, while nothing that has size results from a combination of intelligible elements.

Also we may ask: of what in things is space the cause? None of the four modes of causation can be ascribed to it. It is neither cause in the sense of the matter of existents (for nothing is composed of it), nor as the form and definition of things, nor as end, nor does it move existents.

Further, too, if it is itself an existent, it will be somewhere. Zeno's difficulty demands an explanation; for if everything that exists has a place, place too will have a place, and so on *ad infinitum*.

Again, just as every body is in place, so, too, every place has a body in it. What then shall we say about *growing* things? It follows from these premisses that their place must grow with them, if their place is neither less nor greater than they are.

By asking these questions, then, we must raise the whole problem about place—not only as to what it is, but even whether there is such a thing.

2 · Something can be said of a subject either in virtue of itself or in virtue of something else; and there is place which is common and in which all bodies are, and which is the proper and primary location of each body. I mean, for instance, that you are now in the world because you are in the air and it is in the world; and you are in the air because you are on the earth; and similarly on the earth because you are in this place which contains no more than you.

209b1 Now if place is what *primarily* contains each body, it would be a limit, so that the place would be the form or shape of each body which the magnitude or the matter of the magnitude is defined; for this is the limit of each body.

If, then, we look at the question in this way the place of a thing is its form. But, if we regard the place as the *extension* of the magnitude, it is the matter. For this is different from the magnitude: it is what is contained and defined by the form, as by a bounding plane. Matter or the indeterminate is of this nature; for when the boundary and attributes of a sphere are taken away, nothing but the matter is left.

This is why Plato in the *Timaeus* says that matter and space are the same; for the 'participant' and space are identical. (It is true, indeed, that the account he gives there of the 'participant' is different from what he says in his so-called unwritten teaching. Nevertheless, he did identify place and space.) I mention Plato because, while all hold place to be something, he alone tried to say *what* it is.

In view of these facts we should naturally expect to find difficulty in determining what place is, if indeed it *is* one of these two things, matter or form. They demand a very close scrutiny, especially as it is not easy to recognize them apart.

But it is at any rate not difficult to see that place cannot be either of them. The form and the matter are not separate from the thing, whereas the place can be separated. As we pointed out, where air was, water in turn comes to be, the one replacing the other; and similarly with other bodies. Hence the place of a thing is neither a part nor a state of it, but is separable from it. For place is supposed to be something like a vessel—the vessel being a transportable place. But the vessel is no part of the thing.

In so far then as it is separable from the thing, it is not the form; and in so far as it contains it, it is different from the matter.

Also it is held that what is anywhere is both itself something and that there is a different thing outside it. (Plato of course, if we may digress, ought to tell us why the form and the numbers are not in place, if 'what participates' is place—whether what participates is the Great and the Small or the matter, as he has written in the *Timaeus*.)

Further, how could a body be carried to its own place, if place was the matter or the form? It is impossible that what has no reference to motion or the distinction of up and down can be place. So place must be looked for among things which have these characteristics.

If the place is in the thing (it must be if it is either shape or matter) place will have a place; for both the form and the indeterminate undergo change and motion along with the thing, and are not always in the same place, but are where the thing is. Hence the place will have a place.

Further, when water is produced from air, the place has been destroyed, for the resulting body is not in the same place. What sort of destruction then is that?

This concludes my statement of the reasons why place must be something, and again of the difficulties that may be raised about is essential nature.

3 · The next step we must take is to see in how many ways one thing is said to be *in* another. In one way, as a finger is in a hand, and generally a part in a whole. In another way, as a whole is in its parts; for there is no whole over and above the parts. Again, as man is in animal, and in general a species in a genus. Again, as the genus is in the species, and in general a part of the species in its definition. Again, as health is in the hot and the cold, and in general the form in the matter. Again, as the affairs of Greece are in the King, and generally events are in their primary motive agent. Again, as a thing is in its good, and generally in its end, i.e. in that for the sake of which. And most properly of all, as something is in a vessel, and generally in a place.[26]

[26]Aristotle's remarks rest on the use of the Greek preposition 'ἐν', to which (evidently) the English 'in' does not precisely correspond.

One might raise the question whether a thing can be in itself, or whether nothing can be in itself—everything being either nowhere or in something else. The question is ambiguous; we may mean the thing *qua* itself or *qua* something else.

When there are parts of a whole—the one that in which a thing is, the other the thing which is in it—the whole will be described as being in itself. For a thing is described in terms of its parts, as well as in terms of the thing as a whole, e.g. a man is said to be white because the visible surface of him is white, or to be scientific because his thinking faculty is. The jar then will not be in itself and the wine will not be in itself. But the jar of wine will; for the contents and the container are both parts of the same whole.

In this sense then, but not primarily, a thing can be in itself, namely, as white is in body (for the visible surface is in body), and science is in the mind.

It is from these, which are parts (in the sense at least of being in the man), that the man is called white, &c. (But the jar and the wine in separation are not parts of a whole, though together they are.) So when there are parts, a thing will be in itself, as white is in man because it is in body, and in body because it resides in the visible surface. But it is not in surface in virtue of something else. And these things—the surface and the white—differ in form, and each has a different nature and power.

Thus if we look at the matter inductively we do not find anything to be in itself in any of the senses that have been distinguished; and it can be seen by argument that it is impossible. For each of two things will have to be both, e.g. the jar will have to be both vessel and wine, and the wine both wine and jar, if it is possible for a thing to be in itself; so that, however true it might be that they were in each other, the jar will receive the wine in virtue not of *its* being wine but of the wine's being wine, and the wine will be in the jar in virtue not of *its* being a jar but of the jar's being a jar. Now that they are different in respect of what they are is evident; for that in which something is and that which is in it would be differently defined.

Nor is it possible for a thing to be in itself even accidentally; for two things would be at the same time in the same thing. The jar would be in itself—if a thing whose nature it is to receive can be in itself; and that which it receives, namely (if wine) wine, will be in it.

Obviously then a thing cannot be in itself primarily.

Zeno's problem—that if place is something it must be in something—is not difficult to solve. There is nothing to prevent the first place from being in something else—not indeed in that as in a place, but as health is in the hot as a state of it or as the hot is in body as an affection. So we escape the infinite regress.

Another thing is plain: since the vessel is no part of what is in it (what contains something primarily is different from what is contained), place could not be either the matter or the form of the thing contained, but must be different—for the latter, both the matter and the shape, are parts of what is contained.

This then may serve as a critical statement of the difficulties involved.

4 · What then after all is place? The answer to this question may be elucidated as follows.

Let us take for granted about it the various characteristics which are supposed

correctly to belong to it essentially. We assume first that place is what contains that of which it is the place, and is no part of the thing; again, that the primary place of a thing is neither less nor greater than the thing; again, that place can be left behind by the thing and is separable; and in addition that all place admits of the distinction of up and down, and each of the bodies is naturally carried to its appropriate place and rests there, and this makes the place either up or down.
Having laid these foundations, we must complete the theory. We ought to try to conduct our inquiry into what place is in such a way as not only to solve the difficulties connected with it, but also to show that the attributes supposed to belong to it do really belong to it, and further to make clear the cause of the trouble and of the difficulties about it. In that way, each point will be proved in the most satisfactory manner.

First then we must understand that place would not have been inquired into, if there had not been motion with respect to place. It is chiefly for this reason that we suppose the heaven also to be in place, because it is in constant movement. Of this kind of motion there are two species—locomotion on the one hand and, on the other, increase and diminution. For these too involve change: what was then in this place has now in turn changed to what is larger or smaller.

Again, things are moved either in themselves, actually, or accidentally. In the latter case it may be either something which by its own nature is capable of being moved, e.g. the parts of the body or the nail in the ship, or something which is not in itself capable of being moved, but is *always* moved accidentally, as whiteness or science. These have changed their place only because the subjects to which they belong do so.

We say that a thing is in the world, in the sense of in place, because it is in the air, and the air is in the world; and when we say it is in the air, we do not mean it is in every part of the air, but that it is in the air because of the surface of the air which surrounds it; for if all the air were its place, the place of a thing would not be equal to the thing—which it is supposed to be, and which the primary place in which a thing is actually is.

When what surrounds, then, is not separate from the thing, but is in continuity with it, the thing is said to be in what surrounds it, not in the sense of in place, but as a part in a whole. But when the thing is separate and in contact, it is primarily in the inner surface of the surrounding body, and this surface is neither a part of what is in it nor yet greater than its extension, but equal to it; for the extremities of things which touch are coincident.

Further, if one body is in continuity with another, it is not moved *in* that but *with* that. On the other hand it is moved *in* that if it is separate. It makes no difference whether what contains is moved or not.

[Again, when it is not separate it is described as a part in a whole, as the pupil in the eye or the hand in the body: when it is separate, as the water in the cask or the wine in the jar. For the hand is moved *with* the body and the water *in* the cask.][27]

It will now be plain from these considerations what place is. There are just four

[27]Ross excises the bracketed lines as an alternative version of 211a29-36.

things of which place must be one—the shape, or the matter, or some sort of extension between the extremities, or the extremities (if there is no extension over and above the bulk of the body which comes to be in it).

Three of these it obviously cannot be. The shape is supposed to be place because it surrounds, for the extremities of what contains and of what is contained are coincident. Both the shape and the place, it is true, are boundaries. But not the same thing: the form is the boundary of the thing, the place is the boundary of the body which contains it.

The extension between the extremities is thought to be something, because what is contained and separate may often be changed while the container remains the same (as water may be poured from a vessel)—the assumption being that the extension is something over and above the body displaced. But there is no such extension. One of the bodies which change places and are naturally capable of being in contact with the container falls in—whichever it may chance to be.

If there were an extension which were such as to exist independently and be permanent, there would be an infinity of places in the same thing. For when the water and the air change places, all the portions of the two together will play the same part in the whole which was previously played by all the water in the vessel; at the same time the place too will be undergoing change; so that there will be another place which is the place of the place, and many places will be coincident. There is not a different place of the part, in which it is moved, when the whole vessel changes its place: it is always the same; for it is in the place where they are that the air and the water (or the parts of the water) succeed each other, not in that place in which they come to be, which is part of the place which is the place of the whole world.

The matter, too, might seem to be place, at least if we consider it in what is at rest and is not separate but in continuity. For just as in change of quality there is something which was formerly black and is now white, or formerly soft and now hard—this is why we say that the matter exists—so place, because it presents a similar phenomenon, is thought to exist—only in the one case we say so because *what* was air is now water, in the other because *where* air formerly was there is now water. But the matter, as we said before, is neither separable from the thing nor contains it, whereas place has both characteristics.

Well, then, if place is none of the three—neither the form nor the matter nor an extension which is always there, different from, and over and above, the extension of the thing which is displaced—place necessarily is the one of the four which is left, namely, the boundary of the containing body at which it is in contact with the contained body. (By the contained body is meant what can be moved by way of locomotion.)

Place is thought to be something important and hard to grasp, both because the matter and the shape present themselves along with it, and because the displacement of the body that is moved takes place in a stationary container, for its seems possible that there should be an interval which is other than the bodies which are moved. The air, too, which is thought to be incorporeal, contributes something to the belief: it is not only the boundaries of the vessel which seem to be place, but also what is between them, regarded as empty. Just, in fact, as the vessel is transportable place, so place is a non-portable vessel. So when what is within a thing which is moved, is moved and changes, as a boat on a river, what contains plays the part of a vessel rather than that of place. Place on the other hand is rather what is motionless: so it is rather the whole river that is place, because as a whole it is motionless.

Hence the place of a thing is the innermost motionless boundary of what contains it.

This explains why the middle of the world and the surface which faces us of the rotating system are held to be up and down in the strict and fullest sense for all men: for the one is always at rest, while the inner side of the rotating body remains always coincident with itself. Hence since the light is what is naturally carried up, and the heavy what is carried down, the boundary which contains in the direction of the middle of the universe, and the middle itself, are down, and that which contains in the direction of the extremity, and the extremity itself, are up.

For this reason place is thought to be a kind of surface, and as it were a vessel, i.e. a container of the thing.

Further, place is coincident with the thing, for boundaries are coincident with the bounded.

5 · If then a body has another body outside it and containing it, it is in place, and if not, not. That is why, even if there were to be water which had not a container, the parts of it will be moved (for one part is contained in another), while the whole will be moved in one sense, but not in another. For as a whole it does not simultaneously change its place, though it will be moved in a circle; for this place is the place of its parts. And some parts are moved, not up and down, but in a circle; others up and down, such things namely as admit of condensation and rarefaction.

As was explained, some things are potentially in place, others actually. So, when you have a homogeneous substance which is continuous, the parts are potentially in place: when the parts are separated, but in contact, like a heap, they are actually in place.

Again, some things are *per se* in place, namely every body which is movable either by way of locomotion or by way of increase is *per se* somewhere, but the world, as has been said, is not anywhere as a whole, nor in any place, if, that is, no body contains it. But the line on which it is moved provides a place for its parts; for each is contiguous to the next.

Other things are in place accidentally, as the soul and the world. The latter is, in a way, in place, for all its parts are; for on the circle one part contains another. That is why the upper part is moved in a circle, while the universe is not anywhere. For what is somewhere is itself something, and there must be alongside it some other thing wherein it is and which contains it. But alongside the universe or the Whole there is nothing outside the universe, and for this reason all things are in the world; for the world, we may say, is the universe. Yet their place is not the same as the world. It is part of it, the innermost part of it, which is in contact with the movable body; and for this reason the earth is in water, and this in the air, and the air in the aether, and the aether in the world, but we cannot go on and say that the world is in anything else.

It is clear, too, from these considerations that all the problems which were raised about place will be solved when it is explained in this way.

There is no necessity that the place should grow with the body in it, nor that a point should have a place; nor that two bodies should be in the same place; nor that place should be a corporeal interval (for what is between the boundaries of the place is any body which may chance to be there, not an interval in body).

Further, place is indeed somewhere, not in the sense of being in a place, but as the limit is in the limited; for not everything that is is in place, but only movable body.

Also, it is reasonable that each kind of body should be carried to its own place. For a body which is next in the series and in contact (not by compulsion) is akin, and bodies which are united do not affect each other, while those which are in contact interact on each other.

Nor is it without reason that each should remain naturally in its proper place. For parts do, and that which is in a place has the same relation to its place as a
213a1 separable part to its whole, as when one moves a part of water or air: so, too, air is related to water, for the one is like matter, the other form—water is the matter of air, air as it were the actuality of water; for water is potentially air, while air is potentially water, though in another way.

These distinctions will be drawn more carefully later. On the present occasion it was necessary to refer to them: what has now been stated obscurely will then be made more clear.[28] If the matter and the fulfilment are the same thing (for water is both, the one potentially, the other in fulfilment), water will be related to air in a way as part to whole. That is why these have contact: it is organic union when both become actually one.

This concludes my account of place—both of its existence and of its nature.

6 · The investigation of similar questions about the void, also, must be held to belong to the physicist—namely whether it exists or not, and how it exists or what it is—just as about place. The views taken of it involve arguments both for and against, in much the same sort of way. For those who hold that the void exists regard it as a sort of place or vessel which is supposed to be full when it holds the bulk which it is capable of containing, void when it is deprived of that—as if void and full and place were the same thing, though the essence of the three is different.

We must begin the inquiry by putting down the account given by those who say that it exists, then the account of those who say that it does not exist, and third the common opinions on these questions.

Those who try to show that the void does not exist do not disprove what people really mean by it, but only their erroneous way of speaking; this is true of

[28]See *On Generation and Corruption* I 3.

Anaxagoras and of those who refute the existence of the void in this way. They show that air is something—by straining wine-skins and showing the resistance of the air, and by cutting it off in clepsydras. But people really mean by void an interval in which there is *no* sensible body. They hold that everything which is is body and say that what has nothing in it at all is void (so what is full of air is void). It is not then the existence of air that needs to be proved, but the non-existence of an interval, different from the bodies, either separable or actual—an interval which divides the whole body so as to break its continuity, as Democritus and Leucippus hold, and many other physicists—or even perhaps as something which is outside the whole body, which remains continuous.

These people, then, have not reached even the threshold of the problem, but rather those who say that the void exists.

They argue, for one thing, that change in place (i.e. locomotion and increase) would not occur. For it is maintained that motion would seem not to exist, if there were no void, since what is full cannot contain anything more. If it could, and there were two bodies in the same place, it would also be true that any number of bodies could be together; for it is impossible to draw a line of division beyond which the statement would become untrue. If this were possible, it would follow also that the smallest body would contain the greatest; for many small things make a large thing: thus if many equal bodies can be in the same place, so also can many unequal bodies.

Melissus, indeed, actually argues from this that the universe is immovable; for if it were moved there must, he says, be void, but void is not among the things that exist.

This argument, then, is one way in which they show that there is a void. They also reason from the fact that some things are observed to contract and be compressed, as people say that a cask will hold the wine along with the skins, which implies that the compressed body contracts into the voids present in it.

Again increase, too, is thought by everyone to take place by means of void; for nutriment is body, and it is impossible for two bodies to be together. Evidence of this they find also in what happens to ashes, which absorb as much water as the empty vessel.

The Pythagoreans, too, held that void exists and that it enters the world from the infinite air, the world inhaling also the void which distinguishes the natures of things, as if it were what separates and distinguishes the terms of a series. This holds primarily in the numbers; for the void distinguishes their nature.

These, then, and so many, are the main grounds on which people have argued for and against the existence of the void.

7 · As a step towards settling which view is true, we must determine the meaning of the word.

The void is thought to be place with nothing in it. The reason for this is that people take what exists to be body, and hold that while every body is in place, void is place in which there is no body, so that where there is no body, there is nothing.

214a1 Every body, again, they suppose to be tangible; and of this nature is whatever has weight or lightness. Hence, by deduction, what has nothing heavy or light in it, is void.

This result, then, as I have just said, is reached by deduction. It would be absurd to suppose that the point is void; for the void must be *place* which has in it an interval in tangible body.

But at all events we observe then that in one way the void is described as what is not full of body perceptible to touch; and what has heaviness and lightness is perceptible to touch. So we would raise the question: what would they say of an interval that has colour or sound—is it void or not? Clearly they would reply that if it *could* receive what is tangible it was void, and if not, not.

In another way void is that in which there is not 'this' or corporeal substance. So some say that the void is the matter of the body (they identify the place, too, with this), and in this they speak incorrectly; for the matter is not separable from the things, but they are inquiring about the void as about something separable.

Since we have determined the nature of place, and void must, if it exists, be place deprived of body, and we have stated both in what sense it does not, it is plain that on this showing void does not exist, either unseparated or separated; for the void is meant to be, not body but rather an interval in body. This is why the void is thought to be something, viz. because place is, and for the same reasons. For the fact of motion in respect of place comes to the aid both of those who maintain that place is something over and above the bodies that come to occupy it, and of those who maintain that the void is something. They state that the void is a cause of movement in the sense of that in which movement takes place; and this would be the kind of thing that some say place is.

But there is no necessity for there being a void if there is movement. It is not in the least needed as a condition of movement in general, for a reason which escaped Melissus; viz. that the full can suffer qualitative change.

But not even movement in respect of place involves a void; for bodies may simultaneously make room for one another, though there is no interval separate and apart from the bodies that are in movement. And this is plain even in the rotation of continuous things, as in that of liquids.

And things can also be compressed not into a void but because they squeeze out 214b1 what is contained in them (as, for instance, when water is compressed the air within it is squeezed out); and things can increase in size not only by the entrance of something but also by qualitative change; e.g. if water were to be transformed into air.

In general, both the argument about increase of size and that about the water poured on to the ashes get in their own way. For either not any and every part of the body is increased, or bodies may be increased otherwise than by the addition of body, or there may be two bodies in the same place (in which case they are claiming to solve a general difficulty, but are not proving the existence of void), or the *whole* body must be void, if it is increased in every part and is increased by means of void. The same argument applies to the ashes.

It is evident, then, that it is easy to refute the arguments by which they prove the existence of the void.

8 · Let us explain again that there is no void existing separately, as some maintain. If each of the simple bodies has a natural locomotion, e.g. fire upward and earth downward and towards the middle of the universe, it is clear that the void cannot be a cause of locomotion. What, then, *will* the void be a cause of? It is thought to be a cause of movement in respect of place, and it is not a cause of this.

Again, if void is a sort of place deprived of body, when there is a void where will a body placed in it move to? It certainly cannot move into the whole of the void. The same argument applies as against those who think that place is something separate, into which things are carried; viz. how will what is placed in it move, or rest? The same argument will apply to the void as to the up and down in place, as is natural enough since those who maintain the existence of the void make it a place.

And in what way will things be present either in place or in the void? For the result does not take place when a body is placed as a whole in a place conceived of as separate and permanent; for a part of it, unless it be placed apart, will not be in a place but in the whole. Further, if separate place does not exist, neither will void.

If people say that the void must exist, as being necessary if there is to be movement, what rather turns out to be the case, if one studies the matter, is the opposite, that not a single thing can be moved if there *is* a void; for as with those who say the earth is at rest because of the uniformity, so, too, in the void things must be at rest; for there is no place to which things can move more or less than to another; since the void in so far as it is void admits no difference.

The second reason is this: all movement is either compulsory or according to nature, and if there is compulsory movement there must also be natural (for compulsory movement is contrary to nature, and movement contrary to nature is posterior to that according to nature, so that if each of the natural bodies has not a natural movement, none of the other movements can exist); but how can there be *natural* movement if there is no difference throughout the void or the infinite? For in so far as it is infinite, there will be no up or down or middle, and in so far as it is a void, up differs no whit from down; for as there is no difference in what is nothing, there is none in the void (for the void seems to be a non-existent and a privation); but natural locomotion seems to be differentiated, so that the things that exist by nature must be differentiated. Either, then, nothing has a natural locomotion, or else there is no void.

Further, in point of fact things that are thrown move though that which gave them their impulse is not touching them, either by reason of mutual replacement, as some maintain, or because the air that has been pushed pushes them with a movement quicker than the natural locomotion of the projectile wherewith it moves to its proper place. But in a void none of these things can take place, nor can anything be moved save as that which is carried is moved.

Further, no one could say why a thing once set in motion should stop anywhere;

for why should it stop *here* rather than *here*? So that a thing will either be at rest or must be moved *ad infinitum,* unless something more powerful gets in its way.

Further, things are now thought to move into the void because it yields; but in a void this quality is present equally everywhere, so that things should move in all directions.

Further, the truth of what we assert is plain from the following considerations. We see the same weight or body moving faster than another for two reasons, either because there is a difference in what it moves through, as between water, air, and earth, or because, other things being equal, the moving body differs from the other owing to excess of weight or of lightness.

Now the medium causes a difference because it impedes the moving thing, most of all if it is moving in the opposite direction, but in a secondary degree even if it is at rest; and especially a medium that is not easily divided, i.e. a medium that is somewhat dense.

A, then, will move through B in time C, and through D, which is thinner, in time E (if the length of B is equal to D), in proportion to the density of the hindering body. For let B be water and D air; then by so much as air is thinner and more incorporeal than water, A will move through D faster than through B. Let the speed have the same ratio to the speed, then, that air has to water. Then if air is twice as thin, the body will traverse B in twice the time that it does D, and the time C will be twice the time E. And always, by so much as the medium is more incorporeal and less resistant and more easily divided, the faster will be the movement.

Now there is no ratio in which the void is exceeded by body, as there is no ratio of nought to a number. For if 4 exceeds 3 by 1, and 2 by more than 1, and 1 by still more than it exceeds 2, still there is no ratio by which it exceeds 0; for that which exceeds must be divisible into the excess and that which is exceeded, so that 4 will be what it exceeds 0 by and 0. For this reason, too, a line does not exceed a point—unless it is composed of points. Similarly the void can bear no ratio to the full, and therefore neither can movement through the one to movement through the other, but if a thing moves through the thinnest medium such and such a distance in such and such a time, it moves through the void with a speed beyond any ratio. For let F be void, equal to B and to D. Then if A is to traverse and move through it in a certain time, G, a time less than E, however, the void will bear this ratio to the full. But in a time equal to G, A will traverse the part H of D. And it will surely also traverse in that time any substance F which exceeds air in thinness in the ratio which the time E bears to the time G. For if the body F be as much thinner than D as E exceeds G, A, if it moves through F, will traverse it in a time inverse to the speed of the movement, i.e. in a time equal to G. If, then, there is *no* body in F, A will traverse F still more quickly. But we suppose that its traverse of F when F was void occupied the time G. So that it will traverse F in an equal time whether F be full or void. But this is impossible. It is plain, then, that if there is a time in which it will move through any part of the void, this impossible result will follow: it will be found to traverse a certain distance, whether this be full or void, in an equal time; for there will be some body which is in the same ratio to the other body as the time is to the time.

To sum the matter up, the cause of this result is obvious, viz. that between any two movements there is a ratio (for they occupy time, and there is a ratio between any two times, so long as both are finite), but there is no ratio of void to full.

These are the consequences that result from a difference in the media; the following depend upon an excess of one moving body over another. We see that bodies which have a greater impulse either of weight or of lightness, if they are alike in other respects, move faster over an equal space, and in the ratio which their magnitudes bear to each other. Therefore, they will also move through the void with this ratio of speed. But that is impossible; for why should one move faster? (In moving through *plena* it must be so; for the greater divides them faster by its force. For a moving thing cleaves the medium either by its shape, or by the impulse which the body that is carried along or is projected possesses.) Therefore all will possess equal velocity. But this is impossible.

It is evident from what has been said, then, that, if there is a void, a result follows which is the very opposite of the reason for which those who believe in a void set it up. They think that if movement in respect of place is to exist, the void must exist, separated by itself; but this is the same as to say that place is separate; and this has already been stated to be impossible.

But even if we consider it on its own merits the so-called void will be found to be really vacuous. For as, if one puts a cube in water, an amount of water equal to the cube will be displaced, so too in air (but the effect is imperceptible to sense). And indeed always, in the case of any body that can be displaced, it must, if it is not compressed, be displaced in the direction in which it is its nature to be displaced—always either down, if its locomotion is downwards as in the case of earth, or up, if it is fire, or in both directions—whatever be the nature of the inserted body. Now in the void this is impossible; for it is not body; the void must have penetrated the cube to a distance equal to that which this portion of void formerly occupied in the void, just as if the water or air had not been displaced by the wooden cube, but had penetrated right through it.

But the cube also has a magnitude equal to that occupied by the void; a magnitude which, if it is also hot or cold, or heavy or light, is none the less different in essence from all its attributes, even if it is not separable from them; I mean the bulk of the wooden cube. So that even if it were separated from everything else and were neither heavy nor light, it will occupy an equal amount of void, and fill the same place, as the part of place or of the void equal to itself. How then will the body of the cube differ from the void or place that is equal to it? And if there can be two such things, why cannot there be any number coinciding?

This, then, is one absurd and impossible implication of the theory. It is also evident that the cube will have this same volume even if it is displaced, which is an attribute possessed by all other bodies also. Therefore if this differs in no respect from its place, why need we assume a place for bodies over and above the bulk of each, if their bulk be conceived of as free from attributes? It contributes nothing to the situation if there is an equal interval attached to it as well. [Further, it ought to be clear by the study of moving things what sort of thing void is. But in fact it is found nowhere in the world. For air is something, though it does not *seem* to be so—nor, for that matter, would water, if fishes were made of iron; for the discrimination of the tangible is by touch.][29]

It is clear, then, from these considerations that there is no separate void.

9 · There are some who think that the existence of rarity and density shows that there is a void. If rarity and density do not exist, they say, neither can things contract and be compressed. But if this were not to take place, either there would be no movement at all, or the universe would bulge, as Xuthus said, or air and water must always change into equal amounts (e.g. if air has been made out of a cupful of water, at the same time out of an equal amount of air a cupful of water must have been made), or void must necessarily exist; for compression and expansion cannot take place otherwise.

Now, if they mean by the rare that which has many voids existing separately, it is plain that if void cannot exist separate any more than a place can exist with an extension all to itself, neither can the rare exist in this sense. But if they mean that there is void, not separately existent, but still present in the rare, this is less impossible; yet, first, the void turns out not to be a cause of *all* movement, but only of movement upwards (for the rare is light, which is the reason why they say fire is rare); second, the void turns out to be a cause of movement not as that in which it takes place, but in that the void carries things up as skins by being carried up themselves carry up what is continuous with them. Yet how can void have a local movement or a place? For thus that into which void moves is till then void of a void.

Again, how will they explain, in the case of what is heavy, its movement downwards? And it is plain that if the rarer and more void a thing is the quicker it will move upwards, if it were completely void it would move with a maximum speed. But perhaps even this is impossible, that it should move at all; the same reason which showed that in the void all things are incapable of moving shows that the void cannot move, viz., the fact that the speeds are incomparable.

Since we deny that a void exists, but for the rest the problem has been truly stated, that *either* there will be no movement, if there is no condensation and rarefaction, *or* the universe will bulge, *or* a transformation of water into air will always be balanced by an equal transformation of air into water (for it is clear that more air is produced from the water: it is necessary therefore, if compression does not exist, *either* that the next portion will be pushed outwards and make the outermost part bulge, *or* that somewhere else there must be an equal amount of water produced out of air, so that the entire bulk of the whole may be equal, *or* that nothing moves. For when anything is displaced this will always happen, unless it comes round in a circle; but locomotion is not always circular, but sometimes in a straight line)—these then are the reasons for which they might say that there is a void; *our* statement is based on the assumption that there is a single matter for contraries, hot and cold and the other natural contrarieties, and that what is actually is produced from what is potentially, and that matter is not separable from

[29]These lines are bracketed by editors as a later addition.

the contraries but its being is different, and that a single matter may serve for colour and heat and cold.

The same matter also serves for both a large and a small body. This is evident; for when air is produced from water, the same matter has become something different, not by acquiring an addition to it, but has become actually what it was potentially; and, again, water is produced from air in the same way, the change being sometimes from smallness to greatness, and sometimes from greatness to smallness. Similarly, therefore, if air which is large in extent comes to have a smaller bulk, or becomes greater from being smaller, it is the matter which is potentially both that comes to be each of the two.

For as the same matter becomes hot from being cold, and cold from being hot, because it was potentially both, so too from hot it can become more hot, though nothing in the matter has become hot that was not hot when the thing was less hot; just as, if the arc or curve of a greater circle becomes that of a smaller, whether it remains the same or becomes a different curve, convexity has not come to exist in anything that was not convex but straight (for differences of degree do not depend on an intermission of the quality); nor can we get any portion of a flame, in which both heat and whiteness are not present. So too, then, is the earlier heat related to the later. So that the greatness and smallness, also, of the sensible bulk are extended, not by the matter's acquiring anything new, but because the matter is potentially matter for both states; so that the same thing is dense and rare, and the two qualities have one matter.

The dense is heavy, and the rare is light. [Again, as the arc of a circle when contracted into a smaller space does not acquire a new part which is convex, but what was there had been contracted; and as any part of fire that one takes will be hot; so, too, it is all a question of contraction and expansion of the same matter.][30] There are two types in each case, both in the dense and in the rare; for both the heavy and the hard are thought to be dense, and contrariwise both the light and the soft are rare; and weight and hardness fail to coincide in the case of lead and iron.

From what has been said it is evident, then, that void does not exist either separate (either absolutely separate or as a separate element in the rare) or potentially, unless one is willing to call the cause of movement void, whatever it may be. At that rate the matter of the heavy and the light, *qua* matter of them, would be the void; for the dense and the rare are productive of locomotion in virtue of *this* contrariety, and in virtue of their hardness and softness productive of passivity and impassivity, i.e. not of locomotion but rather of qualitative change.

So much, then, for the discussion of the void, and of the sense in which it exists and the sense in which it does not exist.

10 · Next for discussion after the subjects mentioned is time. The best plan will be to begin by working out the difficulties connected with it, making use of the current arguments. First, does it belong to the class of things that exist or to that of things that do not exist? Then secondly, what is its nature? To start, then: the

[30] The words in brackets are excised as an alternative version of 217^{b}2-11.

218a1 following considerations would make one suspect that it either does not exist at all or barely, and in the obscure way. One part of it has been and is not, while the other is going to be and is not yet. Yet time—both infinite time and any time you like to take—is made up of these. One would naturally suppose that what is made up of things which do not exist could have no share in reality.

Further, if a divisible thing is to exist, it is necessary that, when it exists, all or some of its parts must exist. But of time some parts have been, while others are going to be, and no part of it *is*, though it is divisible. For the 'now' is not a part: a part is a measure of the whole, which must be made up of parts. Time, on the other hand, is not held to be made up of 'nows'.

Again, the 'now' which seems to bound the past and the future—does it always remain one and the same or is it always other and other? It is hard to say.

If it is always different and different, and if none of the *parts* in time which are other and other are simultaneous (unless the one contains and the other is contained, as the shorter time is by the longer), and if the 'now' which is not, but formerly was, must have ceased to be at some time, the '*nows*' too cannot be simultaneous with one another, but the prior 'now' must always have ceased to be. But the prior 'now' cannot have ceased to be in itself (since it then existed); yet it cannot have ceased to be in another 'now'. For we may lay it down that one 'now' cannot be next to another, any more than a point to a point. If then it did not cease to be in the next 'now' but in another, it would exist simultaneously with the innumerable 'nows' between the two—which is impossible.

Yes, but neither is it possible for the 'now' to remain always the same. No determinate divisible thing has a single termination, whether it is continuously extended in one or in more than one dimension; but the 'now' is a termination, and it is possible to cut off a determinate time. Further, if coincidence in time (i.e. being neither prior nor posterior) means to be in one and the same 'now', then, if both what is before and what is after are in this same 'now', things which happened ten thousand years ago would be simultaneous with what has happened to-day, and nothing would be before or after anything else.

This may serve as a statement of the difficulties about the attributes of time.

As to what time is or what is its nature, the traditional accounts give us as little light as the preliminary problems which we have worked through.

Some assert that it is the movement of the whole, others that it is the sphere
218b1 itself.

Yet part, too, of the revolution is a time, but it certainly is not a revolution; for what is taken is part of a revolution, not a revolution. Besides, if there were more heavens than one, the movement of any of them equally would be time, so that there would be many times at the same time.

Those who said that time is the sphere of the whole thought so, no doubt, on the ground that all things are in time and all things are in the sphere of the whole. The view is too naive for it to be worth while to consider the impossibilities implied in it.

But as time is most usually supposed to be motion and a kind of change, we must consider this view.

Now the change or movement of each thing is only *in* the thing which changes or *where* the thing itself which moves or change may chance to be. But time is present equally everywhere and with all things.

Again, change is always faster or slower, whereas time is not; for fast and slow are defined by time—fast is what moves much in a short time, slow what moves little in a long time; but time is not defined by time, by being either a certain amount or a certain kind of it.

Clearly then it is not movement. (We need not distinguish at present between movement and change.)

11 · But neither does time exist without change; for when the state of our minds does not change at all, or we have not noticed its changing, we do not think that time has elapsed, any more than those who are fabled to sleep among the heroes in Sardinia do when they are awakened; for they connect the earlier 'now' with the later and make them one, cutting out the interval because of their failure to notice it. So, just as, if the 'now' were not different but one and the same, there would not have been time, so too when its difference escapes our notice the interval does not seem to be time. If, then, the non-realization of the existence of time happens to us when we do not distinguish any change, but the mind seems to stay in one indivisible state, and when we perceive and distinguish we say time has elapsed, evidently time is not independent of movement and change. It is evident, then, that time is neither movement nor independent of movement.

We must take this as our starting-point and try to discover—since we wish to know what time is—what exactly it has to do with movement.

Now we perceive movement and time together; for even when it is dark and we are not being affected through the body, if any movement takes place in the mind we at once suppose that some time has indeed elapsed; and not only that but also, when some time is thought to have passed, some movement also along with it seems to have taken place. Hence time is either movement or something that belongs to movement. Since then it is not movement, it must be the other.

But what is moved is moved from something to something, and all magnitude is continuous. Therefore the movement goes with the magnitude. Because the magnitude is continuous, the movement too is continuous, and if the movement, then the time; for the time that has passed is always thought to be as great as the movement.

The distinction of before and after holds primarily, then, in place; and there in virtue of relative position. Since then before and after hold in magnitude, they must hold also in movement, these corresponding to those. But also in time the distinction of before and after must hold; for time and movement always correspond with each other. The before and after in motion identical in substratum with motion yet differs from it in being, and is not identical with motion.

But we apprehend time only when we have marked motion, marking it by before and after; and it is only when we have perceived before and after in motion that we say that time has elapsed. Now we mark them by judging that one thing is different from another, and that some third thing is intermediate to them. When we think of the extremes as different from the middle and the mind pronounces that the 'nows' are two, one before and one after, it is then that we say that there is time, and this that we say is time. For what is bounded by the 'now' is thought to be time—we may assume this.

When, therefore, we perceive the 'now' as one, and neither as before and after in a motion nor as the same element but in relation to a 'before' and an 'after', no time is thought to have elapsed, because there has been no motion either. On the other hand, when we do perceive a 'before' and an 'after', then we say that there is time. For time is just this—number of motion in respect of 'before' and 'after'.

Hence time is not movement, but only movement in so far as it admits of enumeration. An indication of this: we discriminate the more or the less by number, but more or less movement by time. Time then is a kind of number. (Number, we must note, is used in two ways—both of what is counted or countable and also of that with which we count. Time, then, is what is counted, not that with which we count: these are different kinds of thing.)

Just as motion is a perpetual succession, so also is time. But every simultaneous time is the same; for the 'now' is the same in substratum—though its being is different— and the 'now' determines time, in so far as time involves the before and after.

The 'now' in one sense is the same, in another it is not the same. In so far as it is in succession, it is different (which is just what its being now was supposed to mean), but its substratum is the same; for motion, as was said, goes with magnitude, and time, as we maintain, with motion. Similarly, then, there corresponds to the point the body which is carried along, and by which we are aware of the motion and of the before and after involved in it. This is an identical *substratum* (whether a point or a stone or something else of the kind), but it is different in definition—as the sophists assume that Coriscus' being in the Lyceum is a different thing from Coriscus' being in the market-place. And the body which is carried along is different, in so far as it is at one time here and at another there. But the 'now' corresponds to the body that is carried along, as time corresponds to the motion. For it is by means of the body that is carried along that we become aware of the before and after in the motion, and if we regard these as countable we get the 'now'. Hence in these also the 'now' as substratum remains the same (for it is what is before and after in movement), but its being is different; for it is in so far as the before and after is that we get the 'now'. This is what is most knowable; for motion is known because of that which is moved, locomotion because of that which is carried. For what is carried is a 'this', the movement is not. Thus the 'now' in one sense is always the same, in another it is not the same; for this is true also of what is carried.

Clearly, too, if there were no time, there would be no 'now', and vice versa. Just as the moving body and its locomotion involve each other mutually, so too do the number of the moving body and the number of its locomotion. For the number of the locomotion is time, while the 'now' corresponds to the moving body, and is like the unit of number.

Time, then, also is both made continuous by the 'now' and divided at it. For here too there is a correspondence with the locomotion and the moving body. For the motion or locomotion is made one by the thing which is moved, because *it* is one—not because it is one in substratum (for there might be pauses in the movement of such a thing)—but because it is one in definition; for this determines the movement as 'before' and 'after'. Here, too, there is a correspondence with the point; for the point also both connects and terminates the length—it is the beginning of one and the end of another. But when you take it in this way, using the one point as two, a pause is necessary, if the same point is to be the beginning and the end. The 'now' on the other hand, since the body carried is moving, is always different.

Hence time is not number in the sense in which there is number of the same point because it is beginning and end, but rather as the extremities of a line form a number, and not as the parts of the line do so, both for the reason given (for we can use the middle point as two, so that on that analogy time might stand still), and further because obviously the 'now' is no *part* of time nor the section any part of the movement, any more than the points are parts of the line—for it is two *lines* that are *parts* of one line.

In so far then as the 'now' is a boundary, it is not time, but an attribute of it; in so far as it numbers, it is number; for boundaries being only to that which they bound, but number (e.g. ten) is the number of these horses, and belongs also elsewhere.

It is clear, then, that time is number of movement in respect of the before and after, and is continuous since it is an attribute of what is continuous.

The smallest number, in the strict sense, is two. But of number as concrete, sometimes there is a minimum, sometimes not: e.g. of a line, the smallest in respect of *multiplicity* is two (or, if you like, one), but in respect of *size* there is no minimum; for every line is divided *ad infinitum*. Hence it is so with time. In respect of number the minimum is one (or two); in point of extent there is no minimum.

It is clear, too, that time is not described as fast or slow, but as many or few and as long or short. For as continuous it is long or short and as a number many or few; but it is not fast or slow—any more than any number with which we count is fast or slow.

Further, there is the same time everywhere at once, but not the same time before and after; for while the present change is one, the change which has happened and that which will happen are different. Time is not number with which we count, but the number of things which are counted; and this according as it occurs before or after is always different, for the 'nows' are different. And the number of a hundred horses and a hundred men is the same, but the things numbered are different—the horses for the men. Further, as a movement can be one and the same again and again, so too can time, e.g. a year or a spring or an autumn.

Not only do we measure the movement by the time, but also the time by the movement, because they define each other. The time marks the movement, since it is its number, and the movement the time. We describe the time as much or little, measuring it by the movement, just as we know the number by what is numbered, e.g. the number of the horses by one horse as the unit. For we know how many horses there are by the use of the number; and again by using the one horse as unit we know the number of the horses itself. So it is with the time and the movement; fo we measure the movement by the time and vice versa. It is reasonable that th should happen; for the movement goes with the distance and the time with tl movement, because they are quanta and continuous and divisible. The moveme has these attributes because the distance is of this nature, and the time has the because of the movement. And we measure both the distance by the movement an the movement by the distance; for we say that the road is long, if the journey is lon; and that this is long, if the road is long—the time, too, if the movement, and tl movement, if the time.

Time is a measure of motion and of being moved, and it measures the motion
221a1 by determining a motion which will measure the whole motion, as the cubit does th length by determining an amount which will measure out the whole. Further to b in time means, for movement, that both it and its essence are measured by time (fo simultaneously it measures both the movement and its essence, and this is what being in time means for it, that its essence should be measured).

Clearly, then, to be in time has the same meaning for other things also, namely, that their being should be measured by time. To be in time is one of two things: to exist when time exists, and as we say of some things that they are 'in number'. The latter means either what is a part or mode of number—in general, something which belongs to number—or that things have a number.

Now, since time is number, the 'now' and the before and the like are in time, just as unit and odd and even are in number, i.e. in the sense that the one set belongs to number, the other to time. But things are in time as they are in number. If this is so, they are contained by time as things in number are contained by number and things in place by place.

Plainly, too, to be in time does not mean to coexist with time, any more than tc be in motion or in place means to coexist with motion or place. For if 'to be in something' is to mean this, then all things will be in anything, and the world will be in a grain; for when the grain is, then also is the world. But this is accidental, whereas the other is necessarily involved: that which is in time necessarily involves that there is time when *it* is, and that which is in motion that there is motion when *it* is.

Since what is in time is so in the same sense as what is in number is so, a time greater than everything in time can be found. So it is necessary that all the things in time should be contained by time, just like other things also which are in anything, e.g. the things in place by place.

A thing, then, will be affected by time, just as we are accustomed to say that time wastes things away, and that all things grow old through time, and that people forget owing to the lapse of time, but we do not say the same of getting to know or of
221b1 becoming young or fair. For time is by its nature the cause rather of decay, since it is the number of change, and change removes what is.

Hence, plainly, things which are always are not, as such, in time; for they are not contained by time, nor is their being measured by time. An indication of this is that none of them is *affected* by time, which shows that they are not in time.

Since time is the measure of motion, it will be the measure of rest too. For all rest is in time. For it does not follow that what is in time is moved, though what is in motion is necessarily moved. For time is not motion, but number of motion; and what is at rest can be in the number of motion. Not everything that is not in motion can be said to be at rest—but only that which can be moved, though it actually is not moved, as was said above.

To be in number means that there is a number of the thing, and that its being is measured by the number in which it is. Hence if a thing is in time it will be measured by time. But time will measure what is moved and what is at rest, the one *qua* moved, the other *qua* at rest; for it will measure their motion and rest respectively.

Hence what is moved will not be measured by the time simply in so far as it has quantity, but in so far as its *motion* has quantity. Thus none of the things which are neither moved nor at rest are in time; for to be in time is to be measured by time, while time is the measure of motion and rest.

Plainly, then, neither will everything that does not exist be in time, i.e. those non-existent things that cannot exist, as the diagonal's being commensurate with the side.

Generally, if time is the measure of motion in itself and of other things accidentally, it is clear that a thing whose being is measured by it will have its being in rest or motion. Those things therefore which are subject to perishing and becoming—generally, those which at one time exist, at another do not—are necessarily in time; for there is a greater time which will extend both beyond their being and beyond the time which measures their being. Of things which do not exist but are contained by time some were, e.g. Homer once was, some will be, e.g. a future event; this depends on the direction in which time contains them; if on both, they have both modes of existence. As to such things as it does not contain in any way, they neither were nor are nor will be. These are those non-existents whose opposites always are, as the incommensurability of the diagonal always is—and this will not be in time. Nor will the commensurability, therefore; hence this eternally is not, because it is contrary to what eternally is. A thing whose contrary is not eternal can be and not be, and it is of such things that there is coming to be and passing away.

13 · The 'now' is the link of time, as has been said (for it connects past and future time), and it is a limit of time (for it is the beginning of the one and the end of the other). But this is not obvious as it is with the point, which is fixed. It divides potentially, and in so far as it is dividing the 'now' is always different, but in so far as it connects it is always the same, as it is with mathematical lines. For the intellect it is not always one and the same point, since it is other and other when one divides the line; but in so far as it is one, it is the same in every respect.

So the 'now' also is in one way a potential dividing of time, in another the termination of both parts, and their unity. And the dividing and the uniting are the same thing and in the same reference, but in essence they are not the same.

So one kind of 'now' is described in this way: another is when the time of something is *near*. He will come now, because he will come to-day; he has come now, because he came to-day. But the things in the *Iliad* have not happened now, nor is the flood now—not that the time from now to them is not continuous, but because they are not near.

'At some time' means a time determined in relation to the first of the two types of 'now', e.g. at some time Troy was taken, and at some time there will be a flood; for it must be determined with reference to the 'now'. There *will* thus be a determinate time from this 'now' to that, and there *was* such in reference to the past event. But if there be no time which is not 'sometime', every time will be determined.

Will time then fail? Surely not, if motion always exists. Is time then always different or does the same time recur? Clearly, it is the same with time as with motion. For if one and the same motion sometimes recurs, it will be one and the same time, and if not, not.

Since the 'now' is an end and a beginning of time, not of the same time however, but the end of that which is past and the beginning of that which is to come, it follows that, as the circle has its convexity and its concavity, in a sense, in the same thing, so time is always at a beginning and at an end. And for this reason it seems to be always different; for the 'now' is not the beginning and the end of the same thing; if it were, it would be at the same time and in the same respect two opposites. And time will not fail; for it is always at a beginning.

'Just now' refers to the part of future time which is near the indivisible present 'now' (When are you walking?—Just now; because the time in which he is going to do so is near), and to the part of past time which is not far from the 'now' (When are you walking?—I have been walking just now). But to say that Troy has just now been taken—we do not say that, because it is too far from the 'now'. 'Lately', too, refers to the part of past time which is near the present 'now'. 'When did you go?' 'Lately', if the time is near the existing now. 'Long ago' refers to the distant past.

'Suddenly' refers to what has departed from its former condition in a time imperceptible because of its smallness; but it is the nature of *all* change to alter things from their former condition. In time all things come into being and pass away; for which reason some called it the wisest of all things, but the Pythagorean Paron called it the most stupid, because in it we also forget; and his was the truer view. It is clear then that it must be in itself, as we said before, a cause of destruction rather than of coming into being (for change, in itself, makes things depart from their former condition), and only accidentally of coming into being, and of being. A sufficient evidence of this is that nothing comes into being without itself moving somehow and acting, but a thing can be destroyed even if it does not move at all. And this is what, as a rule, we chiefly mean by a thing's being destroyed by time. Still, time does not work even this change; but this sort of change too happens to occur in time.

We have stated, then, that time exists and what it is, and in how many ways we speak of the 'now', and what 'at some time', 'lately', 'just now', 'long ago', and 'suddenly' mean.

14 · These distinctions having been drawn, it is evident that every change and everything that moves is in time; for the distinction of faster and slower exists in reference to all change, since it is found in every instance. In the phrase 'moving faster' I refer to that which changes before another into the condition in question, when it moves over the same interval and with a regular movement; e.g. in the case 223a1
of locomotion, if both things move along the circumference of a circle, or both along a straight line; and similarly in all other cases. But what is *before* is in time; for we say 'before' and 'after' with reference to the distance from the 'now', and the 'now' is the boundary of the past and the future; so that since 'nows' are in time, the before and the after will be in time too; for in that in which the 'now' is, the distance from the 'now' will also be. But 'before' is used contrariwise with reference to past and to future time; for in the past we call 'before' what is farther from the 'now', and 'after' what is nearer, but in the future we call the nearer 'before' and the farther 'after'. So that since the 'before' is in time, and every movement involves a 'before', evidently every change and every movement is in time.

It is also worth considering how time can be related to the soul; and why time is thought to be in everything, both in earth and in sea and in heaven. It is because it is an attribute, or state, of movement (since it is the number of movement) and all these things are movable (for they are all in place), and time and movement are together, both in respect of potentiality and in respect of actuality?

Whether if soul did not exist time would exist or not, is a question that may fairly be asked; for if there cannot be some one to count there cannot be anything that can be counted either, so that evidently there cannot be number; for number is either what has been, or what can be, counted. But if nothing but soul, or in soul reason, is qualified to count, it is impossible for there to be time unless there is soul, but only that of which time is an attribute, i.e. if *movement* can exist without soul. The before and after are attributes of movement, and time is these *qua* countable.

One might also raise the question what sort of movement time is the number of. Must we not say 'of *any* kind'? For things both come into being in time and pass away, and grow, and are altered, and are moved locally; thus it is of each movement *qua* movement that time is the number. And so it is simply the number of continuous movement, not of any particular kind of it.

But other things as well may have been moved now, and there would be a 223b1
number of each of the two movements. Is there another time, then, and will there be two equal times at once? Surely not. For a time that is both equal and simultaneous is one and the same time, and even those that are not simultaneous are one in kind; for if there were dogs, and horses, and seven of each, it would be the same number. So, too, movements that have simultaneous limits have the same time, yet the one may in fact be fast and the other not, and one may be locomotion and the other alteration; still the time of the two changes is the same if it is both equal and

simultaneous; and for this reason, while the movements are different and separate, the time is everywhere the same, because the *number* of equal and simultaneous movements is everywhere one and the same.

Now there is such a thing as locomotion, and in locomotion there is included circular movement, and everything is counted by some one thing homogeneous with it, units by a unit, horses by a horse, and similarly times by some definite time, and, as we said, time is measured by motion as well as motion by time (this being so because by a motion definite in time the quantity both of the motion and of the time is measured): if, then, what is first is the measure of everything homogeneous with it, regular circular motion is above all else the measure, because the number of this is the best known. Now neither alteration nor increase nor coming into being can be regular, but locomotion can be. This also is why time is thought to be the movement of the sphere, viz. because the other movements are measured by this, and time by this movement.

This also explains the common saying that human affairs form a circle, and that there is a circle in all other things that have a natural movement and coming into being and passing away. This is because all other things are discriminated by time, and end and begin as though conforming to a cycle; for even time itself is though to be a circle. And this opinion again is held because time is a measure of this kind of locomotion and is itself measured by such. So that to say that the things that come into being form a circle is to say that there is a circle of time; and this is to say that it is measured by the circular movement; for apart from the measure nothing else is observed in what is measured; the whole is just a plurality of measures.

It is said rightly, too, that the number of the sheep and of the dogs is the same *number* if the two numbers are equal, but not the same *decad* or the same *ten*; just as the equilateral and the scalene are not the same *triangle*, yet they are the same *figure*, because they are both triangles. For things are called the same so-and-so if they do not differ by a differentia of that thing, but not if they do; e.g. triangle differs from triangle by a differentia of triangle, therefore they are different triangles; but they do not differ by a differentia of figure, but are in one and the same division of it. For a figure of one kind is a circle and a figure of another kind a triangle, and a triangle of one kind is equilateral and a triangle of another kind scalene. They are the same figure, then, and that is a triangle, but not the same triangle. Therefore the number of two groups also is the same number (for their number does not differ by a differentia of number), but it is not the same decad; for the things of which it is asserted differ; one group are dogs, and the other horses.

We have now discussed time—both time itself and the matters appropriate to the consideration of it.

BOOK V

1 · Everything which changes does so in one of three ways. It may accidentally, as for instance when we say that something musical walks, that which walks being something in which aptitude for music is an accident. Again, a thing is said

without qualification to change because something belonging to it changes, i.e. in statements which refer to part of the thing in question: thus the body is restored to health because the eye or the chest, that is to say a *part* of the whole body, is restored to health. And there is the case of a thing which is in motion neither accidentally nor in respect of something else belonging to it, but in virtue of being *itself* directly in motion. Here we have a thing which is *essentially* movable: and that which is so is a different thing according to the particular variety of motion: for instance it may be a thing capable of alteration—and within the sphere of alteration it is again a different thing according as it is capable of being restored to health or capable of being heated. And there are the same distinctions in the case of the mover: one thing causes motion accidentally, another partially (because something belonging to it causes motion), another of itself directly, as, for instance, the physician heals, the hand strikes. We have, then, the following factors: that which directly causes motion, and that which is in motion; further, that in which motion takes place, namely time, and (distinct from these three) that from which and that to which it proceeds (for every motion proceeds from something and to something, that which is directly in motion being distinct from that to which it is in motion and that from which it is in motion: for instance, wood, hot, and cold—the first is that which is in motion, the second is that to which the motion proceeds, and the third is that from which it proceeds). This being so, it is clear that the motion is in the wood, not in its form; for the motion is neither caused nor experienced by the form or the place or the quantity. So we are left with a mover, a moved, and that to which the motion proceeds; for it is that to which rather than that from which the motion proceeds that gives its name to the change. Thus perishing is change to not-being, thought it is also true that that which perishes changes from being; and becoming is change to being, though it is also change from not-being.

Now a definition of motion has been given above. Every goal of motion, whether it be a form, an affection, or a place, is immovable, as, for instance, knowledge and heat. Here, however, a difficulty may be raised. Affections, it may be said, are motions, and whiteness is an affection: thus there may be change to a motion. To this we may reply that it is not whiteness but whitening that is a motion. Here also things may hold accidentally, or partially and with reference to something other than itself, or directly and with no reference to anything else: for instance, a thing which is becoming white changes accidentally to an object of thought, the colour being only accidentally the object of thought; it changes to colour, because white is a part of colour (or to Europe, because Athens is a part of Europe); but it changes essentially to white colour. It is now clear in what way a thing is in motion essentially or accidentally, and in respect of something other than itself or itself directly moving—in the case both of the mover and of the moved; and it is also clear that the motion is not in the form but in that which is in motion, that is to say the movable in actuality. Now accidental change we may leave out of account; for it is to be found in everything, at any time, and in any subject. Change which is not accidental on the other hand is not to be found in everything, but only in contraries, in things intermediate between contraries, and in contradictories, as may be shown by induction. An intermediate may be a starting-point of change, since it serves as contrary to either of two contraries; for the intermediate is in a sense the extremes. Hence we speak of the intermediate as in a sense a contrary relatively to the extremes and of either extreme as a contrary relatively to the intermediate: for instance, the central note is low relatively to the highest and high relatively to the lowest, and grey is white relatively to black and black relatively to white.

And since every change is *from* something *to* something—as the word itself indicates, implying something 'after' something else, that is to say something earlier and something later[31]—that which changes must change in one of four ways: from subject to subject, from subject to non-subject, from non-subject to subject, or from non-subject to non-subject, where by 'subject' I mean what is affirmatively expressed. So it follows necessarily from what has been said that there are three kinds of change, that from subject to subject, that from subject to non-subject, and that from non-subject to subject; for that from non-subject to non-subject is not change, as in that case there is no opposition either of contraries or of contradictories.

Now change from non-subject to subject, the relation being that of contradiction, is coming to be—unqualified coming to be when the change takes place in an unqualified way, particular coming to be when the change is change in a particular character: for instance, a change from not-white to white is a coming to be of the particular thing, white, while change from unqualified not-being to being is coming to be in an unqualified way, in respect of which we say that a thing comes to be without qualification, not that it comes to be some particular thing. Change from subject to non-subject is perishing—unqualified perishing when the change is from being to not-being, particular perishing when the change is to the opposite negation, the distinction being the same as that made in the case of coming to be.

Now things are said not to be in several ways; and there can be motion neither of that which is not in respect of the affirmation or negation of a predicate, nor of that which is not in the sense that it only *potentially* is, that is to say the opposite of that which *actually* is in an unqualified sense; for although that which is not white or not good may nevertheless be in motion *accidentally* (for example that which is not white might be a man), yet that which is without qualification not a 'this' cannot in any sense be in motion: therefore it is impossible for that which is not to be in motion. This being so, it follows that becoming cannot be a motion; for it is that which is not that becomes. For however true it may be that it *accidentally* becomes, it is nevertheless correct to say that it is that which is not that in an unqualified sense becomes. And similarly it is impossible for that which is not to be at rest.

There are these difficulties, then, [in the way of the assumption that that which is not can be in motion],[32] and it may be further objected that, whereas everything which is in motion is in place, that which is not is not in place; for then it would be *somewhere*.

[31]Change = μεταβολή, in which Aristotle construes 'μετά' in the sense of 'after'.
[32]Ross excises the clause in brackets.

So, too, perishing is not a motion; for a motion has for its contrary either another motion or rest, whereas perishing is the contrary of becoming.

Since, then, every motion is a kind of change, and there are only the three kinds of change mentioned above; and since of these three those which take the form of becoming and perishing, that is to say those which imply a relation of contradiction, are not motions: it necessarily follows that only change from subject to subject is motion. And every such subject is either a contrary or an intermediate (for a privation may be allowed to rank as a contrary) and can be affirmatively expressed, as naked, toothless, or black. If, then, the categories are severally distinguished as substance, quality, place, [time],[33] relation, quantity, and activity or passivity, it necessarily follows that there are three kinds of motion—qualitative, quantitative, and local.

2 · In respect of substance there is no motion, because substance has no contrary among things that are. Nor is there motion in respect of relation; for it may happen that when one correlative changes, the other, although this does not itself change, may be true or not true, so that in these cases the motion is accidental. Nor is there motion in respect of agent and patient—in fact there can never be motion of mover and moved, because there cannot be motion of motion or becoming of becoming or in general change of change.

For in the first place there are two ways in which motion of motion is conceivable. The motion of which there is motion might be conceived as subject; e.g. a man is in motion because he changes from fair to dark. Can it be that in this sense motion grows hot or cold, or changes place, or increases or decreases? Impossible; for change is not a subject. Or can there be motion of motion in the sense that some other subject changes from a change to another mode of being [as that of a man from illness to health]?[34] Even this is possible only in an accidental sense. For the movement itself is change from one form to another, ⟨as that of a man from illness to health.⟩[34] (And the same holds good of becoming and perishing, except that in these processes we have a change to a particular kind of opposite, while the other, motion, is a change to a different kind.) So, if there is to be motion of motion, that which is changing from health to sickness must simultaneously be changing from this very change to another. It is clear, then, that by the time that he has become sick, he must also have changed to whatever may be the other change concerned (for he could be at rest). Moreover this other can never be any casual change, but must be a change from something definite to some other definite thing. So in this case it must be the opposite change, viz. convalescence. It is only accidentally that there can be change of change, e.g. there is a change from remembering to forgetting only because the subject of this change changes at one time to knowledge, at another to ignorance.

Again, if there is to be change of change and becoming of becoming, we shall have an infinite regress. Thus if one of a series of changes is to be a change of

[33]Ross brackets καὶ τῷ ποτέ.
[34]Transposed by Ross.

change, the preceding change must also be so: e.g. if simple becoming was ever in process of becoming, then that which was becoming was also in process of becoming, so that we should not yet have arrived at what was in process of simple becoming but only at what was already in process of becoming in process of becoming. And this again was sometime in process of becoming, so that it is not yet in process of becoming in process of becoming. And since in an infinite series there is no first term, here there will be no first stage and therefore no following stage either. On this hypothesis, then, nothing can become or be moved or change.

Again, if a thing is capable of any particular motion, it is also capable of the corresponding contrary motion or the corresponding coming to rest, and a thing that is capable of becoming is also capable of perishing: consequently, what is in process of becoming in process of becoming is in process of perishing at the very moment when it is in process of becoming in process of becoming; since it cannot be in process of perishing when it is just beginning to become or after it has ceased to become; for that which is in process of perishing must be in existence.

Again, there must be matter underlying all processes of becoming and changing. What can this be in the present case? It is either the body or the soul that undergoes alteration: what is it that correspondingly becomes motion or becoming? And again what is the goal of their motion? It must be the motion or becoming of something from something to something else. But in what sense can this be so? For the becoming of learning cannot be learning: so neither can the becoming of becoming be becoming, nor can the becoming of any process be that process.

Again, since there are three kinds of motion, the subject and the goal of motion must be one or other of these, e.g. locomotion will have to be altered or to be locally moved.

To sum up, then, since everything that is moved is moved in one of three ways, either accidentally, or partially, or essentially, change can change only accidentally, as e.g. when a man who is being restored to health runs or learns: and accidental change we have earlier decided to leave out of account.

Since, then, motion can belong neither to substance nor to relation nor to agent and patient, it remains that there can be motion only in respect of quality, quantity, and place; for with each of these we have a pair of contraries. Motion in respect of quality let us call alteration, a general designation that is used to include both contraries; and by quality I do not here mean a property of substance (in that sense that which constitutes a specific distinction is a quality) but a passive quality in virtue of which a thing is said to be acted on or to be incapable of being acted on. Motion in respect of quantity has no name that includes both contraries, but it is called increase or decrease according as one or the other is designated: that is to say motion in the direction of complete magnitude is increase, motion in the contrary direction is decrease. Motion in respect of place has no name either general or particular; but we may designate it by the general name of locomotion, though strictly the term locomotion is applicable to things that change their place only when they have not the power to come to a stand, and to things that do not move *themselves* locally.[35]

[35]'φορά' ('locomotion') means, taken strictly, 'being carried'.

Change within the same kind from a lesser to a greater or from a greater to a lesser degree is alteration; for it is motion either from a contrary or to a contrary, whether in an unqualified or in a qualified sense; for change to a lesser degree of a quality will be called change to the contrary of that quality, and change to a greater degree of a quality will be regarded as change from the contrary of that quality to the quality itself. It makes no difference whether the change be qualified or unqualified, except that in the former case the contraries will have to be contrary to one another only in a qualified sense; and a thing's possessing a quality in a greater or in a lesser degree means the presence or absence in it of more or less of the opposite quality. It is now clear, then, that there are only these three kinds of motion.

The term 'immovable' we apply in the first place to that which is absolutely incapable of being moved (just as we correspondingly apply the term invisible to sound); in the second place to that which is moved with difficulty after a long time or whose movement is slow at the start—in fact, what we describe as hard to move; and in the third place to that which is naturally designed for and capable of motion, but is not in motion when, where, and as it naturally would be so. This last is the only kind of immovable thing of which I use the term 'being at rest'; for rest is contrary to motion, so that rest will be privation of motion in that which is capable of admitting motion.

The foregoing remarks are sufficient to explain the essential nature of motion and rest, the number of kinds of change, and the different varieties of motion.

3 · Let us now proceed to say what it is to be together and apart, in contact, between, in succession, contiguous, and continuous, and to show in what circumstances each of these terms is naturally applicable.

Things are said to be together in place when they are in one primary place and to be apart when they are in different places. Things are said to be in contact when their extremities are together.

Every change involves opposites, and opposites are either contraries or contradictories; since a contradiction admits of nothing in the middle, it is evident that what is between must involve contraries. What is between involves three things at least; for the contrary is a last point in change, and that which a changing thing, changing continuously and naturally, naturally reaches before it reaches that to which it changes last, is between.[36] A thing is moved continuously if it leaves no gap or only the smallest possible gap in the material—not in the time (for a gap in the time does not prevent things moving continuously, while, on the other hand, there is nothing to prevent the highest note sounding immediately after the lowest) but in the material in which the motion takes place. This is manifestly true not only in local changes but in every other kind as well. That is locally contrary which is most distant in a straight line; for the shortest line is definitely limited, and that which is definitely limited constitutes a measure.

A thing is in succession when it is after the beginning in position or in form or

[36]Ross transposes 227^{a}7–9 and 226^{b}26–7 to follow 226^{b}22.

in some other respect in which it is definitely so regarded, and when further there is nothing of the *same* kind as itself between it and that to which it is in succession, e.g. a line or lines if it is a line, a unit or units if it is a unit, a house if it is a house (there is nothing to prevent something of a *different* kind being between). For that which is in succession is in succession to a particular thing, and is something posterior; for one is not in succession to two, nor is the first day of the month to the second: in each case the latter is in succession to the former.

A thing that is in succession and touches is contiguous. The continuous is a subdivision of the contiguous: things are called continuous when the touching limits of each become one and the same and are, as the word implies, contained in each other: continuity is impossible if these extremities are two. This definition makes it plain that continuity belongs to things that naturally in virtue of their mutual contact form a unity. And in whatever way that which holds them together is one, so too will the whole be one, e.g. by a rivet or glue or contact or organic union.

It is obvious that of these terms 'in succession' is primary; for that which touches is necessarily in succession, but not everything that is in succession touches: and so succession is a property of things prior in definition, e.g. numbers, while contact is not. And if there is continuity there is necessarily contact, but if there is contact, that alone does not imply continuity; for the extremities of things may be together without necessarily being one; but they cannot be one without necessarily being together. So natural union is last in coming to be; for the extremities must necessarily come into contact if they are to be naturally united; but things that are in contact are not all naturally united, while where there is no contact clearly there is no natural union either. Hence, if as some say points and units have an independent existence of their own, it is impossible for the two to be identical; for points can touch while units can only be in succession. Moreover, there can always be something between points (for all lines are intermediate between points), whereas it is not necessary that there should be anything between units; for there is nothing between the numbers one and two.

We have now said what it is to be together and apart, in contact, between and in succession, contiguous and continuous; and we have shown in what circumstances each of these terms is applicable.

4 · There are many ways in which motion is said to be one; for we use the term 'one' in many ways.

Motion is one *generically* according to the different categories to which it may be assigned: thus any locomotion is one generically with any other locomotion, whereas alteration is different generically from locomotion.

Motion is one specifically when besides being one generically it also takes place in a species incapable of subdivision: e.g. colour has specific differences; therefore blackening and whitening differ specifically [but at all events every whitening will be specifically the same with every other whitening and every blackening with every other blackening].[37] But whiteness is not further subdivided

[37] Ross excises this sentence as a doublet of 227^{b}11.

by specific differences: hence any whitening is specifically one with any other whitening. Where it happens that the genus is at the same time a species, it is clear that the motion will then in a sense be one specifically though not in an unqualified sense: learning is an example of this, knowledge being on the one hand a species of apprehension and on the other hand a genus including the various knowledges. A difficulty, however, may be raised as to whether a motion is specifically one when the same thing changes from the same to the same, e.g. when one point changes again and again from a particular place to a particular place: if this motion is specifically one, circular motion will be the same as rectilinear motion, and rolling the same as walking. But is not this difficulty removed by the principle already laid down that if that in which the motion takes place is specifically different (as in the present instance the circular path is specifically different from the straight) the motion itself is also different? We have explained, then, what is meant by saying that motion is one generically or one specifically.

Motion is one in an unqualified sense when it is one essentially or numerically; and the following distinctions will make clear what this is. There are three textures in connexion with which we speak of motion—what, where, when. I mean that there must be something that is in motion, e.g. a man or gold, and it must be in motion *in* something, e.g. a place or an affection, and at some time (for all motion takes place in time). Of these three it is the thing in which the motion takes place that makes it one generically or specifically, it is the thing moved that makes the motion one in subject, and it is the time that makes it consecutive; but it is the three together that make it one without qualification—for that in which the motion takes place (the species) must be one and incapable of subdivision, that during which it takes place (the time) must be one and unintermittent, and that which is in motion must be one—not in an accidental sense (i.e. it must be one as the white that blackens is one or Coriscus who walks is one, not in the accidental sense in which Coriscus and the white may be one), nor if it is done in common (for there might be a case of two men being restored to health at the same time in the same way, e.g. from inflammation of the eye, yet this motion is not one, but only specifically one).

Suppose, however, that Socrates undergoes an alteration specifically the same but at one time and again at another: in this case if it is possible for that which ceased to be again to come into being and remain numerically the same, then this motion too will be one: otherwise it will be the same but not one. And akin to this difficulty there is another; viz. is health one? and generally are the states and affections in bodies one in essence although (as is clear) the things that contain them are obviously in motion and in flux? Thus if a person's health at daybreak and at the present moment is one and the same, why should not this health be numerically one with that which he recovers after an interval? The same argument applies in each case, but with this difference: that if the states are two then it follows simply from this fact that the actuality must also in point of number be two (for only that which is numerically one can give rise to an actuality that is numerically one); but if the state is one, this is not in itself enough to make us regard the actuality also as one (for when a man ceases walking, the walking no longer is, but it will again be if he begins to walk again). But, be this as it may, if the health is one and the same, then it must be possible for that which is one and the same to come to be and to cease to be many times. However, these difficulties lie outside our present inquiry.

Since every motion is continuous, a motion that is one in an unqualified sense must (since every motion is divisible) be continuous, and a continuous motion must be one. There will not be continuity between any motion and any other any more than there is between any two things chosen at random in any other sphere: there can be continuity only when the extremities of the two things are one. Now some things have no extremities at all; and the extremities of others differ specifically although we give them the same name: how should e.g. the end of a line and the end of walking touch or come to be one? Motions that are not the same either specifically or generically may, it is true, be *consecutive* (e.g. a man may run and then at once fall ill of a fever), and again, in the torch-race we have consecutive but not continuous locomotion; for according to our definition there can be continuity only when the ends of the two things are one. Hence motions may be consecutive or successive in virtue of the time being continuous, but there can be continuity only in virtue of the motions themselves being continuous, that is when the end of each is one with the end of the other. Motion, therefore, that is in an unqualified sense continuous and one must be specifically the same, of one thing, and in one time. Unity is required in respect of time in order that there may be no interval of immobility, for where there is intermission of motion there must be rest, and a motion that includes intervals of rest will be not one but many, so that a motion that is interrupted by stationariness is not one or continuous, and it is so interrupted if there is an interval of time. And though of a motion that is not specifically one (even if it is not intermittent) the time is one, the motion is specifically different; for motion that is one must be specifically one, though motion that is specifically one is not necessarily one in an unqualified sense. We have now explained what we mean when we call a motion one without qualification.

Further, a motion is also said to be one generically, specifically, or essentially when it is complete, just as in other cases completeness and wholeness are characteristics of what is one; and sometimes a motion even if incomplete is said to be one, provided only that it is continuous.

And besides the cases already mentioned there is another in which a motion is said to be one, viz. when it is regular; for in a sense a motion that is irregular is not regarded as one, that title belonging rather to that which is regular, as a straight line is regular, the irregular being divisible. But the difference would seem to be one of degree. In every kind of motion we may have regularity or irregularity: thus there may be regular alteration, and locomotion in a regular path, e.g. in a circle or on a straight line, and it is the same with regard to increase and decrease. The difference that makes a motion irregular is sometimes to be found in its path: thus a motion cannot be regular if its path is an irregular magnitude, e.g. a broken line, a spiral, or any other magnitude that is not such that any part of it fits on to any other that may be chosen. Sometimes it is found neither in the subject nor in the time nor in the goal but in the manner of the motion; for in some cases the motion is differentiated by quickness and slowness: thus if its velocity is uniform a motion is regular, if not it is irregular. So quickness and slowness are not species of motion nor do they constitute specific differences of motion, because this distinction occurs in connexion with all the distinct species of motion. The same is true of heaviness and lightness when they refer to the same thing: e.g. they do not specifically distinguish earth from itself or fire from itself. Irregular motion, therefore, while in virtue of being continuous it is one, is so in a lesser degree, as is the case with locomotion in a broken line; and a lesser degree of something always means an admixture of its contrary. And since every motion that is one can be both regular and irregular, motions that are consecutive but not specifically the same cannot be one and continuous; for how should a motion composed of alteration and locomotion be regular? If a motion is to be regular its parts ought to fit one another.

5 · We have further to determine what motions are contrary to each other, and to determine similarly how it is with rest. And we have first to decide whether contrary motions are motions respectively from and to the same thing, e.g. a motion from health and a motion to health (where the opposition, it would seem, is of the same kind as that between coming to be and ceasing to be); or motions respectively from contraries, e.g. a motion from health and a motion from disease; or motions respectively to contraries, e.g. a motion to health and a motion to disease; or motions respectively from a contrary and to the opposite contrary, e.g. a motion from health and a motion to disease; or motions respectively from a contrary to the opposite contrary and from the latter to the former, e.g. a motion from health to disease and a motion from disease to health; for motions must be contrary to one another in one or more of these ways, as there is no other way in which they can be opposed.

Now motions respectively from a contrary and to the opposite contrary, e.g. a motion from health and a motion to disease, are not contrary motions; for they are one and the same. (Yet their being is not the same, just as changing from health is different from changing to disease.) Nor are motions respectively from a contrary and from the opposite contrary contrary motions; for a motion from a contrary is at the same time a motion to a contrary or to an intermediate (of this, however, we shall speak later), but changing to a contrary rather than changing from a contrary would seem to be the cause of the contrariety of motions, the latter being the loss, the former the gain, of contrariness. Moreover, each several motion takes its name rather from the goal than from the starting-point of change, e.g. motion to health we call convalescence, motion to disease sickening. Thus we are left with motions respectively to contraries, and motions respectively to contraries from the opposite contraries. Now it would seem that motions to contraries are at the same time motions from contraries (though their being may not be the same; 'to health' is distinct, I mean, from 'from disease', and 'from health' from 'to disease').

Since then change differs from motion (motion being change from a particular subject to a particular subject), it follows that contrary motions are motions respectively from a contrary to the opposite contrary and from the latter to the former, e.g. a motion from health to disease and a motion from disease to health. Moreover, the consideration of particular examples will also show what kinds of processes are generally recognized as contrary: thus falling ill is regarded as contrary to recovering one's health, and being taught as contrary to being led into error by another; for their goals are contrary. (It is possible to acquire error, like knowledge, either by one's own agency or by that of another.) Similarly we have upward locomotion and downward locomotion, which are contrary lengthwise, locomotion to the right and locomotion to the left, which are contrary breadthwise, and forward locomotion and backward locomotion, which too are contraries.

On the other hand, a process simply to a contrary (e.g. becoming white, where no starting-point is specified) is a change but not a motion. And in all cases of a thing that has no contrary we have as contraries change from and change to the same thing. Thus coming to be is contrary to ceasing to be, and losing to gaining. But these are changes and not motions. And wherever a pair of contraries admits of an intermediate, motions to that intermediate must be held to be in a sense motions to one or other of the contraries; for the intermediate serves as a contrary for the purposes of the motion, in whichever direction the change may be, e.g. grey in a motion from grey to white takes the place of black as starting-point, in a motion from white to grey it takes the place of black as goal, and in a motion from black to grey it takes the place of white as goal; for the middle is opposed in a sense to either of the extremes, as has been said above. Thus two motions are contrary to each other only when one is a motion from a contrary to the opposite contrary and the other is a motion from the latter to the former.

6 · But since a motion appears to have contrary to it not only another motion but also a state of rest, we must determine how this is so. A motion has for its contrary in the unqualified sense another motion, but it also has for an opposite a state of rest (for rest is the privation of motion and the privation of anything may be called its contrary), and motion of one kind has for its opposite rest of that kind, e.g. local motion has local rest. This statement, however, needs further qualification: there remains the question, is the opposite of remaining at a particular place motion from or motion to that place? It is surely clear that since there are two subjects between which motion takes place, motion from one of these to its contrary has for its opposite remaining there, while the reverse motion has for its opposite remaining in the contrary. At the same time these two are also contrary to each other; for it would be absurd to suppose that there are contrary motions and not opposite states
230a1 of rest. States of rest in contraries *are* opposed. To take an example, a state of rest in health is contrary to a state of rest in disease, and the motion to which it is contrary is that from health to disease. For it would be absurd that its contrary motion should be that from disease to health, since motion to that in which a thing is at rest is rather a coming to rest, or at any rate the coming to rest is found to come into being simultaneously with the motion; and one of these two motions it must be. And rest in *whiteness* is not contrary to rest in health.

Of all things that have no contraries there are opposite *changes* (viz. change from the thing and change to the thing, e.g. change from being and change to being), but no *motion*. So, too, of such things there is no remaining though there is absence of change. Should there be a particular subject, absence of change in its being will be contrary to absence of change in its not-being. And here a difficulty may be raised: if what is not is not a particular something, what is it that is contrary to absence of change in a thing's being? and is this absence of change a state of rest? If it is, then either it is not true that every state of rest is contrary to a motion or else coming to be and ceasing to be are motion. It is clear then that, since we exclude these from among motions, we must not say that this absence of change is a state of rest: we must say that it is similar to a state of rest and call it absence of change. And it will have for its contrary either nothing or absence of change in the thing's not-being, or the ceasing to be of the thing; for such ceasing to be is change from it and the thing's coming to be is change to it.

Again, a further difficulty may be raised. How is it that whereas in local change both remaining and moving may be natural or unnatural, in the other changes this is not so? e.g. alteration is not now natural and now unnatural; for convalescence is no more natural or unnatural than falling ill, whitening no more natural or unnatural than blackening; so, too, with increase and decrease: these are not contrary to each other in the sense that either of them is natural while the other is unnatural, nor is one increase contrary to another in this sense; and the same account may be given of becoming and perishing: it is not true that becoming is natural and perishing unnatural (for growing old is natural), nor do we observe one becoming to be natural and another unnatural. We answer that if what happens under violence is unnatural, then violent perishing is unnatural and as such contrary to natural perishing. Are there then also some becomings that are violent and not ordained, and are therefore contrary to natural becomings, and violent increases and decreases, e.g. the rapid growth to maturity of profligates and the rapid ripening of corn when not packed close in the earth? And how is it with alterations? Surely just the same: we may say that some alterations are violent while others are natural, e.g. patients alter naturally or unnaturally according as they throw off fevers on the critical days or not. But then we shall have perishings contrary to one another, not to becomings. And, why should not this in a sense be so? Thus it is so if one is pleasant and another painful: and so one perishing will be contrary to another not in an unqualified sense, but in so far as one has this quality and the other that.

Generally, then, motions and states of rest exhibit contrariety in the manner described above, e.g. upward to downward, these being instances of local contrariety; and upward locomotion belongs naturally to fire and downward to earth, and the locomotions of the two are certainly contrary to each other. And again, fire moves up naturally and down unnaturally; and its natural motion is certainly contrary to its unnatural motion. Similarly with remaining: remaining above is contrary to motion from above downwards, and to earth this remaining comes unnaturally, this motion naturally. So the unnatural remaining of a thing is contrary to its natural motion, just as we find a similar contrariety in the motion of the same thing: one of its motions, the upward or the downward, is natural, the other unnatural.

Here, however, the question arises, has every state of rest that is not permanent a becoming, and is this becoming a coming to a standstill? If so, there must be a becoming of that which is at rest unnaturally, e.g. of earth at rest above; and therefore this earth during that time that it was being carried violently upward was coming to a standstill. But whereas the velocity of that which comes to a standstill seems always to increase, the velocity of that which is carried violently seems always to decrease: so it will *be* in a state of rest without having *become* so. Moreover coming to a standstill seems to be identical or at least concomitant with the locomotion of a thing to its proper place.

There is also another difficulty involved in the view that remaining in a particular place is contrary to motion from that place. For when a thing is moving from or discarding something, it still appears to have that which is being discarded, so that if this state of rest is contrary to the motion from here to its contrary, the contraries will simultaneously belong to the same thing. May we not say, however, that in so far as the thing is still stationary it is in a state of rest in a qualified sense, and in general that whenever a thing is in motion, part of it is at the starting-point while part is at the goal to which it is changing? And consequently a motion finds its contrary rather in another motion than in a state of rest.

With regard to motion and rest, then, we have now explained in what sense each of them is one and under what conditions they exhibit contrariety.

[With regard to coming to a standstill the question may be raised whether there is an opposite state of rest to unnatural as well as to natural motions. It would be absurd if this were not the case; for a thing may remain still merely under violence: thus we shall have a thing being in a non-permanent state of rest without having become so. But it is clear that it must be the case; for just as there is unnatural motion, so, too, a thing may be in an unnatural state of rest. Further, some things have a natural and an unnatural motion, e.g. fire has a natural upward motion and an unnatural downward motion: is it, then, this or the motion of earth that is contrary? For the earth naturally moves downwards. Surely it is clear that both are contrary to it though not in the same sense: the natural motion of earth is contrary inasmuch as the motion of fire is also natural, whereas the upward motion of fire as being natural is contrary to the downward motion of fire as being unnatural. The same is true of the corresponding cases of remaining. But there would seem to be a sense in which a state of rest and a motion are opposites.][38]

BOOK VI

1 · Now if the terms 'continuous', 'in contact', and 'in succession' are understood as defined above—things being continuous if their extremities are one, in contact if their extremities are together, and in succession if there is nothing of their own kind intermediate between them—nothing that is continuous can be

[38]The final paragraph, which several MSS omit, is regarded as an alternative version of 230^{b}10–28 by Ross and others.

composed of indivisibles: e.g. a line cannot be composed of points, the line being continuous and the point indivisible. For the extremities of two points can neither be *one* (since of an indivisible there can be no extremity as distinct from some other part) nor *together* (since that which has no parts can have no extremity, the extremity and the thing of which it is the extremity being distinct).

Moreover, if that which is continuous is composed of points, these points must be either *continuous* or *in contact* with one another: and the same reasoning applies in the case of all indivisibles. Now for the reason given above they cannot be continuous; and one thing can be in contact with another only if whole is in contact with whole or part with part or part with whole. But since indivisibles have no parts, they must be in contact with one another as whole with whole. And if they are in contact with one another as whole with whole, they will not be continuous; for that which is continuous has distinct parts, and these parts into which it is divisible are different in this way, i.e. spatially separate.

Nor, again, can a point be *in succession* to a point or a now to a now in such a way that length can be composed of points or time of nows; for things are in succession if there is nothing of their own kind intermediate between them, whereas intermediate between points there is always a line and between nows a period of time.

Again, they could be divided into indivisibles, since each is divisible into the parts of which it is composed. But, as we saw, no continuous thing is divisible into things without parts. Nor can there be anything of any other kind between; for it would be either indivisible or divisible, and if it is divisible, divisible either into indivisibles or into divisibles that are always divisible, in which case it is continuous.

Moreover, it is plain that everything continuous is divisible into divisibles that are always divisible; for if it were divisible into indivisibles, we should have an indivisible in contact with an indivisible, since the extremities of things that are continuous with one another are one and are in contact.

The same reasoning applies equally to magnitude, to time, and to motion: either all of these are composed of indivisibles and are divisible into indivisibles, or none. This may be made clear as follows. If a magnitude is composed of indivisibles, the motion over that magnitude must be composed of corresponding indivisible motions: e.g. if the magnitude ABC is composed of the indivisibles A, B, C, each corresponding part of the motion DEF of Z over ABC is indivisible. Therefore, since where there is motion there must be something that is in motion, and where there is something in motion there must be motion, therefore the being-moved will also be composed of indivisibles. So Z traversed A when its motion was D, B when its motion was E, and C similarly when its motion was F. Now a thing that is in motion from one place to another cannot at the moment when it was in motion both be in motion and at the same time have completed its motion at the place to which it was in motion (e.g. if a man is walking to Thebes, he cannot be walking to Thebes and at the same time have completed his walk to Thebes); and, as we saw, Z traverses the partless section A in virtue of the presence of the motion D. Consequently, if Z actually passed through A *after* being in process of passing through, the motion must be divisible; for at the time when Z was passing through, it neither was at rest nor had completed its passage but was in an intermediate state; while if it is passing through and has completed its passage at the same time, then that which is walking will at the moment when it is walking have completed its walk and will be in the place to which it is walking; that is to say, it will have completed its motion at the place to which it is in motion. And if a thing is in motion over the whole ABC and its motion is DEF, and if it is not in motion at all over the partless section A but has completed its motion over it, then the motion will consist not of motions but of movings, and will take place by a thing's having completed a motion without being in motion; for on this assumption it has completed its passage through A without passing through it. So it will be possible for a thing to have completed a walk without ever walking; for on this assumption it has completed a walk over a particular distance without walking over that distance. Since, then, everything must be either at rest or in motion, and it is therefore at rest in each of A, B, and C, it follows that a thing can be at the same time continuously at rest and in motion; for, as we saw, it is in motion over the whole ABC and at rest in any part (and consequently in the whole) of it. Moreover, if the indivisibles composing DEF are motions, it would be possible for a thing in spite of the presence in it of motion to be not in motion but at rest; while if they are not motions, it would be possible for motion to be composed of something other than motions.

And if length and motion are thus indivisible, it is similarly necessary that time also be indivisible, that is to say be composed of indivisible nows; for if every motion is divisible and bodies of equal velocity will move less in less time, the time must also be divisible; and if the time in which a thing is carried over A is divisible, A must also be divisible.

2 · And since every magnitude is divisible into magnitudes—for we have shown that it is impossible for anything continuous to be composed of indivisible parts, and every magnitude is continuous—it necessarily follows that the quicker of two things traverses a greater magnitude in an equal time, an equal magnitude in less time, and a greater magnitude in less time, in conformity with the definition sometimes given of the quicker. Suppose that A is quicker than B. Now since of two things that which changes sooner is quicker, in the time FG, in which A has changed from C to D, B will not yet have arrived at D but will be short of it: so that in an equal time the quicker will pass over a greater magnitude. More than this, it will pass over a greater magnitude in less time; for in the time in which A has arrived at D, B being the slower has arrived, let us say, at E. Then since A has occupied the whole time FG in arriving at D, it will have arrived at H in less time than this, say FJ. Now the magnitude CH that A has passed over is greater than the magnitude CE, and the time FJ is less than the whole time FG; so that the quicker will pass over a greater magnitude in less time. And from this it is also clear that the quicker will pass over an equal magnitude in less time than the slower. For since it passes over the greater magnitude in less time than the slower, and (regarded by

itself) passes over the greater in more time than the lesser—LM than LN—, the time PR in which it passes over LM will be more than the times PS in which it passes over LN: so that, the time PR being less than the time T in which the slower passes over LN, PS will also be less than T; for it is less than PR, and that which is less than something less is also itself less. Hence it will traverse an equal magnitude in less time. Again, since the motion of anything must always occupy either an equal time or less or more time, and since, whereas a thing is slower if its motion occupies more time and of equal velocity if its motion occupies an equal time, the quicker is neither of equal velocity nor slower, it follows that the motion of the quicker can occupy neither an equal time nor more time. It can only be, then, that it occupies less time, and thus it is necessary that the quicker will pass over an equal magnitude too in less time.

And since every motion is in time and a motion may occupy any time, and the motion of everything that is in motion may be either quicker or slower, both quicker motion and slower motion may occupy any time: and this being so, it necessarily follows that time also is continuous. By continuous I mean that which is divisible into divisibles that are always divisible: and if we take this as the definition of continuous, it follows necessarily that time is continuous. For since it has been shown that the quicker will pass over an equal magnitude in less time than the slower, suppose that A is quicker and B slower, and that the slower has traversed the magnitude CD in the time FG. Now it is clear that the quicker will traverse the same magnitude in less time than this: let us say in the time FH. Again, since the quicker has passed over the whole CD in the time FH, the slower will in the same time pass over CJ, say, which is less than CD. And since B, the slower, has passed over CJ in the time FH, the quicker will pass over it in less time: so that the time FH will again be divided. And if this is divided the magnitude CJ will also be divided in the same ratio; and again, if the magnitude is divided, the time will also be divided. And we can carry on this process for ever, taking the slower after the quicker and the quicker after the slower, and using what has been demonstrated; for the quicker will divide the time and the slower will divide the length. If, then, this alternation always holds good, and at every turn involves a division, it is evident that all time must be continuous. And at the same time it is clear that all magnitude is also continuous; for the divisions of which time and magnitude respectively are susceptible are the same and equal.

Moreover, the current arguments make it plain that, if time is continuous, magnitude is continuous also, inasmuch as a thing passes over half a given magnitude in half the time, and in general over a less magnitude in less time; for the divisions of time and of magnitude will be the same. And if either is infinite, so is the other, and the one is so in the same way as the other; i.e. if time is infinite in respect of its extremities, length is also infinite in respect of its extremities; if time is infinite in respect of divisibility, length is also infinite in respect of divisibility; and if time is infinite in both respects, magnitude is also infinite in both respects.

Hence Zeno's argument makes a false assumption in asserting that it is impossible for a thing to pass over or severally to come in contact with infinite things in a finite time. For there are two ways in which length and time and generally anything continuous are called infinite: they are called so either in respect of divisibility or in respect of their extremities. So while a thing in a finite time cannot come in contact with things quantitatively infinite, it can come in contact with things infinite in respect of divisibility; for in this sense the time itself is also infinite: and so we find that the time occupied by the passage over the infinite is not a finite but an infinite time, and the contact with the infinites is made by means of moments not finite but infinite in number.

The passage over the infinite, then, cannot occupy a finite time, and the passage over the finite cannot occupy an infinite time: if the time is infinite the magnitude must be infinite also, and if the magnitude is infinite, so also is the time.
233b1 Let AB be a finite magnitude, and an infinite time C, and let a finite period CD of the time be taken. Now in this period the thing will pass over a certain segment of the magnitude: let BE be the segment that it has thus passed over. (This will be either an exact measure of AB or less or greater than an exact measure: it makes no difference which it is.) Then, since a magnitude equal to BE will always be passed over in an equal time, and BE measures the whole magnitude, the whole time occupied in passing over AB will be finite; for it will be divisible into periods equal in number to the segments into which the magnitude is divisible. Moreover, if it is the case that infinite time is not occupied in passing over every magnitude, but it is possible to pass over some magnitude, say BE, in a finite time, and if this measures the whole, and if an equal magnitude is passed over in an equal time, then it follows that the time too is finite. That infinite time will not be occupied in passing over BE is evident if the time be taken as limited in one direction; for as the part will be passed over in less time than the whole, this must be finite, the limit in one direction being given. The same demonstration will also show the falsity of the assumption that infinite length can be traversed in a finite time. It is evident, then, from what has been said that neither a line nor a surface nor in fact anything continuous can be indivisible.

This conclusion follows not only from the present argument but from the consideration that the opposite assumption implies the divisibility of the indivisible. For since the distinction of quicker and slower may apply to motions occupying any period of time and in an equal time the quicker passes over a greater length, it may happen that it will pass over a length twice, or one and a half times, as great as that passed over by the slower; for their respective velocities may stand to one another in this proportion. Suppose, then, that the quicker has in the same time been carried over a length one and a half times as great, and that the respective magnitudes are divided, that of the quicker into three indivisibles, AB, BC, CD, and that of the slower into two, EF, FG. Then the time may also be divided into three indivisibles; for an equal magnitude will be passed over in an equal time. Suppose then that it is thus divided into KL, LM, MN. Again, since in the same time the slower has been carried over EZ, ZH, the time may also be divided into two. Thus the indivisible will be divisible, and that which has no parts will be passed over not in an indivisible but in a greater time. It is evident, therefore, that nothing continuous is without parts.

3 · Necessarily, too, the now—the now so-called not derivatively but in its own right and primarily—is indivisible and is inherent in all time. For the now is an extremity of the past (no part of the future being on this side of it), and again of the 234a1 future (no part of the past being on that side of it): it is, we maintain, a limit of both. And if it is proved that it is of this character and one and the same, it will at once be evident also that it is indivisible.

Now the now that is the extremity of both times must be one and the same; for if each extremity were different, the one could not be in succession to the other, because nothing continuous can be composed of things having no parts; and if the one is apart from the other, there will be time between them, because everything continuous is such that there is something between its limits described by the same name as itself. But if the intermediate thing is time, it will be divisible; for all time has been shown to be divisible. Thus on this assumption the now is divisible. But if the now is divisible, there will be part of the past in the future and part of the future in the past; for past time will be marked off from future time at the actual point of division. Also the now will be a now not in its own right but derivatively, for the division will not be a division in its own right. Furthermore, there will be a part of the now that is past and a part that is future, and it will not always be the same part that is past or future. Nor, then, will the now be the same; for the time may be divided at many points. If, therefore, the now cannot possibly have these characteristics, it follows that it must be the same now that belongs to each of the two times. But if it is the same, it is evident that it is also indivisible; for if it is divisible it will be involved in the same implications as before. It is clear, then, from what has been said that time contains something indivisible, and this is what we call the now.

We will now show that nothing can be in motion in a now. For if this is possible, there can be both quicker and slower motion. Suppose then that in the now N the quicker has traversed the distance AB. That being so, the slower will in the same now have traversed a distance less than AB, say AC. But since the slower will have occupied the whole now in traversing AC, the quicker will occupy less than this in traversing it. Thus we shall have a division of the now, whereas we found it to be indivisible. It is impossible, therefore, for anything to be in motion in a now.

Nor can anything be at rest; for we assert that, that only can be at rest which is of such a nature to be in motion but is not in motion when, where, or as it would naturally be so; since, therefore, nothing is of such a nature as to be in motion in a now, it is clear that nothing can be at rest either.

Moreover, inasmuch as it is the same now that belongs to both the times, and it is possible for a thing to be in motion throughout one time and to be at rest 234b1 throughout the other, and that which is in motion or at rest for the whole of a time will be in motion or at rest in any part of it in which it is of such a nature as to be in motion or at rest: it will follow that the same thing can at the same time be at rest and in motion; for both the times have the same extremity, viz. the now.

Again, we say that a thing is at rest if its condition in whole and in part is uniform now and before; but the now contains no before; consequently, there can be no rest in it.

It follows then that the motion of that which is in motion and the rest of that which is at rest must occupy time.

4 · Further, everything that changes must be divisible. For since every change is from something to something, and when a thing is at the point to which it was changing it is no longer changing, and when both it itself and all its parts are at the point from which it was changing it is not[39] changing (for that which is in whole and in part in an unvarying condition is not in a state of change); it follows, therefore, that part of that which is changing must be at the starting-point and part at the goal; for it cannot be in both or in neither. (Here by 'goal of change' I mean that which comes first in the process of change: e.g. in a process of change from white the goal in question will be grey, not black; for it is not necessary that that which is changing should be at either of the extremes.) It is evident, therefore, that everything that changes must be divisible.

Now motion is divisible in two ways—in virtue of the time that it occupies, according to the motions of the parts of that which is in motion: e.g. if the whole AC is in motion, there will be a motion of AB and a motion of BC. Let DE be the motion of the part AB and EF the motion of the part BC. Then the whole DF must be the motion of AC; for it must constitute its motion inasmuch as they severally constitute the motions of each of its parts. But the motion of a thing can never be constituted by the motion of something else; consequently the whole motion is the motion of the whole magnitude.

Again, since every motion is a motion of something, and the whole motion DF is not the motion of either of the parts (for each of the parts is the motion of one of the parts) or of anything else (for, the whole motion being the motion of a whole, the parts of the motion are the motions of the parts of that whole; and the parts are the motions of AB, BC and of nothing else; for, as we saw, a motion that is one cannot be the motion of more things than one): since this is so, the whole motion will be the motion of the magnitude ABC.

Again, if there is a motion of the whole other than DF, say HI, the motion of each of the parts may be subtracted from it; and these motions will be equal to DE, EF; for the motion of that which is one must be one. So if the whole motion HI may be divided into the motions of the parts, HI will be equal to DF; if on the other hand there is any remainder, say KI, this will be a motion of nothing; for it can be the motion neither of the whole nor of the parts (as the motion of that which is one must be one) nor of anything else (for a motion that is continuous must be the motion of things that are continuous). And the same result follows if the division of HI reveals a surplus. Consequently, if this is impossible, the whole motion must be the same as and equal to DF.

This then is what is meant by the division of motion according to the motions of the parts; and it must be applicable to everything that is divisible into parts.

Motion is also susceptible of another kind of division, that according to time. For since all motion is in time and all time is divisible, and in less time the motion is

[39]Retaining οὐ (MSS) for Ross's οὔπω.

less, it follows that every motion must be divisible according to time. And since everything that is in motion is in motion in a certain sphere and for a certain time and has a motion belonging to it, it follows that the time, the motion, the being-in-motion, the thing that is in motion, and the sphere of the motion must all be susceptible of the same divisions (though spheres of motion are not all divisible in a like manner: thus place is essentially, quality accidentally divisible). For suppose that A is the time occupied by the motion B. Then if all the time has been occupied by the whole motion, it will take less of the motion to occupy half the time, less again to occupy a further subdivision of the time, and so on always. Similarly, if the motion is divisible, the time too will be divisible; for if the whole motion occupies all the time half the motion will occupy half the time, and less of the motion again will occupy less of the time.

In the same way the being-in-motion will also be divisible. For let C be the whole being-in-motion. Then the being-in-motion that corresponds to half the motion will be less than the whole being-in-motion, that which corresponds to a quarter of the motion will be less again, and so on always. Moreover by setting out the being-in-motion corresponding to each of the two motions DC (say) and CE, we may argue that the whole being-in-motion will correspond to the whole motion (for if something else did, there would be more than one being-in-motion corresponding to the same motion), the argument being the same as that whereby we showed that the motion of a thing is divisible into the motions of the parts of the thing; for if we take the being-in-motion corresponding to each of the two motions, we shall see that the whole is continuous.

The same reasoning will show the divisibility of the length, and in fact of everything that forms a sphere of change (though some of these are only accidentally divisible because that which changes is so); for the division of one term will involve the division of all. So, too, in the matter of their being finite or infinite, they will all alike be either the one or the other. And we now see that in most cases the fact that all the terms are divisible or infinite is a direct consequence of the fact that the thing that changes is divisible or infinite; for the attributes 'divisible' and 'infinite' belong in the first instance to the thing that changes. That divisibility does so we have already shown; that infinity does so will be made clear in what follows.

5 · Since everything that changes changes from something to something, that which has changed must at the moment when it has first changed be in that to which it has changed. For that which changes retires from or leaves that from which it changes; and leaving, if not identical with changing, is at any rate a consequence of it. And if leaving is a consequence of changing, having left is a consequence of having changed; for there is a like relation between the two in each case.

One kind of change, then, being change in a relation of contradiction, where a thing has changed from not-being to being it has left not-being. Therefore it will be in being; for everything must either be or not be. It is evident, then, that in contradictory change that which has changed must be in that to which it has changed. And if this is true in this kind of change, it will be true in all other kinds as well; for what holds good in the case of one will hold good likewise in the case of the rest.

Moreover, if we take each kind of change separately, the truth of our conclusion will be equally evident, on the ground that that which has changed must be somewhere or in something. For, since it has left that from which it has changed and must be somewhere, it must be either in that to which it has changed or in something else. If, then, that which has changed to B is in something other than B, say C, it must again be changing from C to B; for B was not assumed to be contiguous, and change is continuous. Thus we have the result that the thing that has changed, at the moment when it has changed, is changing to that to which it has changed, which is impossible: that which has changed, therefore, must be in that to which it has changed. So it is evident likewise that that which has come to be, at the moment when it has come to be, will *be,* and that which has ceased to be will *not be;* for what we have said applies universally to every kind of change, and its truth is most obvious in the case of contradictory change. It is clear, then, that that which has changed, at the moment when it has first changed, is in that to which it has changed.

Now the time primarily in which that which has changed has changed must be indivisible, where by 'primary' I mean a thing's being such-and-such not because some part of it is such-and-such. For let AC be divisible, and let it be divided at B. If then it has changed in AB or again in BC, AC cannot be the primary thing in which it has changed. If, on the other hand, it has been changing in both AB and BC (for it must either have changed or be changing in each of them), it must have been changing in the whole too; but our assumption was that it *had* changed in that. The same argument applies if we suppose that it changes in one part and has changed in the other; for then we shall have something prior to what is primary. So that in which a thing has changed must be indivisible. It is also evident, therefore, that that in which that which has ceased to be has ceased to be and that in which that which has come to be has come to be are indivisible.

But there are two ways of talking about that primarily in which something has changed. On the one hand it may mean the primary time at which the change is completed—the moment when it is correct to say 'it has changed'; on the other hand it may mean the primary time at which it began to change. Now the primary time that has reference to the *end* of the change is something really existent; for a change may be completed, and there is such a thing as an end of change, which we have in fact shown to be indivisible because it is a limit. But that which has reference to the beginning is not existent at all; for there is no such thing as a beginning of change, nor any primary time at which it was changing. For suppose that AD is such a primary time. Then it cannot be indivisible; for, if it were, the nows will be consecutive. Again, if the changing thing is at rest in the whole time CA (for we may suppose that it is at rest), it is at rest in A also; so if AC is without parts, it will simultaneously be at rest and have changed; for it is at rest in A and has changed in D. Since then AD is not without parts, it must be divisible, and the changing thing must have changed in every part of it (for if it has changed in neither of the two parts into which AD is divided, it has not changed in the whole either; if, on the other hand, it is changing in both parts, it is likewise changing in the whole; and if, again,[40] it has changed in one of the two parts, the whole is not the primary time in which it has changed: it must therefore have changed in every part). It is evident, then, that there is no primary time in which it has changed; for the divisions are infinite.

So, too, of that which has changed there is no primary part that has changed. For suppose that of DE the primary part that has changed is DF (everything that changes having been shown to be divisible); and let HI be the time in which DF has changed. If, then, in the whole time DF has changed, in half the time there will be a part that has changed, less than and prior to DF; and again there will be another part prior to this, and yet another, and so on always. Thus of that which changes there cannot be any primary part that has changed. It is evident, then, from what has been said, that neither of that which changes nor of the time in which it changes is there any primary part.

With regard, however, to the actual subject of change—that is to say that in respect of which a thing changes—there is a difference to be observed. For in a 236b1
process of change we may distinguish three terms—that which changes, that in which it changes, and that to which it changes, e.g. the man, the time, and the pallor. Of these the man and the time are divisible; but with the pallor it is otherwise (though they are all divisible accidentally; for that of which the pallor or any other quality is an accident is divisible). For things which are divisible in their own right and not accidentally have no primary part. Take the case of magnitudes: let AB be a magnitude, and suppose that it has moved from B to a primary C. Then if BC is taken to be indivisible, two things without parts will have to be contiguous; if on the other hand it is taken to be divisible, there will be something prior to C to which the magnitude has changed, and something else again prior to that, and so on to always, because the process of division never gives out. Thus there can be no primary thing to which a thing has changed. And if we take the case of quantitative change, we shall get a like result; for here too the change is in something continuous. It is evident, then, that only in qualitative motion can there be anything indivisible in its own right.

6 · Now everything that changes changes in time, and that in two senses may be the primary time, or it may be derivative, as e.g. when we say that a thing changes in a particular year because it changes in a particular day. That being so, that which changes must be changing in any part of the primary time in which it changes. This is clear from our definition of primary, in which the word is said to express just this; it may also, however, be made evident by the following argument. Let TR be the primary time in which that which is in motion is in motion; and (as all time is divisible) let it be divided at K. Now in the time TK it either is in motion or is not in motion, and the same is likewise true of the time TR. Then if it is in motion in

[40]Retaining the MSS reading εἰ δ' for Ross's εἴτ'.

neither of the two parts, it will be at rest in the whole; for it is impossible that it should be in motion in a time in no part of which it is in motion. If on the other hand it is in motion in only one of the two parts of the time, TR cannot be the primary time in which it is in motion; for its motion will have reference to a time other than TR. It must, then, be moving in any part of TR.

And now that this has been proved, it is evident that everything that is in motion must have been in motion before. For if that which is in motion has traversed the distance KL in the primary time TR, in half the time a thing that is in motion with equal velocity and began its motion at the same time will have traversed half the distance. But if the thing whose velocity is equal has traversed a certain distance in the same time, the original thing that is in motion must have traversed the same distance. Hence that which is in motion must have been in motion before.

Again, if by taking the extreme now of the time—for it is the now that defines the time, and time is that which is intermediate between nows—we are enabled to say that motion has taken place in the whole time TR or in fact in any period of it, motion may likewise be said to have taken place in every other such period. But half the time finds an extreme in the point of division. Therefore motion will have taken place in half the time and in fact in any part of it; for as soon as any division is made there is always a time defined by nows. If, then, all time is divisible, and that which is intermediate between nows is time, everything that is changing must have completed an infinite number of changes.

Again, since a thing that changes continuously and has not perished or ceased from its change must either be changing or have changed in any part of the time of its change, and since it cannot be changing in a now, it follows that it must have changed at every now in the time: consequently, since the nows are infinite in number, everything that is changing must have completed an infinite number of changes.

And not only must that which is changing have changed, but that which has changed must also previously have been changing, since everything that has changed from something to something has changed in a period of time. For suppose that a thing has changed from A to B in a now. Now the now in which it has changed cannot be the same as that in which it is at A (since in that case it would be in A and B at once); for we have shown above that that which has changed, when it has changed, is not in that from which it has changed. If, on the other hand, it is a different now, there will be a period of time intermediate between the two; for, as we saw, nows are not consecutive. Since, then, it has changed in a period of time, and all time is divisible, in half the time it will have completed another change, in a quarter another, and so on always: consequently it must have previously been changing.

Moreover, the truth of what has been said is more evident in the case of magnitude, because the magnitude over which what is changing is continuous. For suppose that a thing has changed from C to D. Then if CD is indivisible, two things without parts will be consecutive. But since this is impossible, that which is intermediate between them must be a magnitude and divisible into an infinite number of segments: consequently, it has previously been changing to those segments. Everything that has changed, therefore, must previously have been changing; for the same demonstration also holds good of change with respect to 237b1 what is not continuous, changes, that is to say, between contraries and between contradictories. In such cases we have only to take the time in which a thing has changed and again apply the same reasoning. So that which has changed must have been changing and that which is changing must have changed, and a process of change is preceded by a completion of change and a completion by a process; and we can never take any first stage. The cause of this is that no two things without parts can be contiguous; for the division is infinite, as in the case of lines which are increasing and decreasing.

So it is evident also that that which has become must previously have been becoming, and that which is becoming must previously have become, everything (that is) that is divisible and continuous; though it is not always the actual thing that is becoming of which this is true: sometimes it is something else, that is to say, some part of the thing in question, e.g. the foundation-stone of a house. So, too, in the case of that which is perishing and that which has perished; for that which becomes and that which perishes must contain an element of infiniteness since they are continuous things; and so a thing cannot be becoming without having become or have become without having been becoming. So, too, in the case of perishing and having perished: perishing must be preceded by having perished, and having perished by perishing. It is evident, then, that that which has become must previously have been becoming, and that which is becoming must previously have become; for all magnitudes and all periods of time are always divisible. Consequently, whatever a thing may be in, it is not in it primarily.

7 · Now since the motion of everything that is in motion occupies a period of time, and a greater magnitude is traversed in a longer time, it is impossible that a thing should undergo a finite motion in an infinite time, if this is understood to mean not that the same motion or a part of it is continually repeated, but that the whole is occupied by the whole. In all cases where a thing is in motion with uniform velocity it is clear that the finite magnitude is traversed in a finite time. For if we take a part of the motion which shall be a measure of the whole, the whole motion is completed in as many equal periods of the time as there are parts of the motion. Consequently, since these parts are finite, both in size individually and in number collectively, the whole time must also be finite; for it will be a multiple equal to the time occupied in completing the part multiplied by the number of the parts.

But it makes no difference even if the velocity is not uniform. For let us suppose that the line AB represents a finite stretch over which a thing has been moved in the infinite time, and let CD be the infinite time. Now if one part of the 238a1 stretch must have been traversed before another part (this is clear, that in the earlier and in the later part of the time a different part of the stretch has been traversed; for as the time lengthens a different part of the motion will always be completed in it, whether it changes with uniform velocity or not; and whether the motion increases or diminishes or remains stationary this is none the less so), let us then take AE a part of the interval AB which shall be a measure of AB. Now this occupies a certain period of the infinite time: it cannot itself occupy an infinite time, for that is occupied by the whole AB. And if again I take another part equal to AE, that also must occupy a finite time in consequence of the same assumption. And if I go on taking parts in this way, since there is no part which will be a measure of the infinite time (for the infinite cannot be composed of finite parts whether equal or unequal, because there must be some unity which will be a measure of things finite in multitude or in magnitude, which, whether they are equal or unequal, are none the less limited in magnitude), and the finite interval is measured by the quantities AE: consequently the motion AB must be accomplished in a finite time. (It is the same with coming to rest.) And so it is impossible for one and the same thing to be always in process of becoming or of perishing.

The same reasoning will prove that in a finite time there cannot be an infinite extent of motion or of coming to rest, whether the motion is regular or irregular. For if we take a part which shall be a measure of the whole time, in this part a certain fraction, not the whole, of the magnitude will be traversed, because the whole occupies all the time. Again, in another equal part of the time another part of the magnitude will be traversed; and similarly in each part of the time that we take, whether equal or unequal to the part originally taken. It makes no difference whether the parts are equal or not, if only each is finite; for it is clear that while the time is exhausted, the infinite magnitude will not be exhausted, since the process of subtraction is finite both in respect of the quantity subtracted and of the number of times a subtraction is made. Consequently the infinite magnitude will not be traversed in a finite time; and it makes no difference whether the magnitude is infinite in only one direction or in both; for the same reasoning will hold good.

This having been proved, it is evident that neither can a finite magnitude traverse an infinite magnitude in a finite time, the reason being the same as that given above: in part of the time it will traverse a finite magnitude and in each several part likewise, so that in the whole time it will traverse a finite magnitude.

And since a finite magnitude will not traverse an infinite in a finite time, it is clear that neither will an infinite traverse a finite. For if the infinite could traverse the finite, the finite could traverse the infinite; for it makes no difference which of the two is the thing in motion: either case involves the traversing of the infinite by the finite. For when the infinite magnitude A is in motion a part of it, say CD, will occupy the finite B, and then another, and then another, and so on to always. Thus the two results will coincide: the infinite will have completed a motion over the finite and the finite will have traversed the infinite; for it would seem to be impossible for the motion of the infinite over the finite to occur in any way other than by the finite traversing the infinite either by locomotion over it or by measuring it. Therefore, since this is impossible, the infinite cannot traverse the finite.

Nor again will the infinite traverse the infinite in a finite time. Otherwise it would also traverse the finite, for the infinite includes the finite. We can further prove this in the same way by taking the time as our starting-point.

Since, then, in a finite time neither will the finite traverse the infinite, nor the infinite the finite, nor the infinite the infinite, it is evident also that in a finite time there cannot be infinite motion; for what difference does it make whether we take the motion or the magnitude to be infinite? If either of the two is infinite, the other must be so too; for all locomotion is in place.

8 · Since everything to which motion or rest is natural is in motion or at rest in the natural time, place, and manner, that which is coming to a stand, when it is coming to a stand, must be in motion; for if it is not in motion it must be at rest; but that which is at rest cannot be coming to rest. From this it evidently follows that coming to a stand must occupy a period of time; for the motion of that which is in motion occupies a period of time, and that which is coming to a stand has been shown to be in motion: consequently coming to a stand must occupy a period of time.

Again, since the terms 'quicker' and 'slower' are used only of that which occupies a period of time, and the process of coming to a stand may be quicker or slower, the same conclusion follows.

And that which is coming to a stand must be coming to a stand in any part of the primary time in which it is coming to a stand. For if it is coming to a stand in neither of two parts into which the time may be divided, it cannot be coming to a stand in the whole time, with the result that that which is coming to a stand will not be coming to a stand. If on the other hand it is coming to a stand in only one of the two parts, the whole cannot be the primary time in which it is coming to a stand; for it is coming to a stand in this derivatively, as we said before in the case of things in motion.

And just as there is no primary time in which that which is in motion is in motion, so too there is no primary time in which that which is coming to a stand is coming to a stand, there being no primary stage either of being in motion or of coming to a stand. For let AB be the primary time in which a thing is coming to a stand. Now AB cannot be without parts; for there cannot be motion in that which is without parts, because a moving thing would have moved for a part of it, and that which is coming to a stand has been shown to be in motion. But since AB is divisible, the thing is coming to a stand in every one of its parts; for we have shown above that it is coming to a stand in every one of the parts in which it is primarily coming to a stand. Since, then, that in which primarily a thing is coming to a stand must be a period of time and not something indivisible, and since all time is infinitely divisible, there cannot be anything in which primarily it is coming to a stand.

Nor again can there be a primary time at which a thing at rest was resting; for it cannot have been resting in that which has no parts, because there cannot be motion in that which is indivisible, and that in which rest takes place is the same as that in which motion takes place (for we said that rest occurs if a thing which naturally moves is not moving when and at a time in which motion would be natural to it). Again, we say that a thing rests when it is now in the same state as it was in earlier, judging rest not by any one point but by at least two: consequently that in which a thing is at rest cannot be without parts. Since, then, it is divisible, it must be a period of time, and the thing must be at rest in every one of its parts, as may be shown by the same method as that used above.

So there can be no primary time; and the reason is that rest and motion are always in time, and there is no primary time—nor magnitude nor in fact anything continuous; for everything continuous is divisible into an infinite number of parts.

And since everything that is in motion is in motion in time and changes from something to something, in the time in which in its own right (i.e. not merely in a part of the time) something moves, it is impossible that that which is in motion should be over against some particular thing primarily. For if a thing—itself and each of its parts—occupies the same space for a definite period of time, it is at rest; for it is in just these circumstances that we use the term 'being at rest'—when at one now after another it can be said with truth that a thing, itself and its parts, occupies the same space. So if this is being at rest it is impossible for that which is changing to be as a whole, at the time when it is primarily changing, over against any particular thing (for the whole period of time is divisible), so that in one part of it after another it will be true to say that the thing, itself and its parts, occupies the same space. If this is not so and the aforesaid proposition is true only at a single now, then the thing will be over against a particular thing not for any period of time but only at a moment that limits the time. It is true that at any now it is always over against something; but it is not at rest; for at a now it is not possible for anything to be either in motion or at rest. So while it is true to say that that which is in motion is at a now not in motion and is opposite some particular thing, it cannot in a period of time be at rest over against anything; for that would involve the conclusion that that which is in locomotion is at rest.

9 · Zeno's reasoning, however, is fallacious, when he says that if everything when it occupies an equal space is at rest, and if that which is in locomotion is always in a now, the flying arrow is therefore motionless. This is false; for time is not composed of indivisible nows any more than any other magnitude is composed of indivisibles.

Zeno's arguments about motion, which cause so much trouble to those who try to answer them, are four in number. The first asserts the non-existence of motion on the ground that that which is in locomotion must arrive at the half-way stage before it arrives at the goal. This we have discussed above.[41]

The second is the so-called Achilles, and it amounts to this, that in a race the quickest runner can never overtake the slowest, since the pursuer must first reach the point whence the pursued started, so that the slower must always hold a lead. This argument is the same in principle as that which depends on bisection, though it differs from it in that the spaces with which we have successively to deal are not divided into halves. The result of the argument is that the slower is not overtaken; but it proceeds along the same lines as the bisection-argument (for in both a division of the space in a certain way leads to the result that the goal is not reached, though

[41] See 233a21ff.

the Achilles goes further in that it affirms that even the runner most famed for his speed must fail in his pursuit of the slowest), so that the solution too must be the same. And the claim that that which holds a lead is never overtaken is false: it is not overtaken while it holds a lead; but it is overtaken nevertheless if it is granted that it traverses the finite distance. These then are two of his arguments.

The third is that already given above, to the effect that the flying arrow is at rest, which result follows from the assumption that time is composed of moments: if this assumption is not granted, the conclusion will not follow.

The fourth argument is that concerning equal bodies which move alongside equal bodies in the stadium from opposite directions—the ones from the end of the stadium, the others from the middle—at equal speeds, in which he thinks it follows that half the time is equal to its double. The fallacy consists in requiring that a body travelling at an equal speed travels for an equal time past a moving body and a body of the same size at rest. That is false. E.g. let the stationary equal bodies be AA; let BB be those starting from the middle of the A's[42] (equal in number and in magnitude to them); and let CC be those starting from the end (equal in number and magnitude to them, and equal in speed to the B's). Now it follows that the first B and the first C are at the end at the same time, as they are moving past one another. And it follows that the C has passed all the A's[43] and the B half; so that the time is half, for each of the two is alongside each for an equal time. And at the same time it follows that the first B has passed all the C's. For at the same time the first B and the first C will be at opposite ends,* being an equal time alongside each of the B's as alongside each of the A's, as he says,*[44] because both are an equal time alongside the A's. That is the argument, and it rests on the stated falsity.

Nor in reference to contradictory change shall we find anything impossible—e.g. if it is argued that if a thing is changing from not-white to white, and is in neither condition, then it will be neither white nor not-white; for the fact that it is not *wholly* in either condition will not preclude us from calling it white or not-white. We call a thing white or not-white not because it is wholly either one or the other, but because most of its parts or the most essential parts of it are so: not being in a certain condition is different from not being wholly in that condition. So, too, in the case of being and not-being and all other conditions which stand in a contradictory relation: while the changing thing must of necessity be in one of the two opposites, it is never wholly in either.

Again, in the case of circles and spheres and everything that moves within its own dimensions, it is argued that they will be at rest, on the ground that such things, themselves and their parts, will occupy the same position for a period of time, and that therefore they will be at once at rest and in motion. For, first, the parts do not occupy the same place for any period of time; and secondly, the whole also is always changing to a different position; for the circumference from A is not the same as that from B or C or any other point except accidentally, as a musical man is the

[42]Reading τοῦ μέσου τῶν Α (τοῦ μέσου, Ross).
[43]Reading πάντα τὰ Α (πάντα, Ross).
[44]Ross excises the clause marked * . . . *.

same as a man. Thus one is always changing into another, and the thing will never be at rest. And it is the same with the sphere and everything else which moves within its own dimensions.

10 · That having been demonstrated, we next assert that that which is without parts cannot be in motion except accidentally, i.e. in so far as the body or the magnitude to which it belongs is in motion, just as that which is in a boat may be in motion in consequence of the locomotion of the boat, or a part may be in motion in virtue of the motion of the whole. (By 'that which is without parts' I mean that which is quantitatively indivisible.) For parts have different motions—those in virtue of themselves, and those in virtue of the motion of the whole. The distinction may be seen most clearly in the case of a sphere, in which the velocities of the parts near the centre and of those on the surface are different from one another and from that of the whole; this implies that there is not one motion. As we have said, then, that which is without parts can be in motion in the sense in which a man sitting in a boat is in motion when the boat is travelling, but it cannot be in motion of itself. For suppose that it is changing from AB to BC—either from one magnitude to another, or from one form to another, or from some state to its contradictory—and let D be the primary time in which it undergoes the change. Then in the time in which it is changing it must be either in AB or in BC or partly in one and partly in the other; for this, as we saw, is true of everything that is changing. Now it cannot be partly in each of the two; for then it would be divisible into parts. Nor again can it be in BC; for then it will have changed, whereas the assumption is that it is changing. It remains, then, that in the time in which it is changing, it is in AB. That being so, it will be at rest; for, as we saw, to be in the same condition for a period of time is to be at rest. So it is not possible for that which has no parts to be in motion or to change in any way; for only one condition could have made it possible for it to have motion, viz. that time should be composed of nows, in which case at any now it would have
241a1 moved or changed, so that it would never be in motion, but would always have been moving. But this we have already shown to be impossible: time is not composed of nows, just as a line is not composed of points, and motion is not composed of movings; for this theory simply makes motion consist of indivisibles in exactly the same way as time is made to consist of nows or a length of points.

Again, it may be shown in the following way that there can be no motion of a point or of any other indivisible. That which is in motion can never traverse a space greater than itself without first traversing a space equal to or less than itself. That being so, it is evident that the point also must first traverse a space equal to or less than itself. But since it is indivisible, it is impossible for it to traverse a lesser space first: so it will have to traverse a distance equal to itself. Thus the line will be composed of points; for the point, as it continually traverses a distance equal to itself, will be a measure of the whole line. But since this is impossible, it is likewise impossible for the indivisible to be in motion.

Again, since motion is always in time and never in a now, and all time is divisible, for everything that is in motion there must be a time less than that in which it traverses a distance as great as itself. For that in which it is in motion will be a time, because all motion is in time; and all time has been shown above to be divisible. Therefore, if a point is in motion, there must be a time less than that in which it has itself traversed its own length. But this is impossible; for in less time it must traverse less distance, and thus the indivisible will be divisible into something less, just as the time is so divisible; for that which is without parts and indivisible could be in motion only if it were possible to move in an indivisible now; for in the two questions—that of motion in a now and that of motion of something indivisible—the same principle is involved.

No change is infinite; for every change, whether between contradictories or between contraries, is a change from something to something. Thus in contradictory changes the positive or the negative is the limit, e.g. being is the limit of coming to be and not-being is the limit of ceasing to be; and in contrary changes the particular contraries are the limits, since these are the extreme points of the change, and consequently of every alteration; for alteration is always dependent upon some contraries. Similarly for increase and decrease: the limit of increase is to be found in the complete magnitude proper to the peculiar nature of the thing, while the limit of decrease is the loss of such magnitude. Locomotion, it is true, we cannot show to be finite in this way, since it is not always between contraries. But since that which cannot be cut (in the sense that it is not possible that it should be cut, the term 'cannot' being used in several ways)—since it is not possible that that which in this sense cannot be cut should be being cut, and generally that that which cannot come to be should be coming to be, it follows that it is not possible that that which cannot have changed should be changing to that to which it cannot have changed. If, then, that which is in locomotion is to be changing to something, it must be capable of having changed. Consequently its motion is not infinite, and it will not be in locomotion over an infinite distance; for it cannot have traversed such a distance.

It is evident, then, that a change cannot be infinite in the sense that it is not defined by limits. But it remains to be considered whether it is possible in the sense that one and the same change may be infinite in respect of the time which it occupies. If it is not one change, it would seem that there is nothing to prevent its being infinite; e.g. if a locomotion be succeeded by an alteration and that by an increase and that again by a coming to be: in this way there may be motion for ever so far as the time is concerned; but it will not be one motion, because all these motions do not compose one. If it is to be one, no motion can be infinite in respect of the time that it occupies, with the single exception of rotatory locomotion.

BOOK VII

1 · Everything that is in motion must be moved by something. For if it has not the source of its motion in itself it is evident that it is moved by something other than itself, for there must be something else that moves it. If on the other hand it has

the source of its motion in itself, let AB be taken to represent that which is in motion of itself and not in virtue of the fact that something belonging to it is in motion. Now in the first place to assume that AB, because it is in motion as a whole and is not moved by anything external to itself, is therefore moved by itself—this is just as if, supposing that KL is moving LM and is also itself in motion, we were to deny that KM is moved by anything on the ground that it is not evident which is the part that is moving it and which the part that is moved. In the second place that which is in motion without being moved by anything does not necessarily cease from its motion because something else is at rest; but a thing must be moved by something if the fact of something else having ceased from its motion causes it to be at rest. If this is accepted, everything that is in motion must be moved by something. For if AB is assumed to be in motion, it must be divisible, since everything that is in motion is divisible. Let it be divided, then, at C. Now if CB is not in motion, then AB will not be in motion; for if it is, it is clear that AC would be in motion while BC is at rest, and thus AB cannot be in motion in its own right and primarily. But *ex hypothesi* AB is in motion in its own right and primarily. Therefore if CB is not in motion AB will be at rest. But we have agreed that that which is at rest if something is not in motion must be moved by something. Consequently, everything that is in motion must be moved by something; for that which is in motion will always be divisible, and if a part of it is not in motion the whole must be at rest.

Since everything that is in motion must be moved by something, let us take the case in which a thing is in locomotion and is moved by something that is itself in motion, and that again is moved by something else that is in motion, and that by something else, and so on continually: then the series cannot go on to infinity, but there must be some first mover. For let us suppose that this is not so and take the series to be infinite. Let A then be moved by B, B by C, C by D, and so on, each member of the series being moved by that which comes next to it. Then since *ex hypothesi* the mover while causing motion is also itself in motion, the motion of the moved and the motion of the mover must proceed simultaneously (for the mover is causing motion and the moved is being moved simultaneously); so it is evident that the motions of A, B, C, and each of the other moved movers are simultaneous. Let us take the motion of each separately and let E be the motion of A, F of B, and G and H respectively the motions of C and D; for though they are all moved severally one by another, yet we may still take the motion of each as numerically one, since every motion is from something to something and is not infinite in respect of its extreme points. By a motion that is numerically one I mean a motion that proceeds from something numerically one and the same to something numerically one and the same in a period of time numerically one and the same; for a motion may be the same generically, specifically, or numerically: it is generically the same if it is of the same category, e.g. substance or quality; it is specifically the same if it proceeds from something specifically the same to something specifically the same, e.g. from white to black or from good to bad, which is not of a kind specifically distinct; it is numerically the same if it proceeds from something numerically one to something numerically one in the same time, e.g. from a particular white to a particular black, or from a particular place to a particular place, in a particular time; for if the time were not one and the same, the motion would no longer be numerically one though it would still be specifically one. We have dealt with this question above.[45] Now let us further take the time in which A has completed its motion, and let it be represented by K. Then since the motion of A is finite the time will also be finite. But since the movers and the things moved are infinite, the motion EFGH, i.e. the motion that is composed of all the individual motions, must be infinite. For the motions of A, B, and the others may be equal, or the motions of the others may be greater; but assuming what is possible, we find that whether they are equal or some are greater, in both cases the whole motion is infinite. And since the motion of A and that of each of the others are simultaneous, the whole motion must occupy the same time as the motion of A; but the time occupied by the motion of A is finite: consequently the motion will be infinite in a finite time, which is impossible.

It might be thought that what we set out to prove has thus been shown, but our argument so far does not prove it, because it does not yet prove that anything impossible results; for in a finite time there may be an infinite motion, though not of one thing, but of many: and in the case that we are considering this is so; for each thing accomplishes its own motion, and there is no impossibility in many things being in motion simultaneously. But if (as we see to be universally the case) that which primarily moves locally and corporeally must be either in contact with or continuous with that which is moved, the things moved and the movers must be continuous or in contact with one another, so that together they all form a unity: whether this unity is finite or infinite makes no difference to our present argument; for in any case since the things in motion are infinite in number the motion will be infinite, if it is possible for the motions to be either equal to or greater than one another; for we shall take as actual that which is possible. If, then, A, B, C, D form, either finite or infinite magnitude that passes through the motion EFGH in the finite time K, it follows that an infinite motion is passed through in a finite time: and whether the magnitude in question is finite or infinite this is in either case impossible. Therefore the series must come to an end, and there must be a first mover and a first moved; for the fact that this impossibility rests on an assumption is immaterial, since the case assumed is possible, and the assumption of a possible case ought not to give rise to any impossible result.

2 · That which is the first mover of a thing—in the sense that it supplies not that for the sake of which but the source of the motion—is always together with that which is moved by it (by 'together' I mean that there is nothing between them). This is universally true wherever one thing is moved by another. And since there are three kinds of motion, local, qualitative, and quantitative, there must also be three kinds of mover, that which causes locomotion, that which causes alteration, and that which causes increase or decrease.

Let us begin with locomotion, for this is the primary motion. Everything that is

[45] See 227^b3ff.

in locomotion is moved either by itself or by something else. In the case of things that are moved by themselves it is evident that the moved and the mover are together; for they contain within themselves their first mover, so that there is nothing in between. The motion of things that are moved by something else must proceed in one of four ways; for there are four kinds of locomotion caused by something other than that which is in motion, viz. pulling, pushing, carrying, and twirling. All forms of locomotion are reducible to these. Thus pushing on is a form of pushing in which that which is causing motion away from itself follows up that which it pushes and continues to push it; pushing off occurs when the mover does not follow up the thing that it has moved; throwing when the mover causes a motion away from itself more violent than the natural locomotion of the thing moved, which continues its course so long as it is controlled by the motion imparted to it. Again, pushing apart and pushing together are forms respectively of pushing off and pulling: pushing apart is pushing off, which may be a motion either away from the pusher or away from something else, while pushing together is pulling, which may be a motion towards something else as well as towards the puller. We may similarly classify all the varieties of these last two, e.g. packing and combing: the former is a form of pushing together, the latter a form of pushing apart. The same is true of the other processes of combination and separation (they will all be found to be forms of pushing apart or of pushing together), except such as are involved in the processes of becoming and perishing. (At the same time it is evident that combination and separation are not a different kind of motion; for they may all be apportioned to one or other of those already mentioned.) Again, inhaling is a form of pulling, exhaling a form of pushing; and the same is true of spitting and of all other motions that proceed through the body, whether excretive or assimilative, the assimilative being forms of pulling, the excretive of pushing off. All other kinds of locomotion must be similarly reduced; for they all fall under one or other of our four heads. And again, of these four, carrying and twirling are reducible to pulling and pushing. For carrying always follows one of the other three methods; for that which is carried is in motion accidentally, because it is in or upon something that is in motion, and that which carries it is in doing so being either pulled or pushed or twirled; thus carrying belongs to all the other three kinds of motion in common. And twirling is a compound of pulling and pushing; for that which is twirling a thing must be pulling one part of the thing and pushing another part, since it impels one part away from itself and another part towards itself. If, therefore, it can be shown that that which is pushing and that which is pulling are together with that which is being pushed and that which is being pulled, it will be evident that in all locomotion there is nothing between moved and mover.

But the former fact is clear even from the definitions; for pushing is motion to something else from oneself or from something else, and pulling is motion from something else to oneself or to something else, when the motion of that which is pulling is quicker than the motion that would separate from one another the two things that are continuous; for it is this that causes one thing to be pulled on along with the other. (It might indeed be thought that there is a form of pulling that arises in another way: that wood, e.g. pulls fire in a manner different from the described above. But it makes no difference whether that which pulls is in motion or is stationary when it is pulling: in the latter case it pulls to the place where it is, while in the former it pulls to the place where it was.) Now it is impossible to move anything either from oneself to something else or from something else to oneself without being in contact with it: it is evident, therefore, that in all locomotion there is nothing between moved and mover.

Nor again is there anything intermediate between that which undergoes and that which causes alteration: this can be shown by induction; for in every case we find that the respective extremities of that which causes and that which undergoes alteration are together. For our assumption is that things that are undergoing alteration are altered in virtue of their being affected in respect of their so-called affective qualities; for every body differs from another in possessing a greater or lesser number of sensible characteristics or in possessing the same sensible characteristics in a greater or lesser degree. But the alteration of that which undergoes alteration is also caused by the above-mentioned characteristics, which are affections of some underlying quality. Thus we say that a thing is altered by becoming hot or sweet or thick or dry or white; and we make these assertions alike of what is inanimate and of what is animate, and further, where animate things are in question, we make them both of the parts that have no power of sense-perception and of the senses themselves. For in a way even the senses undergo alteration, since actual perception is a motion through the body in the course of which the sense is affected in a certain way. Thus the animate is capable of every kind of alteration of which the inanimate is capable; but the inanimate is not capable of every kind of alteration of which the animate is capable, since it is not capable of alteration in respect of the senses: moreover the inanimate is unconscious of being affected, whereas the animate is conscious of it, though there is nothing to prevent the animate also being unconscious of it when the alteration does not concern the senses. Since, then, the alteration of that which undergoes alteration is caused by sensible things, in every case of such alteration it is evident that the extremities of that which causes and that which undergoes alteration are together. For the air is continuous with the one and the body with the air. Again, the colour is continuous with the light and the light with the sight. And the same is true of hearing and smelling; for the primary mover in respect to the moved is the air. Similarly, in the case of tasting, the flavour is together with the sense of taste. And it is just the same in the case of things that are inanimate and incapable of sense-perception. Thus there can be nothing between that which undergoes and that which causes alteration.

Nor, again, can there be anything between that which suffers and that which causes increase; for that which starts the increase does so by becoming attached in such a way that the whole becomes one. Again, the decrease of that which suffers decrease is caused by a part of the thing becoming detached. So both that which causes increase and that which causes decrease must be continuous; and if two things are continuous there can be nothing between them.

245b1 It is evident, therefore, that between the moved and the mover—the first and the last—in reference to the moved there is nothing intermediate.

3 · That everything which undergoes alteration is altered by sensible causes, and that there is alteration only in things that are said to be affected in their own right by sensible things, can be seen from the following considerations. Of all other things it would be most natural to suppose that there is alteration in figures and shapes, and in states and in the processes of acquiring and losing these; but as a matter of fact in neither of these two cases is there alteration.

For when anything has been completely shaped or structured, we do not call it by the name of its material: e.g. we do not call the statue bronze or the candle wax or the bed wood, but we use a paronymous expression and call them brazen, waxen, and wooden respectively. But when a thing has been affected and altered in any way we still call it by the original name: thus we speak of the bronze or the wax being fluid or hard or hot (not only that—we also call the fluid and the hot stuff bronze), giving the matter the same name as the affection.

246a1 Since, therefore, having regard to the figure or shape of a thing we no longer call that which has become of a certain figure by the name of the material that exhibits the figure, whereas having regard to a thing's affections or alterations we do, it is evident that becomings of the former kind[46] cannot be alterations.

Moreover it would seem absurd actually to speak in this way, to speak, that is to say, of a man or house or anything else that has come into existence as having been altered. Though it may be true that every such becoming is necessarily the result of something's being altered, the result, e.g. of the matter's being condensed or rarefied or heated or cooled, nevertheless it is not the things that are coming into existence that are altered, and their becoming is not an alteration.

Again, states, whether of the body or of the soul, are not alterations. For some are excellences and others are defects, and neither excellence nor defect is an alteration: excellence is a perfection (for when anything acquires its proper excellence we call it perfect, since it is then really in its natural state: e.g. a circle is perfect when it becomes really a circle and when it is best), while defect is a perishing of or departure from this condition. So just as when speaking of a house we do not call its arrival at perfection an alteration (for it would be absurd to suppose that the coping or the tiling is an alteration or that in receiving its coping or its tiling a house is altered and not perfected), the same also holds good in the case
246b1 of excellences and defects and of the things that possess or acquire them; for excellences are perfections and defects are departures: consequently they are not alterations.

Further, we say that all excellences depend upon particular relations. Thus bodily excellences such as health and fitness we regard as consisting in a blending of hot and cold elements in due proportion, in relation either to one another within the

[46]Reading αἱ γενέσεις αὗται (αἱ γενέσεις, Ross).

body or to the surrounding; and in like manner we regard beauty, strength, and all the other excellences and defects. Each of them exists in virtue of a particular relation and puts that which possesses it in a good or bad condition with regard to its proper affections, where by 'proper' affections I mean those by which the thing is naturally produced or destroyed. Since, then, relatives are neither themselves alterations nor the subjects of alterations or of becoming or in fact of any change whatever, it is evident that neither states nor the processes of losing and acquiring states are alterations, though it may be true that their becoming or perishing, like that of form and shape, necessarily involves the alteration of certain other things, e.g. hot and cold or dry and wet elements or the elements, whatever they may be, on which the states primarily depend. For each defect or excellence involves a relation with those things from which the possessor is naturally subject to alteration: thus excellence disposes its possessor to be unaffected or to be affected thus and so, while defect disposes its possessor to be affected or to be unaffected in a contrary way.

And the case is similar in regard to the states of the soul, all of which too exist 247a1
in virtue of particular relations, the excellences being perfections and the defects departures. Moreover, excellence puts its possessor in good condition, while defect puts its possessor in a bad condition, with regard to its proper affections. Consequently these cannot be alterations either, nor can the processes of losing and acquiring them be so, though their becoming is necessarily the result of an alteration of the sensitive part of the soul, and this is altered by sensible objects; for all moral excellence is concerned with bodily pleasures and pains, which again depend either upon acting or upon remembering or upon anticipating. Now those that depend upon action are determined by sense-perception, and are moved by something sensible; and those that depend upon memory or anticipation are likewise to be traced to sense-perception; for in these cases pleasure is felt either in remembering what one has experienced or in anticipating what one is going to experience. Thus all pleasure of this kind must be produced by sensible things; and since the presence of defect or excellence involves the presence of pleasure or pain (with which excellence and defect are always concerned), and pleasures and pains are alterations of the sensitive part, it is evident that the loss and acquisition of these states too must be the result of the alteration of something. Consequently, though their becoming is accompanied by an alteration, they are not themselves alterations.

Again, the states of the intellectual part of the soul are not alterations, nor is 247b1
there any becoming of them. For the possession of knowledge most especially depends upon a particular relation. And further, it is evident that there is no becoming of these states. For that which is potentially possessed of knowledge becomes possessed of knowledge not by being moved itself but by reason of the presence of something else; for when it meets with the particular object, it knows in a manner the universal through the particular. Again, there is no becoming of the actual use and activity of these states, unless it is thought that there is a becoming of vision and touching and that the use and activity in question is similar to these. And

the original acquisition of knowledge is not a becoming or an alteration; for we are said to know and to understand when our intellect has reached a state of rest and come to a standstill, and there is no becoming that leads to a state of rest, since, as we have said above, no change at all can have a becoming. Moreover, just as when anyone has passed from a state of intoxication or sleep or disease to the contrary state, we do not say that he has become possessed of knowledge again, in spite of the fact that he was previously incapable of using his knowledge, so, too, when anyone originally acquires the state, we do not say that he becomes possessed of knowledge; for the possession of understanding and knowledge is produced by the soul's settling down out of the restlessness natural to it. Hence, too, in learning and in forming judgements on matters relating to their sense-perceptions children are inferior to
248a1 adults owing to the great amount of restlessness and motion in their souls. Nature itself in some cases causes the soul to settle down and come to a state of rest, while in others other things do so; but in either case the result is brought about through the alteration of something in the body, as we see in the case of the use and activity of the intellect arising from a man's becoming sober or being awakened. It is evident, then, from the preceding argument that alteration and being altered occur in sensible things and in the sensitive part of the soul and, except accidentally, in nothing else.

4 · A difficulty may be raised as to whether every motion is commensurable with every other or not. Now if they are all commensurable and if things that move an equal distance in an equal time have an equal speed, then we may have a circumference equal to a straight line, or, of course, the one may be greater or less than the other. Further, if one thing alters and another accomplishes a locomotion in an equal time, we may have an alteration and a locomotion equal to one another: thus an affection will be equal to a length, which is impossible. But is it not only when an equal distance is moved in an equal time that the velocities are equal? But an affection cannot be equal to a length. Therefore there cannot be an alteration equal to or less than a locomotion; and consequently not every motion is commensurable.

But how will our conclusion work out in the case of the circle and the straight line? It would be absurd to suppose that the motion of one thing in a circle and of another in a straight line cannot be similar, but that the one must inevitably move more quickly or more slowly than the other, just as if the course of one were downhill and of the other uphill. Moreover it does not make any difference to the argument to say that the one motion must be quicker or slower than the other; for then the circumference can be greater or less than the straight line; and if so it is possible for the two to be equal. For if in the time A one passes over the distance B
248b1 and the other C, B will be greater than C; for this is what we took 'quicker' to mean; and so it is also quicker if it traverses an equal distance in less time; consequently there will be a part of A in which B will pass over a part of the circle equal to the distance which C will traverse in the whole of A. None the less, if the two are

commensurable, we are confronted with the consequence stated above, viz. that there may be a straight line equal to a circle. But these are not commensurable; and so the corresponding motions are not commensurable either, and things not synonymous are all incommensurable. E.g. a pen, a wine, and the highest note in a scale are not commensurable: we cannot say whether any one of them is sharper than any other; and why is this? they are incommensurable because they are homonymous. But the highest note in a scale is commensurable with the leading-note, because the term 'sharp' has the same meaning as applied to both. Can it be, then, that the term 'quick' has not the same meaning in the two cases? If so, far less will it have the same meaning as applied to alteration and to locomotion.

Or shall we in the first place deny that things are always commensurable if they are not homonymous? For the term 'much' has the same meaning whether applied to water or to air, yet water and air are not commensurable; or, if this is not so, 'double' at any rate would seem to have the same meaning (denoting in each case the proportion of two to one), yet they are not commensurable. But here again may we not use the same argument and say that the term 'much' is homonymous? In fact there are some terms of which even the definitions are homonymous; e.g. if 'much' were defined as 'so much and more', 'so much' would mean something different in different cases; 'equal' is similarly homonymous; and 'one' again is perhaps inevitably homonymous; and if 'one' is, so is 'two'. Otherwise why is it that some things are commensurable while others are not, if the nature is one?

Is it because they are in different primary recipients? Thus horse and dog are so commensurable that we may say which is the whiter, since that which primarily contains the whiteness is the same in both, viz. the surface; and similarly they are commensurable in respect of size. But water and speech are not[47] since the primary recipients are different. But clearly we could thus make all things one and say that each is in a different recipient; thus equality, sweetness, and whiteness will be the 249a1
same, though that which contains them is different in different cases. Moreover, it is not any casual thing that is receptive of any attribute: each single thing is primarily receptive of a single attribute.

Must we then say that, if things are to be commensurable, not only must they be non-homonymous, but there must also be specific differences either in the attribute itself or in that which contains the attribute—that these, I mean, must not be divisible in the way in which colour is divided into kinds? Thus in this respect one thing will not be commensurable with another, i.e. we cannot say that one is more coloured than the other where only colour in general and not any particular colour is meant; but they are commensurable in respect of whiteness.

Similarly in the case of motion: two things are of the same velocity if in an equal time they perform a certain equal amount of motion. Suppose, then, that in a certain time an alteration is undergone by one half of a body's length and a locomotion is accomplished by the other half: can we say that in this case the alteration is equal to the locomotion and of the same velocity? That would be

[47]Both water and speech can be called λευκός or limpid.

absurd, and the reason is that there are different species of motion. And if two things are of equal velocity if they move over an equal distance in an equal time, we have to admit the equality of a straight line and a circumference. What, then, is the reason for this? Is it that locomotion is a genus or that line is a genus? (For the time is the same.) If the lines are specifically different, the locomotions also differ specifically from one another; for locomotion is specifically differentiated according to the specific differentiation of that over which it takes place. (And also accordingly as the instrument of the locomotion is different: thus if feet are the instrument, it is walking, if wings it is flying. Or is that not so? Is locomotion different only according to the shape of the path?) Thus things are of equal velocity if in an equal time they traverse the same magnitude; and when I call it 'the same' I mean that it contains no specific difference and therefore no difference in the motion that takes place over it. So we have now to consider how motion is differentiated; and this discussion serves to show that the genus is not a unity but contains a plurality latent in it and distinct from it, and that some homonymies are far removed from one another, some have a certain likeness, and some are nearly related either generically or analogically, with the result that they seem not to be homonymies though they really are.

When, then, is there a difference of species? If the same thing is in different recipients? or if different things are in different recipients? And how are we to define the limits of a species? What will enable us to decide that particular instances of whiteness or sweetness are the same or different? Is it enough that it appears different in one subject from what it appears in another? Or must there be no sameness at all? And further, where alteration is in question, how is one alteration to be of equal velocity with another? One person may be cured quickly and another slowly, and cures may also be simultaneous: so that, recovery of health being an alteration, we have here alterations of equal velocity, since such alteration occupies an equal time. But what alteration? We cannot here speak of equality here: what is equality in the category of quantity is similarity here. However, let us say that there is equal velocity where the same change is accomplished in an equal time. Are we, then, to find the commensurability in the recipient of the affection or in the affection itself? In the case that we have just been considering it is the fact that health is one and the same that enables us to arrive at the conclusion that the one alteration is neither more nor less than the other, but that both are alike. If on the other hand the affection is different in the two cases, e.g. when the alterations take the form of becoming white and becoming healthy respectively, here there is no sameness or equality or similarity inasmuch as the difference in the affections at once makes the alterations specifically different, and there is no unity of alteration any more than there would be unity of locomotion under like conditions. So we must find out how many species there are of alteration and of locomotion respectively. Now if the things that are in motion—that is to say, the things to which the motions belong in their own right and not accidentally—differ specifically, then their motions will also differ specifically; and if they differ generically or numerically, the motions also will differ generically or numerically. But there still remains the question whether, supposing that two alterations are of equal velocity, we ought to look for this equality in the sameness or similarity of the affections, or in the things altered, to see e.g. whether a certain quantity of each has become white. Or ought we not rather to look for it in both? That is to say, the alterations are the same or different according as the affections are the same or different, while they are equal or unequal according as the things altered are equal or unequal.

And now we must consider the same question in the case of becoming and perishing: how is one becoming of equal velocity with another? They are of equal velocity if in an equal time there are produced two things that are the same and specifically inseparable, e.g. two men (not two animals). Similarly one is quicker than the other if in an equal time the product is different in the two cases. (For we have no pair of terms that will convey this difference in the way in which dissimilarity functions for qualities.) If substances were numbers, there would be a greater number and a lesser number within the same species; but there is no common term that will include both relations, nor are there terms to express each of them separately in the same way as we indicate a higher degree or preponderance of an affection by 'more', of a quantity by 'greater'.

5 · Now since a mover always moves something and is in something, and extends to something (by 'is in something' I mean that it occupies a time; and by 'extends to something' I mean that it involves a certain amount of distance—for at any moment when a thing is causing motion, it also has caused motion, so that there must always be a certain amount of distance that has been traversed and a certain amount of time that has been occupied). If, then, A is the mover, B the moved, C the distance moved, and D the time, then in the same time the same force A will move ½B twice the distance C, and in ½D it will move ½B the whole distance C; for thus the rules of proportion will be observed. Again if a given force moves a given object a certain distance in a certain time and half the distance in half the time, half the motive power will move half the object the same distance in the same time. Let E represent half the motive power A and F half B: then they are similarly related, and the motive power is proportioned to the weight, so that each force will cause the same distance to be traversed in the same time.

But if E moves F a distance C in a time D, it does not necessarily follow that E can move twice F half the distance C in the same time. If, then, A moves B a distance C in a time D, it does not follow that E, being half of A, will in the time D or in any fraction of it cause B to traverse a part of C the ratio between which and the whole of C is proportionate to that between A and E—in fact it might well be that it will cause no motion at all; for it does not follow that, if a given motive power causes a certain amount of motion, half that power will cause motion either of any particular amount or in any length of time: otherwise one man might move a ship, since both the motive power of the ship-haulers and the distance that they all cause the ship to traverse are divisible into as many parts as there are men. Hence Zeno's reasoning is false when he argues that there is no part of the millet that does not make a sound; for there is no reason why any such part should not in any length of time fail to move the air that the whole bushel moves in falling. In fact it does not of itself move even such a quantity of the air as it would move if this part were by itself; for no part even exists otherwise than potentially in the whole.

If there are two movers each of which separately moves one of two weights a given distance in a given time, then the forces in combination will move the combined weights an equal distance in an equal time; for in this case the rules of proportion apply.

Then does this hold good of alteration and of increase also? Surely it does; for there is something that causes increase and something that suffers increase, and the one causes and the other suffers a certain amount of increase in a certain amount of time. Similarly with what alters and what is altered—something is altered a certain amount, or rather degree, in a certain amount of time: thus in twice as much time twice as much alteration will be completed and twice as much alteration will occupy twice as much time; and half in half the time, and in half half, or again, in the same amount of time it will be altered twice as much.

One the other hand if that which causes alteration or increase causes a certain amount of increase or alteration in a certain amount of time, it does not necessarily follow that it will do half in half the time or in half the time half: it may happen that there will be no alteration or increase at all, the case being the same as with the weight.

BOOK VIII

1 · Was there ever a becoming of motion before which it had no being, and is it perishing again so as to leave nothing in motion? Or are we to say that it never had any becoming and is not perishing, but always was and always will be? Is it in fact an immortal never-failing property of things that are, a sort of life as it were to all naturally constituted things?

Now the *existence* of motion is asserted by all who have anything to say about nature, because they all[48] concern themselves with the construction of the world and study the question of becoming and perishing, which processes could not come about without the existence of motion. But those who say that there is an infinite number of worlds, some of which are in process of becoming while others are in process of perishing, assert that there is always motion (for these processes of becoming and perishing of the worlds necessarily involve motion), whereas those who hold that there is only one world, whether everlasting or not, make corresponding assumptions in regard to motion. If then it is possible that at any time nothing should be in motion, this must come about in one of two ways: either in the manner described by Anaxagoras, who says that all things were together and at rest for an infinite period of time, and that then Mind introduced motion and separated them; or in the manner described by Empedocles, according to whom the universe is

[48]Reading πᾶσιν, with the MSS (πᾶσαν, Ross).

alternately in motion and at rest—in motion, when Love is making the one out of many, or Strife is making many out of one, and at rest in the intermediate periods of time—his account being as follows:

> Since One hath learned to spring from Manifold,
> And One disjoined makes Manifold arise,
> Thus they Become, nor stable is their life:
> But since their motion must alternate be,
> Thus have they ever Rest upon their round:[49]

for we must suppose that he means by 'alternate' that they change from the one motion to the other. We must consider, then, how this matter stands; for the discovery of the truth about it is of importance, not only for the study of nature, but also for the investigation of the First Principle.

Let us take our start from what we have already laid down in our course on Physics. Motion, we say, is the actuality of the movable in so far as it is movable. Each kind of motion, therefore, necessarily involves the presence of the things that are capable of that motion. In fact, even apart from the definition of motion, every one would admit that in each kind of motion it is that which is capable of that motion that is in motion: thus it is that which is capable of alteration that is altered, and that which is capable of local change that is in locomotion; and so there must be something capable of being burned before there can be a process of being burned, and something capable of burning before there can be a process of burning. Moreover, these things also must either have a beginning before which they had no being, or they must be eternal. Now if there was a becoming of every movable thing, it follows that before the motion in question another change or motion must have taken place in which that which was capable of being moved or of causing motion had its becoming. To suppose, on the other hand, that these things were in being throughout all previous time without there being any motion appears unreasonable on a moment's thought, and still more unreasonable, we shall find, on further consideration. For if we are to say that, while there are on the one hand things that are movable, and on the other hand things that are motive, there is a time when there is a first mover and a first moved, and another time when there is no such thing but only something that is at rest, then this thing must previously have been in process of change; for there must have been some cause of its rest, rest being the privation of motion. Therefore, before this first change there will be a previous change. For some things cause motion in only one way, while others can produce either of two contrary motions: thus fire causes heating but not cooling, whereas it would seem that knowledge may be directed to two contrary ends while remaining one and the same. Even in the former class, however, there seems to be something similar; for a cold thing in a sense causes heating by turning away and retiring, just as one possessed of knowledge voluntarily makes an error when he uses his knowledge in the reverse way. But at any rate all things that are capable of affecting and being affected, or of causing motion and being moved, are capable of it not

[49] Frag. 17, lines 9–13, Diels-Kranz.

under all conditions, but only when they are in a particular condition and approach one another: so it is on the approach of one thing to another that the one causes motion and the other is moved, and when they are present under such conditions as rendered the one motive and the other movable. So if the motion was not always in process, it is clear that they cannot have been in a condition such as to render them capable respectively of being moved and of causing motion, but one or other of them needed change; for in what is relative this is a necessary consequence: e.g. if one thing is double another when before it was not so, one or other of them, if not both, must have changed. It follows, then, that there will be a change previous to the first.

(Further, how can there be any before and after without the existence of time? Or how can there be any time without the existence of motion? If, then, time is the number of motion or itself a kind of motion, it follows that, if there is always time, motion must also be eternal. But so far as time is concerned we see that all with one exception are in agreement in saying that it is uncreated: in fact, it is just this that enables Democritus to show that all things cannot have had a becoming; for time, he says, is uncreated. Plato alone asserts the creation of time, saying that it is simultaneous with the world, and that the world came into being. Now since time cannot exist and is unthinkable apart from the now, and the now is a kind of middle-point, uniting as it does in itself both a beginning and an end, a beginning of future time and an end of past time, it follows that there must always be time; for the extremity of the last period of time that we take must be found in some now, since in time we can take nothing but nows. Therefore, since the now is both a beginning and an end, there must always be time on both sides of it. But if this is true of time, it is evident that it must also be true of motion, time being a kind of affection of motion.)

The same reasoning will also serve to show the imperishability of motion: just as a becoming of motion would involve, as we saw, a change previous to the first, in the same way a perishing of motion would involve a change subsequent to the last: for when a thing ceases to be moved, it does not therefore at the same time cease to be movable—e.g. the cessation of being burned does not involve the cessation of the capacity of being burned, since a thing may be capable of being burned without being burned—nor, when a thing ceases to be a mover, does it therefore at the same time cease to be motive. Again, the destructive agent will have to be destroyed when it has destroyed, and then that which has the capacity of destroying *it* will have to be destroyed afterwards; for being destroyed is a kind of change. If, then, this is impossible, it is clear that motion is eternal and cannot have existed at one time and not at another: in fact, such a view can hardly be described as anything else than fantastic.

And much the same may be said of the view that such is how things naturally are and that this must be regarded as a principle, as would seem to be the view of Empedocles when he says that the constitution of the world is of necessity such that Love and Strife alternately predominate and cause motion, while in the intermediate period of time there is a state of rest. Probably also those who, like

Anaxagoras, assert a single principle would hold this view. But that which holds by nature and is natural can never be anything disorderly; for nature is everywhere the cause of order. Moreover, there is no ratio in the relation of the infinite to the infinite, whereas order always means ratio. But if we say that there is first a state of rest for an infinite time, and then motion is started at some moment, and that the fact that it is this rather than a previous moment is of no importance, and that it involves no order, then we can no longer say that it is nature's work; for if anything is of a certain character naturally, it either is so invariably and is not sometimes of this and sometimes of another character (e.g. fire, which travels upwards naturally, does not sometimes do so and sometimes not) or there is a ratio in the variation. It would be better, therefore, to say with Empedocles and anyone else who may have maintained such a theory as his that the universe is alternately at rest and in motion; for in a system of this kind we have at once a certain order. But even here the holder of the theory ought not only to assert the fact: he ought also to explain the cause of it; i.e. he should not make any mere assumption or lay down any unreasoned axiom, but should employ either inductive or demonstrative reasoning. The Love and Strife postulated are not in themselves causes, nor is it of the essence of either that it should be so, the essential function of the former being to unite, of the latter to separate. If he is to go on to explain this alternate predominance, he should adduce cases where such a state of things exists, as he points to the fact that among mankind we have something that unites men, namely Love, while on the other hand enemies avoid one another: thus from the observed fact that this occurs in certain cases comes the assumption that it occurs also in the universe. Then, again, some argument is needed to explain why the predominance of each lasts for an equal period of time. But it is a wrong assumption to suppose universally that we have an adequate first principle in virtue of the fact that something always is so or always happens so. Thus Democritus reduces the causes that explain nature to the fact that things happened in the past in the same way as they happen now; but he does not think fit to seek for a principle to explain this 'always': so, while his theory is right in so far as it is applied to certain individual cases, he is wrong in making it of universal application. Thus, a triangle always has its angles equal to two right angles, but there is nevertheless an ulterior cause of the eternity, whereas principles are external and have no ulterior cause. Let this conclude what we have to say in support of our contention that there never was a time when there was not motion, and never will be a time when there will not be motion.

2 · The arguments that may be advanced against this position are not difficult to dispose of. The chief considerations that might be thought to indicate that motion may exist though at one time it had not existed at all are the following:

First, it may be said that no change is eternal; for the nature of all change is such that it proceeds *from* something *to* something, so that every change must be bounded by the contraries that mark its course, and no motion can go on to infinity.

Again, we see that a thing that neither is in motion nor contains any motion within itself can be set in motion; e.g. inanimate things that are (whether the whole or some part is in question) not in motion but at rest, are at some moment set in motion; whereas, if motion cannot have a becoming before which it had no being, these things ought to be either always or never in motion.

The fact is evident above all in the case of animate beings; for it sometimes happens that there is no motion in us and we are quite still, and that nevertheless we are then at some moment set in motion, that is to say it sometimes happens that we produce a beginning of motion in ourselves from within ourselves, without anything having set us in motion from without. We see nothing like this in the case of inanimate things, which are always set in motion by something else from without: the animal, on the other hand, we say, moves itself; therefore, if an animal is ever in a state of absolute rest, we have a motionless thing in which motion can be produced from the thing itself, and not from without. Now if this can occur in an animal, why should not the same be true also of the universe as a whole? If it can occur in a small world it could also occur in a great one; and if it can occur in the world, it could also occur in the infinite; that is, if the infinite could as a whole possibly be in motion or at rest.

Of these objections, then, the first-mentioned—that motion to opposites is not always the same and numerically one—is a correct statement; in fact, this may be said to be necessary, provided that it is possible for the motion of that which is one and the same to be not always one and the same. (I mean that e.g. we may question whether the note given by a single string is one and the same, or is different, although the string is in the same condition and is moved in the same way.) But still, however this may be, there is nothing to prevent there being a motion that is the same in virtue of being continuous and eternal: we shall have something to say later that will make this point clearer.

No absurdity is involved in the fact that something not in motion may be set in motion, that which is to cause motion from without being at one time present, and at another absent. Nevertheless, how this can be so remains matter for inquiry; how it comes about, I mean, that the same motive force at one time causes a thing to be in motion, and at another does not do so; for the difficulty raised by our objector really amounts to this—why is it that some things are not always at rest, and others always in motion?

The third objection may be thought to present more difficulty than the others, namely, that which alleges that motion arises in things in which it did not exist before, and adduces in proof the case of animate things: thus an animal is first at rest and afterwards walks, not having been set in motion apparently by anything from without. This, however, is false; for we observe that there is always some part of the animal's organism in motion, and the cause of the motion of this part is not the animal itself, but, it may be, its environment. Moreover, we say that the animal itself originates not all of its motions but its locomotion. So it may well be the case—or rather perhaps it must be the case—that many motions are produced in the body by its environment, and some of these set in motion the intellect or the appetite, and this again then sets the whole animal in motion: this is what happens in sleep: though there is then no perceptive motion in them, there is some motion that causes them to wake up again. But we will leave this point also to be elucidated at a later stage in our discussion.

3 · Our enquiry will resolve itself at the outset into a consideration of the above-mentioned problem—what can be the reason why some things in the world at one time are in motion and at another are at rest again? Now one of three things must be true: either all things are always at rest, or all things are always in motion, or some things are in motion and others at rest; and in this last case again either the things that are in motion are always in motion and the things that are at rest are always at rest, or they are all naturally capable alike of motion and of rest; or there is yet a third possibility remaining—it may be that some things in the world are always motionless, others always in motion, while others again admit of both conditions. This last is the account of the matter that we must give; for herein lies the solution of all the difficulties raised and the conclusion of the investigation upon which we are engaged.

To maintain that all things are at rest, and to disregard sense-perception and attempt to show the theory to be reasonable, would be an instance of intellectual weakness: it would call in question a whole system, not a particular detail; moreover, it would be an attack not only on the physicist but on almost all sciences and all opinions, since motion plays a part in all of them. Further, just as in arguments about mathematics objections that involve first principles do not affect the mathematician—and the other sciences are in similar case—so, too, objections involving the point that we have just raised do not affect the physicist; for it is a hypothesis that nature is a principle of motion.

The assertion that all things are in motion we may fairly regard as false, though it is less subversive of physical science; for though in our course on physics it was laid down that nature is a principle of rest no less than of motion, nevertheless motion is the natural state; moreover, the view is actually held by some that not merely some things but all things in the world are in motion and always in motion, though we cannot apprehend the fact by sense-perception. Although the supporters of this theory do not state clearly what kind of motion they mean, or whether they mean all kinds, it is no hard matter to reply to them. For there cannot be a continuous process either of increase or of decrease: that which comes between the two has to be included. The theory resembles that about the stone being worn away by the drop of water or split by plants growing out of it: if so much has been extruded or removed by the drop, it does not follow that half the amount has previously been extruded or removed in half the time; but, as in the case of the hauled ship, so many drops set so much in motion, but a part of them will not set as much in motion in any period of time. The amount removed is, it is true, divisible into a number of parts, but no one of these was set in motion separately: they were all set in motion together. It is evident, then, that from the fact that the decrease is divisible into an infinite number of parts it does not follow that some part must always be passing away: it all passes away at a particular moment. Similarly, too, in the case of any alteration whatever, if that which suffers alteration is infinitely divisible it does not follow from this that the same is true of the alteration itself, which often occurs all at once, as in freezing. Again, when any one has fallen ill, there must follow a period of time in which he will recover: the change cannot take place in an instant; and the change cannot be a change to anything else but health. The assertion, therefore, that alteration is continuous is too much at odds with the evident facts; for alteration is from one contrary to another. Moreover, a stone becomes neither harder nor softer. Again, in the matter of locomotion, it would be a strange thing if a stone could be falling or resting on the ground without our being able to perceive the fact. Again, earth and all other bodies necessarily remain in their proper places and are moved from them only by violence; from the fact, then, that some of them are in their proper places it follows that in respect of place all things cannot be in motion. These and other similar arguments, then, should convince us that it is impossible either that all things are always in motion or that all things are always at rest.

Nor again can it be that some things are always at rest, others always in motion, and nothing sometimes at rest and sometimes in motion. This theory must be pronounced impossible on the same grounds as those previously mentioned: viz. that we see the above-mentioned changes occurring in the case of the same things. We may further point out that the defender of this position is fighting against the evident facts; for there can be no increase and no compulsory motion, if it is impossible that a thing can be at rest before being set in motion unnaturally. This theory, then, does away with becoming and perishing. Moreover, motion, it would seem, is generally thought to be a sort of becoming and perishing; for a thing comes to be that, or in that, to which it changes; and it ceases to be that, or in that, from which it changes. It is clear, therefore, that there are cases of occasional motion and occasional rest.

We have now to take the assertion that all things are sometimes at rest and sometimes in motion and to confront it with the arguments previously advanced. We must take our start again, as we did before, from the possibilities that we distinguished just above. Either all things are at rest, or all things are in motion, or some things are at rest and others in motion. And if some things are at rest and others in motion, then it must be that either all things are sometimes at rest and sometimes in motion, or some things are always at rest and the remainder always in motion, or some of the things are always at rest and others always in motion while others again are sometimes at rest and sometimes in motion. Now we have said before that it is impossible that all things should be at rest: nevertheless we may now repeat the point. For even if it is really the case, as some assert, that what is is infinite and motionless, it certainly does not appear to be so if we follow sense-perception: many things that exist appear to be in motion. Now if there is such a thing as false opinion or opinion at all, there is also motion; and similarly if there is such a thing as imagination, or if it is the case that anything seems to be different at different times; for imagination and opinion are thought to be motions of a kind. But to investigate this question at all—to seek an argument in a case where we are too well off to require argument—implies bad judgement of what is better and what is worse, what commends itself to belief and what does not, what is a principle and what is not. It is likewise impossible that all things should be in motion or that some things should be always in motion and the remainder always at rest. We have sufficient ground for rejecting all these theories in the single fact that we *see* some things sometimes in motion and sometimes at rest. It is evident, therefore, that it is no less impossible that some things should be always in motion and the remainder always at rest than that all things should be at rest or that all things should be in motion continuously. It remains, then, to consider whether all things are so constituted as to be capable both of being in motion and of being at rest, or whether, while some things are so constituted, some are always at rest and some are always in motion; for it is this last view that we have to show to be true.

4 · Now of things that cause motion or suffer motion, some do so accidentally, others in their own right—accidentally if they merely belong to or contain as a part a thing that causes motion or suffers motion, in their own right if they cause motion or suffer motion not merely by belonging to such a thing or containing it as a part.

Of things which move in their own right, some derive their motion from themselves, others from something else: and in some cases their motion is natural, in others violent and unnatural. Thus in things that derive their motion from themselves, e.g. all animals, the motion is natural. (For when an animal is in motion its motion is derived from itself; and whenever the source of the motion of a thing is in the thing itself we say that the motion of that thing is natural. Therefore the animal as a whole moves itself naturally; but the body of the animal may be in motion unnaturally as well as naturally: it depends upon the kind of motion that it may chance to be suffering and the kind of element of which it is composed.) And the motion of things that derive their motion from something else is in some cases natural, in others unnatural: e.g. upward motion of earthy things and downward motion of fire are unnatural. Moreover the parts of animals are often in motion in an unnatural way, their positions and the character of the motion being abnormal. The fact that a thing that is in motion derives its motion from something is most evident in things that are in motion unnaturally, because in such cases it is clear that the motion is derived from something other than the thing itself. Next to things that are in motion unnaturally those whose motion while natural is derived from themselves—e.g. animals—make this fact clear; for here the uncertainty is not as to whether the motion is derived from something but as to how we ought to distinguish in the thing between the mover and the moved. It would seem that in animals, just as in ships and things not naturally constituted, that which causes motion is separate from that which suffers motion, and that in this way the animal as a whole causes its own motion.

The greatest difficulty, however, is presented by the remaining case of those that we last distinguished. Where things derive their motion from something else, we laid it down that some move contrary to nature: the others remain to be contrasted with them, as moving by nature. It is in these cases that difficulty would be experienced in deciding whence the motion is derived, e.g. in the case of light and heavy things. When these things are in motion to positions the reverse of those they would properly occupy, their motion is violent: when they are in motion to their proper positions—the light thing up and the heavy thing down—their motion is natural; but in this case it is no longer evident, as it is when the motion is unnatural, whence their motion is derived. It is impossible to say that their motion is derived from themselves: this is a characteristic of life and peculiar to living things. Further, if it were, it would have been in their power to stop themselves (I mean that if e.g. a thing can cause itself to walk it can also cause itself not to walk), and so, if fire itself possesses the power of upward locomotion, it is clear that it should also possess the power of downward locomotion. Moreover if things move themselves, it would be unreasonable to suppose that in only one kind of motion is their motion derived from themselves. Again, how can anything continuous and naturally unified move itself? In so far as a thing is one and continuous not merely in virtue of contact, it is impassive: it is only in so far as a thing is divided that one part of it is by nature active and another passive. Therefore none of these things move themselves (for they are naturally unified), nor does anything else that is continuous: in each case the mover must be separate from the moved, as we see to be the case with inanimate things when an animate thing moves them. It is the fact that these things also always derive their motion from something: what it is would become evident if we were to distinguish the different kinds of cause.

The above-mentioned distinctions can also be made in the case of things that cause motion: some of them are capable of causing motion unnaturally (e.g. the lever is not naturally capable of moving the weight), others naturally (e.g. what is actually hot is naturally capable of moving what is potentially hot); and similarly in the case of all other things of this kind.

In the same way, too, what is potentially of a certain quality or of a certain quantity or in a certain place is naturally movable when it contains the corresponding principle in itself and not accidentally (for the same thing may be both of a certain quality and of a certain quantity, but the one is an accidental, not an essential property of the other). So when fire or earth is moved by something the motion is violent when it is unnatural, and natural when it brings to actuality the proper activities that they potentially possess. But the fact that the term 'potentially' is used in more than one way is the reason why it is not evident whence such motions as the upward motion of fire and the downward motion of earth are derived. One who is learning a science knows potentially in a different way from one who while already possessing the knowledge is not actually exercising it. Wherever something capable of acting and something capable of being acted on are together, what is potential becomes actual: e.g. the learner becomes from one potential something another potential something (for one who possesses knowledge of a science but is not actually exercising it knows the science potentially in a sense, though not in the same sense as before he learnt it). And when he is in this condition, if something does not prevent him, he actively exercises his knowledge: otherwise he would be in the contradictory state of not knowing. In regard to natural bodies also the case is similar. Thus what is cold is potentially hot: then a change takes place and it is fire, and it burns, unless something prevents and hinders it. So, too, with heavy and light: light is generated from heavy, e.g. air from water (for water is first such potentially), and air is actually light, and will at once realize its proper activity unless something prevents it. The activity of lightness consists in the light thing being in a certain place, namely high up: when it is in the contrary place, it is being prevented. The case is similar also in regard to quantity and quality. But, be it noted, this is the question we are trying to answer—how can we account for the motion of light things and heavy things to their proper places? The reason for it is that they have a natural tendency towards a certain position; and this is what it is to be light or heavy, the former being determined by an upward, the latter by a downward, tendency. As we have said, a thing may be potentially light or heavy in more ways than one. Thus not only when a thing is water is it in a sense potentially light, but when it has become air it may be still potentially light; for it may be that through some hindrance it does not occupy an upper position, whereas, if what hinders it is removed, it realizes its activity and continues to rise higher. The process whereby what is of a certain quality changes to a condition of actuality is similar: thus the exercise of knowledge follows at once upon the possession of it unless something prevents it. So, too, what is of a certain quantity extends itself over a certain space unless something prevents it. The thing in a sense is and in a sense is not moved by one who moves what is obstructing and preventing its motion—e.g. one who pulls away a pillar or one who removes the stone from a wineskin in the water is the accidental cause of motion; and in the same way the rebounding ball is moved not by the wall but by the thrower. So it is clear that in all these cases the thing does not move itself, but it contains within itself the source of motion—not of moving something or of causing motion, but of suffering it.

If then the motion of all things that are in motion is either natural or unnatural and violent, and all things whose motion is violent and unnatural are moved by something, and something other than themselves, and again all things whose motion is natural are moved by something—both those that are moved by themselves and those that are not moved by themselves (e.g. light things and heavy things, which are moved either by that which brought the thing into existence and made it light 256a1 and heavy, or by that which released what was hindering and preventing it); then all things that are in motion must be moved by something.

5 · Now this may come about in either of two ways, either not because of the mover itself, but because of something else which moves the mover, or because of the mover itself. Further, in the latter case, either the mover immediately precedes the last thing in the series, or there may be one or more intermediate links: e.g. the stick moves the stone and is moved by the hand, which again is moved by the man; in the man, however, we have reached a mover that is not so in virtue of being moved by something else. Now we say that the thing is moved both by the last and by the

first of the movers, but more strictly by the first, since the first moves the last, whereas the last does not move the first, and the first will move the thing without the last, but the last will not move it without the first: e.g. the stick will not move anything unless it is itself moved by the man. If then everything that is in motion must be moved by something, and by something either moved by something else or not, and in the former case there must be some first mover that is not itself moved by anything else, while in the case of the first mover being of this kind there is no need of another (for it is impossible that there should be an infinite series of movers, each of which is itself moved by something else, since in an infinite series there is no first term)—if then everything that is in motion is moved by something, and the first mover is moved but not by anything else, it must be moved by itself.

This same argument may also be stated in another way as follows. Every mover moves something and moves it with something, either with itself or with something else: e.g. a man moves a thing either himself or with a stick, and a thing is knocked down either by the wind itself or by a stone propelled by the wind. But it is impossible for that with which a thing is moved to move it without being moved by that which imparts motion by its own agency; but if a thing imparts motion by its own agency, it is not necessary that there should be anything else with which it imparts motion, whereas if there is a different thing with which it imparts motion, there must be something that imparts motion not with something else but with itself, or else there will be an infinite series. If, then, anything is a mover while being itself moved, the series must stop somewhere and not be infinite. Thus, if the stick moves something in virtue of being moved by the hand, the hand moves the stick; and if something else moves with the hand the hand also is moved by something different from itself. So when motion by means of an instrument is at each stage caused by something different from the instrument, this must always be preceded by something else which imparts motion with itself. Therefore, if this is moving and
256b1 there is nothing else that moves it, it must move itself. So this reasoning also shows that, when a thing is moved, if it is not moved immediately by something that moves itself, the series brings us at some time or other to a mover of this kind.

And if we consider the matter in yet another way we shall get this same result. If everything that is in motion is moved by something that is in motion, either this is an accidental attribute of the things (so that each of them moves something while being itself in motion, but not because it is itself in motion) or it belongs to them in their own right. If, then, it is an accidental attribute, it is not necessary that that which causes motion should be in motion; and if this is so it is clear that there may be a time when nothing that exists is in motion, since the accidental is not necessary but contingent. Now if we assume something possible, nothing impossible will follow (though something false may). But the non-existence of motion is an impossibility; for we have shown above that there must always be motion.

Moreover, the conclusion to which we have been led is a reasonable one. For there must be three things—the moved, the mover, and the instrument of motion. Now the moved must be in motion, but it need not move anything else; the instrument of motion must both move something else and be itself in motion (for it changes together with the moved, with which it is in contact and continuous, as is clear in the case of things that move other things locally, in which case the two things must up to a certain point be in contact); and the mover—that is to say, that which causes motion in such a manner that it is not merely the instrument of motion—must be unmoved. Now we see the last things, which have the capacity of being in motion, but do not contain a motive principle, and also things which are in motion but are moved by themselves and not by anything else: it is reasonable, therefore, not to say necessary, to suppose the existence of the third term also, that which causes motion but is itself unmoved. So, too, Anaxagoras is right when he says that Mind is impassive and unmixed, since he makes it the principle of motion; for it could cause motion in this way only by being itself unmoved, and have control only by being unmixed.

Now if the mover is not accidentally but necessarily in motion—so that, if it were not in motion, it would not move anything—then the mover, in so far as it is in motion, must be moved either with the same kind of motion, or with a different kind—either that which is heating, I mean, is itself becoming hot, that which is making healthy becoming healthy, and that which is causing locomotion in process of locomotion, or else that which is making healthy is in process of locomotion, and that which is causing locomotion in process of increase. But it is evident that this is impossible. For we must apply this to the very lowest species into which motion can be divided: e.g. we must say that if someone is teaching some lesson in geometry, he is also being taught that same lesson in geometry, and that if he is throwing he is being thrown in just the same manner. Or if we reject this assumption we must say that one kind of motion is derived from another; e.g. that that which is causing locomotion is in process of increase, that which is causing this increase is being altered by something else, and that which is causing this alteration is suffering some different kind of motion. But the series must stop somewhere, since the kinds of motion are limited; and if we say that the series bends back, i.e. that that which is causing alteration is in process of locomotion, we do no more than if we had said at the outset that that which is causing locomotion is in process of locomotion, and that one who is teaching is being taught; for it is clear that everything that is moved is also moved by the mover that is further back in the series—in fact the earlier mover is that which more strictly moves it. But this is of course impossible; for it involves the consequence that one who is teaching is learning whereas teaching necessarily implies possessing knowledge, and learning not possessing it. Still more unreasonable is the consequence that, since everything that is moved is moved by something that is itself moved, everything that has a capacity for causing motion is capable of being moved: i.e. it will have a capacity for being moved in the sense in which one might say that everything that has a capacity for making healthy has a capacity for being made healthy, and that which has a capacity for building has a capacity for being built, either immediately or through one or more links (as it will if, while everything that has a capacity for causing motion has a capacity for being moved by something else, the motion that it has the capacity for suffering is not that with which it affects what is next to it, but a motion of a different kind; e.g. that which has a capacity for making healthy might have a capacity for learning: the series, however, could be traced back, as we said before, until at some time or other we arrive at the same kind of motion). Now the first alternative is impossible, and the second is fantastic: it is absurd that that which has a capacity for causing alteration should necessarily have a capacity for increase. It is not necessary, therefore, that that which is moved should always be moved by something else that is itself moved: so there will be an end to the series. Consequently the first thing that is in motion will derive its motion either from something that is at rest or from itself. But if there *were* any need to consider which of the two, that which moves itself or that which is moved by something else, is the cause and principle of motion, everyone would decide for the former; for that which is in itself a cause is always prior to that which is so in virtue of something else.

We must therefore make a fresh start and consider the question: if a thing moves itself, in what sense and in what manner does it do so? Now everything that is in motion must be infinitely divisible; for it has been shown already in our general
257b1 course on *Physics,* that everything that is in motion in its own right is continuous. Now it is impossible that that which moves itself should in its entirety move itself; for then, while being specifically one and indivisible, it would as a whole both undergo and cause the same locomotion or alteration; thus it would at the same time be both teaching and being taught, or both restoring to and being restored to the same health. Moreover, we have established the fact that it is the movable that is moved; and this moves potentially, not in fulfilment, and the potential is in process to fulfilment, and motion is an incomplete fulfilment of the movable. The mover on the other hand is already in actuality: e.g. it is that which is hot that produces heat, and in general that which produces the form possesses it. Consequently, the same thing in respect of the same thing will be at the same time both hot and not hot. So, too, in every other case where the mover must have the synonymous property. Therefore when a thing moves itself it is one part of it that is the mover and another part that is moved. But it is not self-moving in the sense that each of the two parts is moved by the other part: the following considerations make this evident. If each of the two parts is to move the other, there will be no first mover; for that which is earlier in the series is more the cause of its being moved than that which comes next, and will be more truly the mover; for we found that there are two kinds of mover, that which is itself moved by something else and that which derives its motion from itself; and that which is further from the thing that is moved is nearer to the principle of motion than that which is intermediate. Again, there is no necessity for the mover to be moved by anything but itself; so it can only be accidentally that the other part moves it in return. I take then the possible case of its not moving it: then there will be a part that is moved and a part that is an unmoved mover. Again, there is no necessity for the mover to be moved in return: on the contrary the necessity that there should always be motion makes it necessary that there should be some mover that is either unmoved or moved by itself. Again, we should then have a thing undergoing the same motion that it is causing—that which is producing heat, therefore, being heated. But as a matter of fact that which primarily moves itself

cannot contain either a single part that moves itself or a number of parts each of which moves itself. For, if the whole is moved by itself, it must be moved either by some part of itself or as a whole by itself as a whole. If, then, it is moved in virtue of some part of it being moved by that part itself, it is this part that will be the primary self-mover, since, if this part is separated from the whole, the part will still move itself, but the whole will do so no longer. If on the other hand the whole is moved by itself as a whole, it must be accidentally that the parts move themselves; and therefore, their self-motion not being necessary, we may take the case of their not being moved by themselves. Therefore in the whole of the thing we may distinguish $258^{a}1$ that which imparts motion without itself being moved and that which is moved; for only in this way is it possible for a thing to be self-moved. Further, if the whole moves itself we may distinguish in it that which imparts the motion and that which is moved: so while we say that AB is moved by itself, we may also say that it is moved by A. And since that which imparts motion may be either a thing that is moved by something else or a thing that is unmoved, and that which is moved may be either a thing that imparts motion to something else or a thing that does not, that which moves itself must be composed of something that is unmoved but imparts motion and also of something that is moved but does not necessarily impart motion but may or may not do so. Thus let A be something that imparts motion but is unmoved, B something that is moved by A and moves C, C something that is moved by B but moves nothing (granted that we eventually arrive at C we may take it that there is only one intermediate term, though there may be more). Then the whole ABC moves itself. But if I take away C, AB will move itself, A imparting motion and B being moved, whereas C will not move itself or in fact be moved at all. Nor again will BC move itself apart from A; for B imparts motion only through being moved by something else, not through being moved by any part of itself. So only AB moves itself. That which moves itself, therefore, must comprise something that imparts motion but is unmoved and something that is moved but does not necessarily move anything else; and each of these two things, or at any rate one of them, must be in contact with the other. If, then, that which imparts motion is continuous—that which is moved must of course be so—the one will be in contact with the other. So it is clear that it is not through some part of the whole being of such a nature as to be capable of moving itself that the whole moves itself: it moves itself as a whole, both being moved and imparting motion through containing a part that imparts motion and a part that is moved. It does not impart motion as a whole nor is it moved as a whole: it is A that imparts motion and B alone that is moved.

Here a difficulty arises: if something is taken away from A (supposing that that which imparts motion but is unmoved is continuous), or from B, the part that is moved, will the remainder of A continue to impart motion or the remainder of B continue to be moved? If so, it will not be AB primarily that is moved by itself, since, when something is taken away from AB, the remainder of AB will continue to move itself. Perhaps there is nothing to prevent each of the two parts, or at any rate one of $258^{b}1$ them, that which is moved, being potentially divided though actually undivided, so that it if is divided it will not continue in the possession of the same nature; and so there is nothing to prevent self-motion residing primarily in things that are potentially divisible.

From what has been said, then, it is evident that that which primarily imparts motion is unmoved; for, whether that which is in motion but moved by something leads straight to the first unmoved, or whether it leads to what is in motion but moves itself and stops its own motion, on both suppositions we have the result that in all cases of things being in motion that which primarily imparts motion is unmoved.

6 · Since there must always be motion without intermission, there must necessarily be something eternal, whether one or many, that first imparts motion, and this first mover must be unmoved. Now the question whether each of the things that are unmoved but impart motion is eternal is irrelevant to our present argument; but the following considerations will make it clear that there must necessarily be some such thing, which, while it has the capacity of moving something else, is itself unmoved and exempt from all change, both unqualified and accidental. Let us suppose, if you will, that in the case of certain things it is possible for them at different times to be and not to be, without any process of becoming and perishing (in fact it would seem to be necessary, if a thing that has not parts at one time is and at another time is not, that any such thing should without undergoing any change at one time be and at another time not be). And let us further suppose it possible that some principles that are unmoved but capable of imparting motion at one time are and at another time are not. Even so, this cannot be true of *all* such principles, since there must clearly be something that *causes* things that move themselves at one time to be and at another not to be. For, since nothing that has not parts can be in motion, everything which moves itself must have magnitude, though nothing that we have said makes this necessarily true of every mover. So the fact that some things become and others perish, and that this is so continuously, cannot be caused by any one of those things that, though they are unmoved, do not always exist; nor again some be caused by some and others by others. The eternity and continuity of the process cannot be caused either by any one of them singly or by the sum of them, because this causal relation must be eternal and necessary, whereas the sum of these movers is infinite and they do not all exist together. It is clear, then, that though there may be countless instances of the perishing of movers unmoved, and though many things that move themselves perish and are succeeded by others that come into being, and though one thing that is unmoved moves one thing while another moves another, nevertheless there is something that comprehends them all, and that as something apart from each one of them, and this it is that is the cause of the fact that some things are and others are not and of the continuous process of change; and this causes the motion of the other movers, while they are the causes of the motion of other things. Motion, then, being eternal, the first mover, if there is but one, will be eternal also; if there are more than one, there will be a plurality of such eternal movers. We ought, however, to suppose that there is one rather than many, and a finite rather than an infinite number. When the consequences of either assumption

are the same, we should always assume that things are finite rather than infinite in number, since in things constituted by nature that which is finite and that which is better ought, if possible, to be present rather than the reverse; and here it is sufficient to assume only one mover, the first of unmoved things, which being eternal will be the principle of motion to everything else.

The following argument also makes it evident that the first mover must be something that is one and eternal. We have shown that there must always be motion. That being so, motion must be continuous, because what is always is continuous, whereas what is in succession is not continuous. But further, if motion is continuous, it is one; and it is one only if the mover and the moved are each of them one, since in the event of a thing's being moved now by one thing and now by another the whole motion will not be continuous but successive.

Moreover a conviction that there is a first unmoved something may be reached not only from the foregoing arguments, but also by considering again the principles operative in movers.[50] Now it is evident that among existing things there are some that are sometimes in motion and sometimes at rest. This fact has served to make it clear that it is not true either that all things are in motion or that all things are at rest or that some things are always at rest and the remainder always in motion: on this matter proof is supplied by things that fluctuate between the two and have the capacity of being sometimes in motion and sometimes at rest. The existence of things of this kind is clear to all; but we wish to explain also the nature of each of the other two kinds and show that there are some things that are always unmoved and some things that are always in motion. In the course of our argument directed to this end we established the fact that everything that is in motion is moved by something, and that the mover is either unmoved or in motion, and that, if it is in motion, it is moved at each stage either by itself or by something else; and so we proceeded to the position that of things that are moved, the principle of things that are in motion is that which moves itself, and the principle of the whole series is the unmoved. Further it is evident from actual observation that there are things that have the characteristic of moving themselves, e.g. the animal kingdom and the whole class of living things. This being so, then, the view was suggested that perhaps it may be possible for motion to come to be in a thing without having been in existence at all before, because we see this actually occurring in animals: they are unmoved at one time and then again they are in motion, as it seems. We must grasp the fact, therefore, that animals move themselves only with one kind of motion, and that this is not strictly originated by them. The cause of it is not derived from the animal itself: there are other natural motions in animals, which they do not experience through their own instrumentality, e.g. increase, decrease, and respiration: these are experienced by every animal while it is at rest and not in motion in respect of the motion set up by its own agency; here the motion is caused by the environment and by many things that enter into the animal: thus in some cases the cause is nourishment—when it is being digested animals sleep, and when it is being distributed they awake and move themselves, the first principle of this motion being

[50]Retaining *τῶν κινούντων*, excised by Ross.

thus originally derived from outside. Therefore animals are not always in continuous motion by their own agency: it is something else that moves them, itself being in motion and changing as it comes into relation with each several thing that moves itself. (Moreover in all these things the first mover and cause of their self-motion is itself moved by itself, though in an accidental sense: that is to say, the body changes its place, so that that which is in the body changes its place also and moves itself by leverage.) Hence we may be sure that if a thing belongs to the class of unmoved things which move themselves accidentally, it is impossible that it should cause continuous motion. So the necessity that there should be motion continuously requires that there should be a first mover that is unmoved even accidentally, if, as we have said, there is to be in the world of things an unceasing and undying motion, and the world is to remain self-contained and within the same limits; for if the principle is permanent, the universe must also be permanent, since it is continuous with the principle. (We must distinguish, however, between accidental motion of a thing by itself and such motion by something else, the former being confined to perishable things, whereas the latter belongs also to certain principles of heavenly bodies, of all those, that is to say, that experience more than one locomotion.)

And further, if there is always something of this nature, a mover that is itself unmoved and eternal, then that which is first moved by it must also be eternal. Indeed this is clear also from the consideration that there would otherwise be no becoming and perishing and no change of any kind in other things, if there were nothing in motion to move them; for the motion imparted by the unmoved will always be imparted in the same way and be one and the same, since the unmoved does not itself change in relation to that which is moved by it. But that which is moved by something that, though it is in motion, is moved directly by the unmoved stands in varying relations to the things that it moves, so that the motion that it causes will not be always the same: by reason of the fact that it occupies contrary positions or assumes contrary forms it will produce contrary motions in each several thing that it moves and will cause it to be at one time at rest and at another time in motion.

The foregoing argument, then, has served to clear up the point about which we raised a difficulty at the outset—why is it that instead of all things being either in motion or at rest, or some things being always in motion and the remainder always at rest, there are things that are sometimes in motion and sometimes not? The cause of this is now plain: it is because, while some things are moved by an eternal unmoved mover and are therefore always in motion, other things are moved by something that is in motion and changing, so that they too must change. But the unmoved mover, as has been said, since it remains simple and unvarying and in the same state, will cause motion that is one and simple.

7 · This matter will be made clearer, however, if we start afresh from another point. We must consider whether it is or is not possible that there should be a continuous motion, and, if it is possible, which this motion is, and which is the primary motion; for it is plain that if there must always be motion, and a particular

motion is primary and continuous, then it is this motion that is imparted by the first mover, and so it is necessarily one and the same and continuous and primary.

Now of the three kinds of motion that there are—motion in respect of magnitude, motion in respect of affection, and motion in respect of place—it is this last, which we call locomotion, that must be primary. For it is impossible that there should be increase without the previous occurrence of alteration; for that which is increased, although in a sense it is increased by what is like itself, is in a sense increased by what is unlike itself: thus it is said that contrary is nourishment to contrary; but one thing gets attached to another by becoming like it. There must be alteration then, in that there is this change from contrary to contrary. But the fact that a thing is altered requires that there should be something that alters it, something that makes the potentially hot actually hot: so it is plain that the mover does not maintain a uniform relation to it but is at one time nearer to and at another farther from that which is altered; and we cannot have this without locomotion. If, therefore, there must always be motion, there must also always be locomotion as the primary motion, and, if there is a primary as distinguished from a secondary form of locomotion, it must be the primary form. Again, all affections have their origin in condensation and rarefaction: thus heavy and light, soft and hard, hot and cold, are considered to be forms of density and rarity. But condensation and rarefaction are combination and separation, processes in virtue of which substances are said to become and perish; and in being combined and separated things must change in respect of place. And further, when a thing is increased or decreased its magnitude changes in respect of place.

Again, there is another point of view from which it will be clearly seen that locomotion is primary. As in the case of other things so too in the case of motion the word 'primary' may be used in several ways. A thing is said to be prior to other things when, if it does not exist, the others will not exist, whereas it can exist without the others; and there is also priority in time and priority in being. Now there must be motion continuously, and it may exist continuously either by being continuous or by being successive but rather by being continuous; and it is better that it should be continuous rather than successive motion, and we always assume the presence in nature of the better, if it be possible: since, then, continuous motion is possible (this will be proved later: for the present let us take it for granted), and no other motion can be continuous except locomotion, locomotion must be primary. For there is no necessity for the subject of locomotion to be the subject either of increase or of alteration, nor need it become or perish; on the other hand there cannot be any one of these processes without the existence of the continuous motion imparted by the first mover.

Again, locomotion must be primary in time; for this is the only motion possible for eternal things. It is true indeed that, in the case of any individual thing that has a becoming, locomotion must be the last of its motions; for after its becoming it first experiences alteration and increase, and locomotion is a motion that belongs to such things only when they are perfected. But there must previously be something else that is in process of locomotion to be the cause of the becoming of things that become, without itself being in process of becoming, as e.g. the begotten is preceded by what begot it; otherwise becoming might be thought to be the primary motion on the ground that the thing must first become. But though this is so in the case of any individual thing that becomes, nevertheless before anything becomes, something else must be in motion, not itself becoming but being, and before this there must again be something else. And since becoming cannot be primary—for, if it were, everything that is in motion would be perishable—it is plain that no one of the motions next in order can be prior to locomotion. By the motions next in order I mean increase and then alteration, decrease, and perishing. All these are posterior to becoming; consequently, if not even becoming is prior to locomotion, then no one of the other processes of change is so either.

In general, that which is becoming appears as something imperfect and proceeding to a principle; and so what is posterior in the order of becoming is prior in the order of nature. Now all things that go through the process of becoming acquire locomotion last. It is this that accounts for the fact that some living things, e.g. plants and many kinds of animals, owing to lack of the requisite organ,[51] are entirely without motion, whereas others acquire it in the course of their being perfected. Therefore, if the degree in which things possess locomotion corresponds to the degree in which they have realized their natural development, then this motion must be prior to all others in respect of being; and not only for this reason but also because a thing that is in motion loses its being less in the process of locomotion than in any other kind of motion: it is the only motion that does not involve a change of being in the sense in which there is a change in quality when a thing is altered and a change in quantity when a thing is increased or decreased. Above all it is plain that this motion, motion in respect of place, is what is in the strictest sense produced by that which moves itself; but it is the self-mover that we declare to be the principle of things that are moved and impart motion and the primary source for things that are in motion.

It is clear, then, from the foregoing arguments that locomotion is the primary motion. We have now to show which kind of locomotion is primary. The same process of reasoning will also make clear at the same time the truth of the assumption we have made both now and at a previous stage that it is possible that there should be a motion that is continuous and eternal. Now it is clear from the following considerations that no other motion can be continuous. Every other motion and change is from an opposite to an opposite: thus for the processes of becoming and perishing the limits are what is and what is not, for alteration the contrary affections, and for increase and decrease either greatness and smallness or perfection and imperfection of magnitude; and changes to contraries are contrary changes. Now a thing that is undergoing any particular kind of motion, but though
261b1 previously existent has not always undergone it, must previously have been at rest. It is clear, then, that for the changing thing the contraries will be states of rest. And we have a similar result in the case of changes; for becoming and perishing, whether regarded without qualification or as affecting something in particular, are oppo-

[51]Retaining τοῦ ὀργάνου, which Ross excises.

sites: therefore provided it is impossible for a thing to undergo opposite changes at the same time, the change will not be continuous, but a period of time will intervene between the opposite processes. The question whether these contradictory changes are contraries or not makes no difference, provided only it is impossible for them both to be present to the same thing at the same time: the point is of no importance to the argument. Nor does it matter if the thing need not *rest* in the contradictory state, or if there is no change contrary to rest: it may be true that what is not is not at rest, and that perishing is a process to what is not. All that matters is the intervention of a time: it is this that prevents the change from being continuous; so, too, in our previous instances the important thing was not the relation of contrariety but the impossibility of the two processes being present at the same time. And there is no need to be disturbed by the fact that there may be more than one contrary to the same thing, that motion will be contrary both to rest and to motion in the contrary direction. We have only to grasp the fact that motion is in a sense the opposite both of a state of rest and of the contrary motion, in the same way as the equal and the mean is the opposite both of that which surpasses it and of that which it surpasses, and that it is impossible for the opposite motions or changes to be present to a thing at the same time. Furthermore, in the case of becoming and perishing it would seem to be an utterly absurd thing if as soon as anything has become it must necessarily perish and cannot continue to exist for any time; and this might generate a similar belief in the other cases, since it is natural that they should all be uniform.

8 · Let us now proceed to maintain that it is possible that there should be an infinite motion that is single and continuous, and that this motion is rotatory motion. The motion of everything that is in process of locomotion is either rotatory or rectilinear or a compound of the two: consequently, if one of the former two is not continuous, that which is composed of them both cannot be continuous either. Now it is plain that if the locomotion of a thing is rectilinear and finite it is not continuous locomotion; for the thing must turn back, and that which turns back in a straight line undergoes two contrary locomotions, since, so far as place is concerned, upward motion is the contrary of downward motion, forward motion of backward, and motion to the left of motion to the right, these being the pairs of contraries in the sphere of place. But we have already defined single and continuous motion to be motion of a single thing in a single period of time and operating within a sphere admitting of no further specific differentiation (for we have three things to consider, first that which is in motion, e.g. a man or a god, secondly the 'when', that is to say, the time, and thirdly the sphere within which it operates, which may be either place or affection or form or magnitude). Now contraries are specifically different and not one; and within the sphere of place we have the above-mentioned distinctions. Moreover we have an indication that motion from A to B is the contrary of motion from B to A in the fact that, if they occur at the same time, they arrest and stop each other. And the same is true in the case of a circle: the motion from A towards B is the contrary of the motion from A towards C; for even if they are continuous and there is no turning back they arrest each other, because contraries annihilate or

obstruct one another. On the other hand lateral motion is not the contrary of upward motion. But what shows most clearly that rectilinear motion cannot be continuous is the fact that turning back necessarily implies coming to a stand, not only when it is a straight line that is traversed, but also in the case of locomotion in a circle (which is not the same thing as rotatory locomotion; for a thing may either proceed on its course without a break or turn back again when it has reached the same point from which it started). We may assure ourselves of the necessity of this coming to a stand not only by perception but also by argument. We may start as follows: we have three points, beginning, middle, and end; and the middle is both beginning and end relatively to each of the others, being one in number but two in definition. We have further the distinction between the potential and the actual. So in the straight line any one of the points lying between the two extremes is potentially a middle-point; but it is not actually so unless that which is in motion divides the line by coming to a stand at that point and beginning its motion again: thus the middle-point becomes both a beginning and an end, a beginning of the latter part and an end of the first part. This is the case e.g. when A in the course of its locomotion comes to a stand at B and starts again towards C; but when its motion is continuous A cannot either have come to be or have ceased to be at the point B: it can only have been there at a now, and not in any period of time except the whole[52] of which the now is a dividing-point. To maintain that it has come to be and ceased to be there will involve the consequence that A in the course of its locomotion will always be coming to a stand; for it is impossible that A should simultaneously have come to be at B and ceased to be there, so that the two things must have happened at different points of time, and therefore there will be the intervening period of time: consequently A will be in a state of rest at B, and similarly at all other points, since the same reasoning holds good in every case. When to A, that which is in the process of locomotion, B, the middle-point, serves both as an end and as a beginning, A must come to a stand at B, because it makes it two just as one might do in thought. However, the point A is the beginning at which it has ceased to be, and it is at C that it has come to be when its course is finished and it comes to a stand. So this is how we must meet the difficulty that then arises, which is as follows. Suppose the line E is equal to F, that A proceeds in continuous locomotion from the extreme point to C, and that, at the moment when A is at the point B, D is proceeding in uniform locomotion and with the same velocity as A from the extremity of F to G: then D will have reached G before A has reached C; for that which makes an earlier start and departure must make an earlier arrival. For A has not simultaneously come to be and ceased to be at B, which is why it is late. For if it does both simultaneously, it will not be late—for this to happen it will be necessary that it should come to a stand there. Therefore we must not hold that when A came to be at B, D was at the same time in motion from the extremity of F; for the fact of A's having come to be at B will involve its ceasing to be there, and the two events will not be simultaneous, whereas the truth is that A is at B at a sectional point of time and

[52]Omitting τῷ ΑΒΓ in line 31.

does not occupy time there. In this case, therefore, where the motion of a thing is continuous, it is impossible to use this form of expression. On the other hand in the case of a thing that turns back in its course we must do so. For suppose G in the course of its locomotion proceeds to D and then turns back and proceeds downwards again: then the extreme point D has served as beginning and end for it, one point thus serving as two: therefore A must have come to a stand there; it cannot have come to be at D and departed from D simultaneously, for in that case it would simultaneously be there and not be there at the same now. And here we cannot apply the same solution: we cannot argue that G is at D at a sectional point of time and has not come to be or ceased to be there. For here the goal that is reached is necessarily one that is actual, not potential. Now the points in the middle are potential; but this one is actual, and regarded from below it is an end, while regarded from above it is a beginning, so that it stands in these same relations to the motions. Therefore that which turns back in traversing a rectilinear course must come to a stand. Consequently there cannot be a continuous rectilinear motion that is eternal.

The same method should also be adopted in replying to those who ask, in the terms of Zeno's argument, whether we admit that before any distance can be traversed half the distance must be traversed, that these half-distances are infinite in number, and that it is impossible to traverse distances infinite in number—or some put the same argument in another form, and would have us grant that in the time during which a motion is in progress we should first count the half-motion for every half-distance that we get, so that we have the result that when the whole distance is traversed we have counted an infinite number, which is admittedly impossible. Now in our first discussions of motion we put forward a solution of this difficulty turning on the fact that the period of time contains within itself an infinite number of units: there is no absurdity, we said, in supposing the traversing of infinite distances in infinite time, and the element of infinity is present in the time no less than in the distance. But, although this solution is adequate as a reply to the questioner (the question asked being whether it is impossible in a finite time to traverse or count an infinite number of units), nevertheless as an account of the fact and the truth it is inadequate. For suppose the distance to be left out of account and the question asked to be no longer whether it is possible in a finite time to traverse an infinite number of distances, and suppose that the inquiry is made to refer to the time itself (for the time contains an infinite number of divisions): then this solution will no longer be adequate, and we must apply the truth that we enunciated in our recent discussion. In the act of dividing the continuous distance into two halves one point is treated as two, since we make it a beginning and an end; and this same result is produced by the act of counting halves as well as by the act of dividing into halves. But if divisions are made in this way, neither the distance nor the motion will be continuous; for motion if it is to be continuous must relate to what is continuous; and though what is continuous contains an infinite number of halves, they are not actual but potential halves. If he makes the halves actual, he will get not a continuous but an intermittent motion. In the case of counting the halves, it is clear that this result

263b1 follows; for then one point must be reckoned as two: it will be the end of the one half and the beginning of the other, if he counts not the one continuous whole but the two halves. Therefore to the question whether it is possible to pass through an infinite number of units either of time or of distance we must reply that in a sense it is and in a sense it is not. If the units are actual, it is not possible; if they are potential, it is possible. For in the course of a continuous motion the traveller has traversed an infinite number of units in an accidental sense but not in an unqualified sense; for though it is an accidental characteristic of the distance to be an infinite number of half-distances, it is different in essence and being.

It is also plain that unless we hold that the point of time that divides earlier from later always belongs only to the later so far as the thing is concerned, we shall be involved in the consequence that the same thing at the same moment is and is not, and that a thing is not at the moment when it has become. It is true that the point is common to both times, the earlier as well as the later, and that, while numerically one and the same, it is not so in definition, being the end of the one and the beginning of the other; but so far as the thing is concerned it always belongs to the later affection. Let us suppose a time ACB and a thing D, D being white in the time A and not white in the time B. Then D is at C white and not white; for if we were right in saying that it is white during the whole time A, it is true to call it white at any moment of A, and not white in B, and C is in both A and B. We must not allow, therefore, that it is white in the whole of A, but must say that it is so in all of it except the last now C. C already belongs to the later period, and if in the whole of A not white was becoming and white perishing, at C it had become or perished. And so either that is the first moment at which it is true to call the thing not white;[53] or a thing may not be at the moment when it has become and may be at the moment when it has perished; or else things must at the same time be white and not white and in general be and not be. Further, if anything that is after having previously not been must become being and is not when it is becoming, time cannot be divisible into indivisible times. For suppose that D was becoming white at A and that at another indivisible time B, consecutive with A, D has already become white and so is white at that moment: then, inasmuch as at A it was becoming white and so was not white and at B it is white, there must have been a becoming between A and B and therefore also a time in which the becoming took place. On the other hand, 264a1 those who deny indivisibles are not affected by this argument: according to them it has become and is white at the last point of the actual time in which it was becoming white; and this point has no other point consecutive with or in succession to it, whereas indivisible times are successive. Moreover it is clear that if it was becoming white in the whole time A, there was no more time in which it had become and was becoming than the total of the time in which it was merely becoming.

These and such-like, then, are the arguments on which one might rely as being appropriate to the subject matter. If we look at the question generally, the same result would also appear to be indicated by the following arguments. Everything

[53]Omitting λευκόν at line 23; the received text reads: '. . . call the thing white or not white'.

whose motion is continuous must, on arriving at any point in the course of its locomotion, have been previously also in process of locomotion to that point, if it is not forced out of its path by anything: e.g. on arriving at B a thing must also have been in process of locomotion to B, and that not merely when it was near to B, but from the moment of its starting on its course, since there can be no reason for its being so at any particular stage rather than at an earlier one. So, too, in the case of the other kinds of motion. Now we are to suppose that a thing proceeds in locomotion from A and that when it arrives at C it comes again, moving continuously, to A. Then when it is undergoing locomotion from A to C it is at the same time undergoing also its locomotion to A from C: consequently, it is simultaneously undergoing two contrary motions, since the two motions that follow the same straight line are contrary to each other. At the same time it changes from a state in which it is not: so, inasmuch as this is impossible, the thing must come to a stand at C. Therefore the motion is not a single motion, since motion that is interrupted by stationariness is not single.

Further, the following argument will serve better to make this point clear universally in respect of every kind of motion. If the motion undergone by that which is in motion is always one of those already enumerated, and the state of rest that it undergoes is one of those that are the opposites of the motions (for we found no other besides these), and moreover that which is undergoing but does not always undergo a particular motion (by this I mean one of the various specifically distinct motions, not some particular part of the whole motion) must have been previously undergoing the state of rest that is the opposite of the motion, the state of rest being privation of motion; then, inasmuch as the two motions that follow the same straight line are contrary motions, and it is impossible for a thing to undergo simultaneously two contrary motions, that which is undergoing locomotion from A to C cannot also simultaneously be undergoing locomotion from C to A; and since the latter locomotion is not simultaneous with the former but is still to be undergone, before it is undergone there must occur a state of rest at C; for this, as we found, is the state of rest that is the opposite of the motion from C. The foregoing argument, then, makes it plain that the motion is not continuous.

Again, there is the following argument, more appropriate than its predecessors. At the same time something has ceased to be not white and has become white. Then if the alteration to white and from white is continuous and does not persist for any time, at the same time it has ceased to be not white and has become white and has become not white; for the time of the three will be the same.

Again, from the continuity of the time in which the motion takes place we cannot infer continuity in the motion, but only successiveness: in fact, how could contraries, e.g. whiteness and blackness, meet in the same extreme point?

On the other hand, motion on a circular line will be one and continuous; for here we are met by no impossible consequence: that which is in motion from A will in virtue of the same direction of energy be simultaneously in motion to A (since it is in motion to the point at which it will finally arrive), and yet will not be undergoing two contrary or opposite motions; for a motion to a point and a motion from that point are not always contraries or opposites: they are contraries only if they are on the same straight line (for this has points contrary in place, e.g. the points on a diameter—for they are furthest from one another), and they are opposites only if they are along the same line. Therefore there is nothing to prevent the motion being continuous and free from all intermission; for rotatory motion is motion of a thing from its place to its place, whereas rectilinear motion is motion from its place to another place.

Moreover rotatory motion is never at the same points, whereas rectilinear motion repeatedly is so. Now a motion that is always shifting its ground can be continuous; but a motion that is repeatedly at the same points cannot be so, since then the same thing would have to undergo simultaneously two opposite motions. So, too, there cannot be continuous motion in a semicircle or in any other arc of a circle, since here also the same ground must be traversed repeatedly and two contrary processes of change must occur. For the beginning and the termination do not coincide, whereas in motion over a circle they do coincide, and so this is the only perfect motion.

This analysis shows that the other kinds of motion cannot be continuous either; for in all of them we find that there is the same ground to be traversed repeatedly: thus in alteration there are the intermediate stages, and in quantitative change there are the intervening degrees of magnitude; and in becoming and perishing the same thing is true. It makes no difference whether we take the intermediate stages of the change to be few or many, or whether we add or subtract one; for in either case we find that there is still the same ground to be traversed repeatedly. Thus it is plain from what has been said that those physicists who assert that all sensible things are always in motion are wrong; for their motion must be one or other of the motions just mentioned: in fact they mostly conceive it as alteration (things are always in flux and decay, they say), and they go so far as to speak even of becoming and perishing as a process of alteration. On the other hand, our argument has shown universally of all motions, that no motion admits of continuity except rotatory motion: consequently neither alteration nor increase admits of continuity. So much for the view that there is no change that admits of infinity or continuity except rotatory locomotion.

9 · It can now be shown plainly that rotation is the primary locomotion. Every locomotion, as we said before, is either rotatory or rectilinear or a compound of the two; and the two former must be prior to the last, since they are the elements of which the latter consists. Moreover rotatory locomotion is prior to rectilinear locomotion, because it is more simple and complete. For the line traversed in rectilinear motion cannot be infinite; for there is no such thing as an infinite straight line; and even if there were, it would not be traversed by anything in motion; for the impossible does not happen and it is impossible to traverse an infinite distance. On the other hand rectilinear motion on a finite line is composite if it turns back, i.e. two motions, while if it does not turn back it is incomplete and perishable; and in the order of nature, of definition, and of time alike the complete is prior to the incomplete and the imperishable to the perishable. Again, a motion that admits of

being eternal is prior to one that does not. Now rotatory motion can be eternal; but no other motion, whether locomotion or motion of any other kind, can be so, since in all of them rest must occur, and with the occurrence of rest the motion has perished.

The result at which we have arrived, that rotatory motion is single and continuous, and rectilinear motion is not, is a reasonable one. In rectilinear motion we have a definite beginning, end and middle, which all have their place in it in such a way that there is a point from which that which is in motion will begin and a point at which it will end (for when anything is at the limits of its course, whether at the whence or at the whither, it is in a state of rest). On the other hand in circular motion there are no such definite points; for why should any one point on the line be a limit rather than any other? Any one point as much as any other is alike beginning, middle, and end, so that they are both always and never at a beginning and at an end (so that a sphere is in a way both in motion and at rest; for it continues to occupy the same place). The reason of this is that in this case all these characteristics belong to the centre: that is to say, the centre is alike beginning, middle, and end of the space traversed; consequently since this point is not a point on the circular line, there is no point at which that which is in process of locomotion can be in a state of rest as having traversed its course, because in its locomotion it is proceeding always about a central point and not to an extreme point; and because this remains still, the whole is in a sense always at rest as well as continuously in motion. Our next point gives a convertible result: on the one hand, because rotation is the measure of motions it must be the primary motion (for all things are measured by what is primary); on the other hand, because rotation is the primary motion it is the measure of all other motions. Again, rotatory motion is also the only motion that admits of being regular. In rectilinear locomotion the motion of things in leaving the beginning is not uniform with their motion in approaching the end, since the velocity of a thing always increases proportionately as it removes itself farther from its position of rest; on the other hand rotatory motion alone has by nature no beginning or end in itself but only outside.

As to locomotion being the primary motion, this is a truth that is attested by all who have ever made mention of motion: they all assign their principles of motion to things that impart motion of this kind. Thus separation and combination are motions in respect of place, and the motion imparted by Love and Strife takes these forms, the latter separating and the former combining. Anaxagoras, too, says that Mind, his first mover, separates. Similarly those who assert no cause of this kind but say that void accounts for motion—they also hold that the motion of natural substance is motion in respect of place; for their motion that is accounted for by void is locomotion, and its sphere of operation may be said to be place. Moreover they are of opinion that the primary substances are not subject to any of the other motions, though the things that are compounds of these substances are so subject: the processes of increase and decrease and alteration, they say, are effects of the combination and separation of atoms. It is the same, too, with those who make out that the becoming or perishing of a thing is accounted for by density or rarity; for it is by combination and separation that the place of these things in their systems is determined. Moreover to these we may add those who make soul the cause of motion; for they say that things that undergo motion have as their first principle that which moves itself; and when animals and all living things move themselves, the motion is motion in respect of place. Finally, we say that a thing is in motion in the strict sense of the term only when its motion is motion in respect of place: if a thing is in process of increase or decrease or is undergoing some alteration while remaining at rest in the same place, we say that it is in motion in some particular respect: we do not say that it is in motion without qualification.

We have argued that there always was motion and always will be motion throughout all time, and we have explained what is the first principle of this eternal motion; we have explained further which is the primary motion and which is the only motion that can be eternal; and we have pronounced the first mover to be unmoved.

10 · We have now to assert that the first mover must be without parts and without magnitude, beginning with the establishment of the premisses on which this conclusion depends.

One of these premisses is that nothing finite can cause motion during an infinite time. We have three things, the mover, the moved, and thirdly that in which the motion takes place, namely the time; and these are either all infinite or all finite or some—that is to say two of them or one of them—finite and some infinite. Let A be the mover, B the moved, and C infinite time. Now let us suppose that D moves E, a part of B. Then the time occupied by this motion cannot be equal to C; for the greater the amount moved, the longer the time occupied. It follows that the time F is not infinite. Now we see that by continuing to add to D I shall use up A and by continuing to add to E I shall use up B; but I shall not use up the time by continually subtracting a corresponding amount from it, because it is infinite. Consequently the part of C which is occupied by all A in moving the whole of B, will be finite. Therefore a finite thing cannot impart to anything an infinite motion. It is clear, then, that it is impossible for the finite to cause motion during an infinite time.

That in no case is it possible for an infinite force to reside in a finite magnitude, can be shown as follows: we take it for granted that the greater force is always that which in less time does an equal amount of work—heating, for example, or sweetening or throwing, or in general causing motion. Then that on which the forces act must be affected to some extent by the finite magnitude possessing an infinite force—in fact to a greater extent than by anything else, since the infinite force is greater than any other. But then there cannot be any time in which its action could take place. Suppose that A is the time occupied by the infinite power in the performance of an act of heating or pushing, and that AB is the time occupied by a finite power in the performance of the same act: then by adding to the latter another finite power and continually increasing the magnitude of the power so added I shall at some time or other reach a point at which the finite power has completed the motive act in the time A; for by continual addition to a finite magnitude I must arrive at a magnitude that exceeds any assigned limit, and in the same way by continual subtraction I must arrive at one that falls short of any assigned limit. So we get the result that the finite force will occupy the same amount of time in performing the motive act as the infinite force. But this is impossible. Therefore nothing finite can possess an infinite force. So it is also impossible for a finite force to reside in an infinite magnitude. It is true that a greater force can reside in a lesser magnitude; but then a still greater force will reside in a greater. Now let AB be an infinite magnitude. Then BC possesses a certain force that occupies a certain time, let us say the time EF, in moving D. Now if I take a magnitude twice as great as BC, the time occupied by this magnitude in moving D will be half of EF (assuming this to be the proportion): so we may call this time FG. That being so, by continually taking a greater magnitude in this way I shall never arrive at AB, whereas I shall always be getting a lesser fraction of the time originally given. Therefore the force must be infinite; for it exceeds any finite force if the time occupied by the action of any finite force must also be finite (for if a given force moves something in a certain time, a greater force will do so in a lesser time, but still a definite time, in inverse proportion). But a force must always be infinite—just as a number or a magnitude is—if it exceeds all definite limits. This point may also be proved in another way—by taking a finite magnitude in which there resides a force the same in kind as that which resides in the infinite magnitude, so that this force will be a measure of the finite force residing in the infinite magnitude.

It is plain, then, from the foregoing arguments that it is impossible for an infinite force to reside in a finite magnitude or for a finite force to reside in an infinite magnitude. But first it will be well to discuss a difficulty that arises in connexion with locomotion. If everything that is in motion with the exception of things that move themselves is moved by something, how is it that some things, e.g. things thrown, continue to be in motion when their mover is no longer in contact with them? If we say that the mover in such cases moves something else at the same time, e.g. the air, and that this in being moved is also a mover, then it will similarly be impossible for this to be in motion when the original mover is not in contact with it or moving it: all the things moved would have to be in motion simultaneously and also to have ceased simultaneously to be in motion when the original mover ceases to move them, even if, like the magnet, it makes that which it has moved capable of being a mover. Therefore, we must say that the original mover gives the power of being a mover either to air or to water or to something else of the kind, naturally adapted for imparting and undergoing motion; but this thing does not cease simultaneously to impart motion and to undergo motion: it ceases to be in motion at the moment when its mover ceases to move it, but it still remains a mover, and so it causes something else consecutive with it to be in motion, and of this again the same may be said. The motion ceases when the motive force produced in one member of the consecutive series is at each stage less, and it finally ceases when one member no longer causes the next member to be a mover but only causes it to be in motion. The motion of these last two—of the one as mover and of the other as moved—must cease simultaneously, and with this the whole motion ceases. Now the things in which this motion is produced are things that admit of being sometimes in motion and sometimes at rest, and the motion is not continuous but only appears so; for it is motion of things that are either successive or in contact, there being not one mover but a number consecutive with one another. That is why motion of this kind takes place in air and water. Some say that it is mutual replacement; but the difficulty raised cannot be solved otherwise than in the way we have described. Mutual replacement makes all the members of the series move and impart motion simultaneously, so that their motions also cease simultaneously; but there appears to be continuous motion in a single thing, and therefore, since it cannot be moved by the same mover, the question is, what moves it?

Since there must be continuous motion in the world of things, and this is a single motion, and a single motion must be a motion of a magnitude (for that which is without magnitude cannot be in motion), and of a single magnitude moved by a single mover (for otherwise there will not be continuous motion but a consecutive series of separate motions), then if the mover is a single thing, it is either in motion or unmoved: if, then, it is in motion, it will have to keep pace with that which it moves and itself be in process of change, and it will also have to be moved by something: so we have a series that must come to an end, and a point will be reached at which motion is imparted by something that is unmoved. Thus we have a mover that has no need to change along with that which it moves but will be able to cause motion always (for the causing of motion under these conditions involves no effort); and this motion alone is regular, or at least it is so in a higher degree than any other, since the mover is never subject to any change. So, too, in order that the motion may continue to be of the same character, the moved must not be subject to change in relation to it. So it must occupy either the centre or the circumference, since these are the principles. But the things nearest the mover are those whose motion is quickest, and in this case it is the motion of the circumference that is the quickest: therefore the mover occupies the circumference.

There is a difficulty in supposing it to be possible for anything that is in motion to cause motion continuously and not merely in the way in which it is caused by something repeatedly pushing (in which case the continuity amounts to no more than successiveness). Such a mover must either itself continue to push or pull or perform both these actions, or else the action must be taken up by something else and be passed on from one mover to another (the process that we described before as occurring in the case of things thrown, since the air, being divisible, is a mover in virtue of the fact that different parts of the air are moved one after another); and in either case the motion cannot be a single motion, but only a consecutive series of motions. The only continuous motion, then, is that which is caused by the unmoved mover; for it remains always invariable, so that its relation to that which it moves remains also invariable and continuous.

Now that these points are settled, it is clear that the first unmoved mover cannot have any magnitude. For if it has magnitude, this must be either a finite or an infinite magnitude. Now we have already proved in our course on *Physics* that there cannot be an infinite magnitude; and we have now proved that it is impossible for a finite magnitude to have an infinite force, and also that it is impossible for a thing to be moved by a finite magnitude during an infinite time. But the first mover causes a motion that is eternal and causes it during an infinite time. It is clear, therefore, that is indivisible and is without parts and without magnitude.

ON THE HEAVENS

J. L. Stocks

BOOK I

1 · The science which has to do with nature clearly concerns itself for the [268a1] most part with bodies and magnitudes and their properties and movements, but also with the principles of this sort of substance, as many as they may be. For of things constituted by nature some are bodies and magnitudes, some possess body and magnitude, and some are principles of things which possess these. Now a continuum is that which is divisible into parts always capable of subdivision, and a body is that which is every way divisible. A magnitude if divisible one way is a line, if two ways a surface, and if three a body. Beyond these there is no other magnitude, because the three dimensions are all that there are, and that which is divisible in three directions is divisible in all. For, as the Pythagoreans say, the universe and all that is in it is determined by the number three, since beginning and middle and end give the number of the universe, and the number they give is the triad. And so, having taken these three from nature as (so to speak) laws of it, we make further use of the number three in the worship of the Gods. Further, we use the terms in practice in this way. Of two things, or men, we say 'both', but not 'all': three is the first number to which the term 'all' is applied. And in this, as we have said, we do but follow the lead which nature herself gives. Therefore, since 'every' and 'all' and 'complete' do not differ from one another in respect of form, but only, if at all, in their matter and in that to which they are applied, body alone among magnitudes can be complete. For it alone is determined by the three dimensions, that is, is an 'all'. But if it is divisible in three dimensions it is every way divisible, while the other magnitudes are divisible in one dimension or in two; for the divisibility and continuity of magnitudes depend upon the number of the dimensions, one sort being continuous in one direction, another in two, another in all. All magnitudes, then, which are divisible are also continuous. Whether we can also say that whatever is continuous is divisible does not yet, on our present grounds, appear. One thing, however, is clear. We cannot pass beyond body to a further kind, as we passed from length to [268b1] surface, and from surface to body. For if we could, it would cease to be true that body is complete magnitude. We could pass beyond it only in virtue of a defect in it and that which is complete cannot be defective, since it extends in every direction.

TEXT: D. J. Allan, OCT, Oxford, 1936

Now bodies which are classed as parts of the whole are each complete according to our formula, since each possesses every dimension. But each is determined relatively to that part which is next to it by contact, for which reason each of them is in a sense many bodies. But the whole of which they are parts must necessarily be complete, and must, as the term indicates, extend in every direction and not just in some.

2 · The question as to the nature of the whole, whether it is infinite in size or limited in its total mass, is a matter for subsequent inquiry. We will now speak of those parts of the whole which are specifically distinct. Let us take this as our starting-point. All natural bodies and magnitudes we hold to be, as such, capable of locomotion; for nature, we say, is their principle of movement. But all movement that is in place, all locomotion, as we term it, is either straight or circular or a combination of these two which are the only simple movements. And the reason is that these two, the straight and the circular line, are the only simple magnitudes. Now revolution about the centre is circular motion, while the upward and downward movements are in a straight line, 'upward' meaning motion away from the centre, and 'downward' motion towards it. All simple motion, then, must be motion either away from or towards or about the centre. This seems to be in exact accord with what we said above: as body found its completion in three dimensions, so its movement completes itself in three forms.

Bodies are either simple or compounded of such; and by simple bodies I mean those which possess a principle of movement in their own nature, such as fire and earth with their kinds, and whatever is akin to them. Necessarily, then, movements also will be either simple or in some sort compound—simple in the case of the simple bodies, compound in that of the composite—and the motion is according to the prevailing element. Supposing, then, that there is such a thing as simple movement, and that circular movement is simple, and that both movement of a simple body is simple and simple movement is of a simple body (for if it is movement of a compound it will be in virtue of a prevailing element), then there must necessarily be some simple body which moves naturally and in virtue of its own nature with a circular movement. By constraint, of course, it may be brought to move with the motion of something else different from itself, but it cannot so move naturally, since there is one sort of movement natural to each of the simple bodies. Again, if the unnatural movement is the contrary of the natural and a thing can have no more than one contrary, it will follow that circular movement, being a simple motion, must be unnatural, if it is not natural, to the body moved. If then the body whose movement is circular is fire or some other element, its natural motion must be the contrary of the circular motion. But a single thing has a single contrary; and upward and downward motion are the contraries of one another. If, on the other hand, the body moving with this circular motion which is unnatural to it is something different from the elements, there will be some other motion which is natural to it. But this cannot be. For if the natural motion is upward, it will be fire or air, and if downward, water or earth. Further, this circular motion is necessarily primary. For the complete is naturally prior to the incomplete, and the circle is a complete thing. This cannot be said of any straight line:—not of an infinite line; for then it would have a limit and an end: nor of any finite line; for in every case there is something beyond it, since any finite line can be extended. And so, since the prior movement belongs to the body which is naturally prior, and circular movement is prior to straight, and movement in a straight line belongs to simple bodies—fire moving straight upward and earthy bodies straight downward towards the centre—since this is so, it follows that circular movement also must be the movement of some simple body. For the movement of composite bodies is, as we said, determined by that simple body which prevails in the composition. From this it is clear that there is in nature some bodily substance other than the formations we know, prior to them all and more divine than they. Or again, we may take it that all movement is either natural or unnatural, and that the movement which is unnatural to one body is natural to another—as for instance, is the case with the upward and downward movements, which are natural and unnatural to fire and earth respectively. It necessarily follows that circular movement, being unnatural to these bodies, is the natural movement of some other. Further, if, on the one hand, circular movement is *natural* to something, it must surely be some simple and primary body which naturally moves with a natural circular motion, as fire moves up and earth down. If, on the other hand, the movement of the rotating bodies about the centre is *unnatural,* it would be remarkable and indeed quite inconceivable that this movement alone should be continuous and eternal, given that it is unnatural. At any rate the evidence of all other cases goes to show that it is the unnatural which quickest passes away. And so, if, as some say, the body so moved is fire, this movement is just as unnatural to it as downward movement; for any one can see that fire moves in a straight line away from the centre. On all these grounds, therefore, we may infer with confidence that there is something beyond the bodies that are about us on this earth, different and separate from them; and that the superior glory of its nature is proportionate to its distance from this world of ours.

3 · In consequence of what has been said, in part by way of assumption and in part by way of demonstration, it is clear that not every body possesses either lightness or heaviness. We must explain in what sense we are using the words 'heavy' and 'light', sufficiently, at least, for our present purposes: we can examine the terms more precisely later, when we come to consider their essential nature. Let us then apply the term 'heavy' to that which naturally moves towards the centre, and 'light' to that which moves naturally away from the centre. The heaviest thing will be that which sinks to the bottom of all things that move downward, and the lightest that which rises to the surface of everything that moves upward. Now, necessarily, everything which moves either up or down possesses lightness or heaviness or both—but not both relatively to the same thing; for things are heavy and light relatively to one another; air, for instance, is light relatively to water, and water light relatively to earth. But the body which moves in a circle cannot possibly possess heaviness or lightness. For neither naturally nor unnaturally can it move

either towards or away from the centre. Movement in a straight line certainly does not belong to it *naturally*, since one sort of movement is, as we saw, appropriate to each simple body, and so we should be compelled to identify it with one of the bodies which move in this way. Suppose, then, that the movement is *unnatural*. In that
270a1 case, if it is the downward movement which is unnatural, the upward movement will be natural; and if it is the upward which is unnatural, the downward will be natural. For we decided that of contrary movements, if the one is unnatural to anything, the other will be natural to it. But since the natural movement of the whole and of its part—of earth, for instance, as a whole and of a small clod—have one and the same direction, it results, in the first place, that this body can possess no lightness or heaviness at all (for that would mean that it could move by its own nature either from or towards the centre); and, secondly, that it cannot possibly move in the way of locomotion by being dragged upwards or pulled downwards. For neither naturally nor unnaturally can it move with any other motion but its own, either itself or any part of it, since the reasoning which applies to the whole applies also to the part.

It is equally reasonable to assume that this body will be ungenerated and indestructible and exempt from increase and alteration, since everything that comes to be comes into being from a contrary and some substrate, and passes away likewise in a substrate by the action of a contrary into a contrary, as we explained in our opening discussions.[1] Now the motions of contraries are contrary. If then this body can have no contrary, because there can be no contrary motion to the circular, nature seems justly to have exempted from contraries the body which was to be ungenerated and indestructible. For it is on contraries that generation and destruction depend. Again, that which is subject to increase increases upon contact with a kindred body, which is resolved into its matter. But there is nothing out of which this body can have been generated. And if it is exempt from increase and destruction, the same reasoning leads us to suppose that it is also unalterable. For alteration is movement in respect of quality; and qualitative states and dispositions, such as health and disease, do not come into being without changes of properties. But all natural bodies which change their properties we see to be subject to increase and diminution. This is the case, for instance, with the bodies of animals and their parts and with vegetable bodies, and similarly also with those of the elements. And so, if the body which moves with a circular motion cannot admit of increase or diminution, it is reasonable to suppose that it is also unalterable.

270b1 The reasons why the primary body is eternal and not subject to increase or diminution, but unaging and unalterable and unmodified, will be clear from what has been said to any one who believes in our assumptions. Our theory seems to confirm the phenomena and to be confirmed by them. For all men have some conception of the nature of the gods, and all who believe in the existence of gods at all, whether barbarian or Greek, agree in allotting the highest place to the deity, surely because they suppose that immortal is linked with immortal and regard any other supposition as impossible. If then there is, as there certainly is, anything divine, what we have just said about the primary bodily substance was well said.

[1]See *Physics* I 7–9.

The mere evidence of the senses is enough to convince us of this, at least with human certainty. For in the whole range of time past, so far as our inherited records reach, no change appears to have taken place either in the whole scheme of the outermost heaven or in any of its proper parts. The name, too, of that body seems to have been handed down right to our own day from our distant ancestors who conceived of it in the fashion which we have been expressing. The same ideas, one must believe, recur in men's minds not once or twice but again and again. And so, implying that the primary body is something else beyond earth, fire, air, and water, they gave the highest place the name of *aether*, derived from the fact that it 'runs always'[2] for an eternity of time. Anaxagoras, however, misuses this name, taking aether as equivalent to fire.

It is also clear from what has been said why the number of what we call simple bodies cannot be greater than it is. The motion of a simple body must itself be simple, and we assert that there are only these two simple motions, the circular and the straight, the latter being subdivided into motion away from and motion towards the centre.

4 · That there is no other form of motion contrary to the circular may be proved in various ways. In the first place, there is an obvious tendency to oppose the straight line to the circular. For concave and convex are not only regarded as opposed to one another, but they are also coupled together and treated as a unity in 271ª1 opposition to the straight. And so, if there is a contrary to circular motion, motion in a straight line must be recognized as having the best claim to that name. But the two forms of rectilinear motion are opposed to one another by reason of their places; for up and down is a difference and a contrary opposition in place. Secondly, it may be thought that the same reasoning which holds good of the rectilinear path applies also to the circular, movement from *A* to *B* being opposed as contrary to movement from *B* to *A*. But what is meant is still rectilinear motion. For that is limited, while the circular paths which pass through the same points are infinite in number. Even if we are confined to the single semicircle and the opposition is between movement from *C* to *D* and from *D* to *C* along that semicircle, the case is no better. For the motion is the same as that along the diameter, since we invariably regard the distance between two points as the length of the straight line which joins them. It is no more satisfactory to construct a circle and treat motion along one semicircle as contrary to motion along the other. For example, taking a whole circle, motion from *E* to *F* on the semicircle *G* may be opposed to motion from *F* to *E* on the semicircle *H*. But even supposing these are contraries, it in no way follows that the motions on the whole circle are contraries. Nor again can motion along the circle from *A* to *B* be regarded as the contrary of motion from *A* to *C*; for the motion goes from the same point towards the same point, and contrary motion was distinguished as motion from a contrary to its contrary. And even if one circular motion is the contrary of another, one of the two would be pointless; for that which moves in a circle, at whatever point it begins, must necessarily pass through all the contrary places alike. (By contrarieties of place I mean up and down, back and front, and

[2] αἰθήρ from ἀεὶ θεῖν.

right and left.) But contrarieties of movements correspond to those of places. For if the two motions were equal, there would be no movement, and if one of the two were preponderant, the other would not occur. So that if both bodies were there, one of them, inasmuch as it would not be moving with its own movement, would be pointless, in the sense in which a shoe is pointless when it is not worn. But God and nature create nothing that is pointless.

271b1 5 · This being clear, we must go on to consider the questions which remain. First, is there an infinite body, as the majority of the ancient philosophers thought, or is this an impossibility? The decision of this question, either way, is not unimportant, but rather all important, to our search for the truth. It is this problem which practically always has been and may be expected to be the source of the differences of those who have written about nature as a whole, since the least initial deviation from the truth is multiplied later a thousandfold. Admit, for instance, the existence of a minimum magnitude, and you will find that the minimum which you have introduced causes the greatest truths of mathematics to totter. The reason is that a principle is great rather in power than in extent; hence that which was small at the start turns out a giant at the end. Now the infinite possesses this power of principles, and indeed in the sphere of quantity possesses it in the highest degree; so that it is in no way absurd or unreasonable that the assumption that an infinite body exists should be of peculiar moment to our inquiry. The infinite, then, we must now discuss, opening the whole matter from the beginning.

Every body is necessarily to be classed either as simple or as composite; the infinite body, therefore, will be either simple or composite. But it is clear, further, that if the simple bodies are finite, the composite must also be finite, since that which is composed of bodies finite both in number and in magnitude is itself finite in respect of number and magnitude: its quantity is in fact the same as that of the bodies which compose it. What remains for us to consider, then, is whether any of the simple bodies can be infinite in magnitude, or whether this is impossible. Let us try the primary body first, and then go on to consider the others.

The body which moves in a circle must necessarily be finite in every respect, for the following reasons. If the body so moving is infinite, the radii drawn from the centre will be infinite. But the space between infinite radii is infinite—by the space between the lines I mean the area outside which no magnitude which is in contact with the lines can be found. This, I say, will be infinite; for in the case of finite radii it is always finite; and again one can always go on to take more than the given
272a1 quantity, so that just as we say that number is infinite, because there is no greatest, the same argument applies also to the space between the radii. Now the infinite cannot be traversed, and if the body is infinite the interval between the radii is necessarily infinite: circular motion therefore is an impossibility. Yet we see that the heavens revolve in a circle, and by argument also we have determined that there is something to which circular movement belongs.

Again, if from a finite time a finite time be subtracted, what remains must be finite and have a beginning. And if the time of a journey has a beginning, there must be a beginning also of the movement, and consequently also of the distance traversed. This applies universally. Take a line, *ACE*, infinite in one direction, *E*, and another line, *BB*, infinite in both directions. Let *ACE* describe a circle, revolving upon *A* as centre. In its circular movement it will cut *BB* for a certain finite time; the total time is finite in which the heavens complete their circular orbit, and consequently the time subtracted from it, during which the one line in its motion cuts the other, is also finite. Therefore there will be a point at which *ACE* began for the first time to cut *BB*. This, however, is impossible. The infinite, then, cannot revolve in a circle; nor could the world, if it were infinite.

That the infinite cannot move away may also be shown as follows. Let *A* be a finite line moving past the finite line, *B*. Of necessity *A* will pass clear of *B* and *B* of *A* at the same moment; for each overlaps the other to precisely the same extent. Now if the two were moving in contrary directions, they would pass clear of one another more rapidly; if one were still and the other moving past it, less rapidly; provided that the speed of the latter were the same in both cases. This, however, is clear: that it is impossible to traverse an infinite line in a finite time. Infinite time, then, would be required. (This we demonstrated above in the discussion of movement.)[3] And it makes no difference whether a finite is passing by an infinite or an infinite by a finite. For when *A* is passing *B*, then *B* overlaps *A*, and it makes no difference whether *B* is moved or unmoved, except that, if both move, they pass clear of one another more quickly. It is, however, quite possible that a moving line should in certain cases pass one which is stationary quicker than it passes one moving in an opposite direction. One has only to imagine the movement to be slow where both move and much faster where one is stationary. To suppose one line stationary, then, makes no difficulty for our argument, since it is quite possible for *A* to pass *B* at a slower rate when both are moving than when only one is. If, therefore, the time which the finite moving line takes to pass the other is infinite, then necessarily the time occupied by the motion of the infinite past the finite is also infinite. For the infinite to move at all is thus absolutely impossible; since the very smallest movement must take an infinity of time. Moreover the heavens certainly revolve, and they complete their circular orbit in a finite time; so that they pass round the whole extent of any line within their orbit, such as the finite line *AB*. The revolving body, therefore, cannot be infinite.

Again, as a line which has a limit[4] cannot be infinite, or, if it is infinite, is so only in length, so a surface cannot be infinite in that respect in which it has a limit: or, indeed if it is completely determinate, in any respect whatever. E.g. if it is a square or a circle or a sphere, it cannot be infinite, any more than a foot-long line can. There is then no such thing as an infinite sphere or circle, and where there is no circle there can be no circular movement, and similarly where there is no infinite at all there can be no infinite movement; and from this it follows that, an infinite circle being itself an impossibility, there can be no circular motion of an infinite body.

Again, take a centre *C*, an infinite line, *AB*, another infinite line at right angles to it, *E*, and a moving radius, *CD*. *CD* will never cease contact with *E*, but the

[3] I.e. *Physics* VI 7.
[4] Retaining the MSS reading ἧς πέρας.

position will always be something like *CE*, *CD* cutting *E* at *F*. The infinite line, therefore, does not complete the circle.

Again, if the heaven is infinite and moves in a circle, we shall have to admit that in a finite time it has traversed the infinite. For suppose the fixed heaven infinite, and that which moves within it equal to it. It results that when the infinite body has completed its revolution, it has traversed an infinite equal to itself in a finite time. But that we know to be impossible.

It can also be shown, conversely, that if the time of revolution is finite, the distance traversed must also be finite; but the distance traversed was equal to itself; therefore, it is itself finite.

We have now shown that the body which moves in a circle is not endless or infinite, but has its limit.

6 · Further, neither that which moves towards nor that which moves away from the centre can be infinite. For the upward and downward motions are contraries and are therefore motions towards contrary places. But if one of a pair of contraries is determinate, the other must be determinate also. Now the centre is determined; for, from whatever point the body which sinks to the bottom starts its downward motion, it cannot go farther than the centre. The centre, therefore, being determinate, the upper place must also be determinate. But if these two places are determined and finite, the corresponding bodies must also be finite. Further, if up and down are determinate, the intermediate place is also necessarily determinate. For, if it is indeterminate, there will be infinite motion; and that we have already shown to be an impossibility.[5] The middle region then is determinate, and consequently any body which either is in it, or might be in it, is determinate. But the bodies which move up and down may be in it, since the one moves naturally away from the centre and the other towards it.

From this it is clear that an infinite body is an impossibility; but there is a further point. If there is no such thing as infinite weight, then it follows that none of these bodies can be infinite. For the supposed infinite body would have to be infinite in weight. (The same argument applies to lightness; for if there is infinite weight, there is infinite lightness, if the rising body is infinite.) This is proved as follows. Assume the weight to be finite, and take an infinite body, *AB*, of the weight *C*. Subtract from the infinite body a finite mass, *BD*, the weight of which shall be *E*. *E* then is less than *C*, since it is the weight of a lesser mass. Suppose then that the smaller goes into the greater a certain number of times, and take *BF* bearing the same proportion to *BD* which the greater weight bears to the smaller. For you may subtract as much as you please from an infinite. If now the masses are proportionate to the weights, and the lesser weight is that of the lesser mass, the greater must be that of the greater. The weights, therefore, of the finite and of the infinite body are equal. Again, if the weight of a greater body is greater than that of a less, the weight of *GB* will be greater than that of *FB*; and thus the weight of the finite body is greater than that of the infinite. And, further, the weight of unequal masses will be the same, since the infinite and the finite cannot be equal. It does not matter

[5]At *Physics* VIII 8.

whether the weights are commensurable or not. If they are *incommensurable* the same reasoning holds. For instance, suppose *E* multiplied by three is rather more than *C*: the weight of three masses of the full size of *BD* will be greater than *C*. We thus arrive at the same impossibility as before. Again we may assume weights which are *commensurate;* for it makes no difference whether we begin with the weight or with the mass. For example, assume the weight *E* to be commensurate with *C*, and take from the infinite mass a part *BD* of weight *E*. Then let a mass *BF* be taken having the same proportion to *BD* which the two weights have to one another. (For the mass being infinite you may subtract from it as much as you please.) These assumed bodies will be commensurate in mass and in weight alike. Nor again does it make any difference to our demonstration whether the total mass has its weight equally or unequally distributed. For it must always be possible to take from the infinite mass bodies of equal weight to *BD* by diminishing or increasing the size of the section to the necessary extent.

From what we have said, then, it is clear that the weight of the infinite body cannot be finite. It must then be infinite. We have therefore only to show this to be impossible in order to prove an infinite body impossible. But the impossibility of infinite weight can be shown in the following way. A given weight moves a given distance in a given time; a weight which is as great and more moves the same distance in a less time, the times being in inverse proportion to the weights. For instance, if one weight is twice another, it will take half as long over a given movement. Further, a finite weight traverses any finite distance in a finite time. It necessarily follows from this that infinite weight, if there is such a thing, being, on the one hand, as great and more than as great as the finite, will move accordingly, but being, on the other hand, compelled to move in a time inversely proportionate to its greatness, cannot move at all. The time should be less in proportion as the weight is greater. But there is no proportion between the infinite and the finite: proportion can only hold between a less and a greater *finite* time. And though you may say that the time of the movement can be continually diminished, yet there is no minimum. Nor, if there were, would it help us. For some finite body could have been found greater than the given finite in the same proportion which is supposed to hold between the infinite and the given finite; so that an infinite and a finite weight must have traversed an equal distance in equal time. But that is impossible. Again, whatever the time, so long as it is finite, in which the infinite performs the motion, a finite weight must necessarily move a certain finite distance in that same time. Infinite weight is therefore impossible, and the same reasoning applies also to infinite lightness. Bodies then of infinite weight and of infinite lightness are equally impossible.

7 · That there is no infinite body may be shown, as we have shown it, by a detailed consideration of the various cases. But it may also be shown universally, not only by such reasoning as we advanced in our discussion of principles[6] (though in that passage we have already determined universally the sense in which the existence of an infinite is to be asserted or denied), but also suitably to our present

[6] I.e. *Physics* III 4–8.

purpose in the following way. That will lead us to a further question. Even if the total mass is not infinite, it may yet be great enough to admit a plurality of universes. The question might possibly be raised whether there is any obstacle to there being other universes composed on the pattern of our own, more than one, though stopping short of infinity. First, however, let us treat of the infinite universally.

Every body must necessarily be either finite or infinite, and if infinite, either of similar or of dissimilar parts. If its parts are *dissimilar,* they must represent either a finite or an infinite number of kinds. That the kinds cannot be *infinite* is evident, if our original presuppositions remain unchallenged. For the
274b1 primary movements being finite in number, the kinds of simple body are necessarily also finite, since the movement of a simple body is simple, and the simple movements are finite, and every natural body must always have its proper motion. Now if the infinite body is to be composed of a *finite* number of kinds, then each of its parts (i.e. water, or fire) must necessarily be infinite. But this is impossible, because, as we have already shown, infinite weight and lightness do not exist. Moreover it would be necessary also that their places should be infinite in extent, so that the movements too of all these bodies would be infinite. But this is not possible, if we are to hold to the truth of our original presuppositions and to the view that neither that which moves downward, nor, by the same reasoning, that which moves upward, can be in a process of moving to infinity. For it is true in regard to quality, quantity, and place alike that it is impossible for a thing to be coming to be what it cannot have come to be. I mean that if it is impossible for a thing to have come to be white, or a cubit long, or in Egypt, it is also impossible for it to be coming to be any of these. It is thus impossible for a thing to be moving to a place at which in its motion it can never by any possibility arrive. Again, suppose the body to exist in dispersion, it may be maintained none the less that the total of all these scattered particles, say, of fire, is infinite. But body we saw to be that which has extension every way. How then can there be several dissimilar elements, each infinite? Each would have to be infinitely extended every way.

It is not possible, again, that the infinite should exist as a whole of *similar* parts. For, in the first place, there is no other movement beyond those mentioned: we must therefore give it one of them. And if so, we shall have to admit either infinite weight or infinite lightness. Nor, secondly, could the body whose movement is circular be infinite, since it is impossible for the infinite to move in a circle. This, indeed, would be as good as saying that the heavens are infinite, which we have shown to be impossible.

Moreover, in general, it is impossible that the infinite should move at all. If it did, it would move either naturally or by constraint; and if by constraint, it possesses also a natural motion, that is to say, there is another place, infinite like itself, to which it will move. But that is impossible.

That in general it is impossible for the infinite to be acted upon by the finite or to act upon it may be shown as follows.

275a1 Let A be an infinite, B a finite, C the time of a given movement produced by one in the other. Suppose, then, that A was heated, or impelled, or modified in any way, or caused to undergo any sort of movement whatever, by *B* in the time *C*. Let *D* be less than *B*; and, assuming that a lesser agent moves a lesser patient in an equal time, call the quantity thus modified by *D*, *E*. Then, as *D* is to *B*, so is *E* to some finite quantum. We assume that the alteration of equal by equal takes equal time, and the alteration of less by less or of greater by greater takes the same time, if the quantity of the patient is such as to keep the proportion which obtains between the agents, greater and less. If so, no movement can be caused in the infinite by any finite agent in any time whatever. For a less agent will produce that movement in a less patient in an equal time, and the proportionate equivalent of that patient will be a finite quantity, since no proportion holds between finite and infinite.

Nor, again, can the infinite produce a movement in the finite in any time whatever. Let *A* be an infinite, *B* a finite, *C* the time of action. In the time *C*, *D* will produce that motion in a patient less than *B*, say *F*. Then take *E*, bearing the same proportion to *D* as the whole *BF* bears to *F*. *E* will produce the motion in *BF* in the time *C*. Thus the finite and the infinite effect the same alteration in equal times. But this is impossible; for the assumption is that the greater effects it in a shorter time. It will be the same with any time that can be taken, so that there will be no time in which the infinite can effect this movement. And, as to infinite time, in that nothing can move another or be moved by it. For such time has no limit, while the action and the effect have.

Nor can infinite be acted upon in any way by infinite. Let *A* and *B* be infinites, *CD* being the time of the action of *A* upon *B*. Now the whole *B* was modified in a certain time, and the part of this infinite, *E*, cannot be so modified in the same time, since we assume that a less quantity makes the movement in a less time. Let *E*, then, when acted upon by *A*, complete the movement in the time *D*. Then, as *D* is to *CD*, so is *E* to some finite part of *B*. This part will necessarily be moved by *A* in the time *CD*. For we suppose that the same agent produces a given effect on a greater and a smaller mass in longer and shorter times, the times and masses varying proportion- 275b1
ately. There is thus no finite time in which infinites can move one another. Is their time then infinite? No, for infinite time has no end, but the movement communicated has.

If therefore every perceptible body possesses the power of acting or of being acted upon, or both of these, it is impossible that an infinite body should be perceptible. All bodies, however, that occupy place are perceptible. There is therefore no infinite body beyond the heaven. Nor again is there anything of limited extent beyond it. And so beyond the heaven there is no body at all. For if you suppose it an object of thought, it will be in a place—since place is what 'within' and 'beyond' denote—and therefore an object of perception. But nothing that is not in a place is perceptible.

The question may also be examined in the light of more general considerations as follows. The infinite, considered as a whole of similar parts, cannot, on the one hand, move in a circle. For there is no centre of the infinite, and that which moves in a circle moves about the centre. Nor again can the infinite move in a straight line. For there would have to be another place infinite like itself to be the goal of its natural movement and another, equally great, for the goal of its unnatural movement. Moreover, whether its rectilinear movement is natural or constrained, in either case the force which causes its motion will have to be infinite. For infinite force is force of an infinite body, and of an infinite body the force is infinite. So the motive body also will be infinite. (The proof of this is given in our discussion of movement,[7] where it is shown that no finite thing possesses infinite power, and no infinite thing finite power.) If then that which moves naturally can also move unnaturally, there will be two infinites, one which causes, and another which exhibits the latter motion. Again, what is it that moves the infinite? If it moves itself, it must be animate. But how can it possibly be conceived as an infinite animal? And if there is something else that moves it, there will be two infinites, that which moves and that which is moved, differing in their form and power.

If the whole is not continuous, but exists, as Democritus and Leucippus think, in the form of parts separated by void, there must necessarily be one movement of all the parts. They are distinguished, we are told, from one another by their figures; but their nature is one, like many pieces of gold separated from one another. But each piece must, as we assert, have the same motion. For a single clod moves to the same place as the whole mass of earth, and a spark to the same place as the whole mass of fire. So that if it be weight that all possess, no body is, strictly speaking, light; and if lightness, none is heavy. Moreover, whatever possesses weight or lightness will have its place either at one of the extremes or in the middle region. But this is impossible while the world is conceived as infinite. And, generally, that which has no centre or extreme limit, no up or down, gives the bodies no place for their motion; and without that movement is impossible. A thing must move either naturally or unnaturally, and the two movements are determined by the proper and alien places. Again, a place in which a thing rests or to which it moves unnaturally, must be the natural place for some other body, as induction shows. Necessarily, therefore, not everything possesses weight or lightness, but some things do and some do not. From these arguments then it is clear that the body of the universe is not infinite.

8 · We must now proceed to explain why there cannot be more than one heaven—the further question mentioned above. For it may be thought that we have not proved universally of bodies that none whatever can exist outside our universe, and that our argument applied only to those of indeterminate position.

Now all things rest and move naturally and by constraint. A thing moves naturally to a place in which it rests without constraint, and rests naturally in a place to which it moves without constraint. On the other hand, a thing moves by constraint to a place in which it rests by constraint, and rests by constraint in a place to which it moves by constraint. Further, if a given movement is due to constraint, its contrary is natural. If, then, it is by constraint that earth moves from a certain place to the centre here, its movement from here to there will be natural, and if earth from there rests here without constraint, its movement hither will be natural.

[7] *Physics* VIII 10.

And the natural movement in each case is one. Further, these worlds, being similar in nature to ours, must all be composed of the same bodies as it. Moreover each of the bodies, fire, I mean, and earth and their intermediates, must have the same power as in our world. For if those elements are named homonymously and not in virtue of having the same form as ours, then the whole to which they belong can only be called a world homonymously. Clearly, then, one of the bodies will move naturally away from the centre and another towards the centre, since fire must be identical with fire, earth with earth, and so on, as the fragments of each are identical in this world. That this must be the case is evident from the principles laid down in our discussion of the movements; for these are limited in number, and the distinction of the elements depends upon the distinction of the movements. Therefore, since the movements are the same, the elements must also be the same everywhere. The particles of earth, then, in another world move naturally also to our centre and its fire to our circumference. This, however, is impossible, since, if it were true, earth must, in its own world, move upwards, and fire to the centre; in the same way the earth of our world must move naturally away from the centre when it moves towards the centre of another universe. This follows from the supposed juxtaposition of the worlds. For either we must refuse to admit the identical nature of the simple bodies in the various universes, or, admitting this, we must make the centre and the extremity one as suggested. This being so, it follows that there cannot be more worlds than one.

To postulate a difference of nature in the simple bodies according as they are more or less distant from their proper places is unreasonable. For what difference can it make whether we say that a thing is this distance away or that? One would have to suppose a difference proportionate to the distance and increasing with it, but the form is in fact the same. Moreover, the bodies must have some movement, since the fact that they move is quite evident. Are we to say then that all their movements, even those which are mutually contrary, are due to constraint? No, for a body which has no natural movement at all cannot be moved by constraint. If then the bodies have a natural movement, the movement of the particular instances of each form must necessarily have for goal a place numerically one, i.e. a particular centre or a particular extremity. If it be suggested that the goal in each case is one in form but numerically more than one, on the analogy of particulars which are many though each undifferentiated in form, we reply that the variety of goal cannot be limited to this portion or that but must extend to all alike. For all are equally undifferentiated in form, but any one is different numerically from any other. What I mean is this: if the portions in this world behave similarly both to one another and to those in another world, then the portion which is taken hence will not behave differently either from the portions in another world or from those in the same world, but similarly to them, since in form no portion differs from another. The result is that we must either abandon our present assumptions or assert that the centre and the extremity are each numerically one. But this being so, the heaven, by the same evidence and the same necessary inferences, must be one only and no more.

A consideration of the other kinds of movement also makes it plain that there is some point to which earth and fire move naturally. For in general that which is moved changes from something into something, the starting-point and the goal being different in form, and always it is a finite change. For instance, to recover health is to change from disease to health, to increase is to change from smallness to greatness. Locomotion must be similar; for it also has its goal and starting-point—and therefore the starting-point and the goal of the natural movement must differ in form—just as the movement of coming to health does not take any direction which chance or the wishes of the mover may select. Thus, too, fire and earth move not to infinity but to opposite points; and since the opposition in place is between above and below, these will be the limits of their movement. (Even in circular movement there is a sort of opposition between the ends of the diameter, though the movement as a whole has no contrary: so that here too the movement has in a sense an opposed and finite goal.) There must therefore be some end to locomotion: it cannot continue to infinity.

This conclusion that local movement is not continued to infinity is corroborated by the fact that earth moves more quickly the nearer it is to the centre, and fire the nearer it is to the upper place. But if movement were infinite speed would be infinite also; and if speed then weight and lightness. For as the lower of two bodies would be quick because of its weight, so infinite increase of weight necessitates infinite increase of speed.

277b1 Further, it is not the action of another body that makes one of these bodies move up and the other down; nor is it constraint, like the 'extrusion' of some writers. For in that case the larger the mass of fire or earth the slower would be the upward or downward movement; but the fact is the reverse: the greater the mass of fire or earth the quicker always is its movement towards its own place. Again, the speed of the movement would not increase towards the end if it were due to constraint or extrusion; for a constrained movement always diminishes in speed as the source of constraint becomes more distant, and a body moves without constraint to the place whence it was moved by constraint.

A consideration of these points, then, gives adequate assurance of the truth of our contentions. The same could also be shown with the aid of the discussions which fall under First Philosophy, as well as from the nature of the circular movement, which must be eternal both here and in the other worlds. It is plain, too, from the following considerations that the universe must be one.

The bodily elements are three, and therefore the places of the elements will be three also; the place, first, of the body which sinks to the bottom, namely the region about the centre; the place, secondly, of the revolving body, namely the outermost place, and thirdly, the intermediate place, belonging to the intermediate body. Here in this third place will be the body which rises to the surface; since, if not here, it will be outside, and it cannot be outside: for we have two bodies, one weightless, one endowed with weight, and below is the place of the body endowed with weight, since the region about the centre has been given to the heavy body. And its position cannot be unnatural to it; for it would have to be natural to something else, and there is nothing else. It must then occupy the intermediate place. What distinctions there are within the intermediate itself we will explain later on.

We have now said enough to make plain the character and number of the bodily elements, the place of each, and further, in general, how many in number the various places are.

9 · We must show not only that the heaven is one, but also that more than one heaven is impossible, and, further, that, as exempt from decay and generation, the heaven is eternal. We may begin by rehearsing the puzzles. From one point of view it might seem impossible that the heaven should be one and unique, since in all formations and products whether of nature or of art we can distinguish the shape in itself and the shape in combination with matter. For instance the form of the sphere is one thing and the gold or bronze sphere another; the shape of the circle again is one thing, the bronze or wooden circle another. For when we state the essential nature of the sphere or circle we do not include in the formula gold or bronze, because they do not belong to its substance; but if we are speaking of the copper or gold sphere we do include them. We still make the distinction even if we cannot conceive or apprehend any other example beside the particular thing. This may, of course, sometimes be the case: it might be, for instance, that only one circle could be found; yet none the less the difference will remain between being circle and being this particular circle, the one being form, the other form in matter, i.e. a particular thing. Now since the heaven is perceptible it must be regarded as a particular; for everything that is perceptible subsists, as we know, in matter. But if it is a particular, there will be a distinction between being this heaven and being a heaven without qualification. There is a difference, then, between this heaven and a heaven without qualification; the second is form and shape, the first form in combination with matter; and any shape or form has, or may have, more than one particular instance.

On the supposition of Forms such as some assert, this must be the case, and equally on the view that no such entity has a separate existence. For in every case in which the substance is in matter it is a fact of observation that the particulars of like form are several or infinite in number. Hence there either are, or may be, more heavens than one. On these grounds, then, it might be inferred either that there are or that there might be several heavens. We must, however, return and ask how much of this argument is correct and how much not.

Now it is quite right to say that the formula of the shape apart from the matter must be different from that of the shape in the matter, and we may allow this to be true. We are not, however, therefore compelled to assert a plurality of worlds. Such a plurality is in fact impossible if this world contains the entirety of matter, as in fact it does. But perhaps our contention can be made clearer in this way. Suppose aquilinity to be curvature in the nose or flesh, and flesh to be the matter of aquilinity. Suppose, further, that all flesh came together into a single whole of flesh endowed with this aquiline quality. Then neither would there be, nor could there arise, any other thing that was aquiline. Similarly, suppose flesh and bones to be the matter of man, and suppose a man to be created of all flesh and all bones in indissoluble union. The possibility of another man would be removed. Whatever case you took it would be the same. The general rule is this: a thing whose substance resides in a substratum of matter can never come into being in the absence of all matter. Now the heaven is certainly a particular and a material thing; if however it is composed not of a part but of the whole of matter, then though being a heaven and being this heaven are still distinct, yet there is no other heaven, and no possibility of others being made, because all the matter is already included in this. It remains, then, only to prove that it is composed of all natural perceptible body.

First, however, we must explain what we mean by 'heaven' and in how many ways we use the word, in order to make clearer the object of our inquiry. In one sense, then, we call 'heaven' the substance of the extreme circumference of the whole, or that natural body whose place is at the extreme circumference. We recognize habitually a special right to the name 'heaven' in the extremity or upper region, which we take to be the seat of all that is divine. In another sense, we use this name for the body continuous with the extreme circumference, which contains the moon, the sun, and some of the stars; these we say are 'in the heaven'.

In yet another sense we give the name to all body included within the extreme circumference, since we habitually call the whole or totality 'the heaven'. The word, then, is used in three senses.

Now the whole included within the extreme circumference must be composed of *all* physical and sensible body, because there neither is, nor can come into being, any body outside the heaven. For if there is a natural body outside the extreme circumference it must be either a simple or a composite body, and its position must be either natural or unnatural. But it cannot be any of the simple bodies. For it has been shown that that which moves in a circle cannot change its place. And it cannot be that which moves from the centre or that which lies lowest. *Naturally* they could not be there, since their proper places are elsewhere; and if these are there *unnaturally,* the exterior place will be natural to some other body, since a place which is unnatural to one body must be natural to another; but we saw that there is no other body besides these. Then it is not possible that any simple body should be outside the heaven. But, if no simple body, neither can any mixed body be there; for the presence of the simple body is involved in the presence of the mixture. Further neither can any body come into that place; for it will do so either naturally or unnaturally, and will be either simple or composite; so that the same argument will apply, since it makes no difference whether the question is 'Is it there?' or 'Can it come to be there?' From our arguments then it is evident not only that there is not, but also that there could never come to be, any bodily mass whatever outside the circumference. For the world as a whole includes *all* its appropriate matter, which is, as we saw, natural perceptible body. So that neither are there now, nor have there ever been, nor can there ever be formed more heavens than one, but this heaven of ours is one and unique and complete.

It is therefore evident that there is also no place or void or time outside the heaven. For in every place body can be present; and void is said to be that in which the presence of body, though not actual, is possible; and time is the number of movement. But in the absence of natural body there is no movement, and outside the heaven, as we have shown, body neither exists nor can come to exist. It is clear then that there is neither place, nor void, nor time, outside the heaven. Hence whatever is there, is of such a nature as not to occupy any place, nor does time age it; nor is there any change in any of the things which lie beyond the outermost motion; they continue through their entire duration unalterable and unmodified, living the best and most self-sufficient of lives. As a matter of fact, this word 'duration' possessed a divine significance for the ancients; for the fulfilment which includes the period of life of any creature, outside of which no natural development can fall, has been called its duration. On the same principle the fulfilment of the whole heaven, the fulfilment which includes all time and infinity, is duration—a name based upon the fact that it *is always*[8]—being immortal and divine. From it derive the being and life which other things, some more or less articulately but others feebly, enjoy. So, too, in its discussions concerning the divine, popular philosophy often propounds the view that whatever is divine, whatever is primary and supreme, is necessarily unchangeable. This fact confirms what we have said. For there is nothing else stronger than it to move it—since that would be more divine—and it has no defect and lacks none of its proper excellences. Its unceasing movement, then, is also reasonable, since everything ceases to move when it comes to its proper place, but the body whose path is the circle has one and the same place for starting-point and goal.

10 · Having established these distinctions, we may now proceed to the question whether the heaven is ungenerated or generated, indestructible or destructible. Let us start with a review of the theories of other thinkers; for the proofs of a theory are difficulties for the contrary theory. Besides, those who have first heard the pleas of our adversaries will be more likely to credit the assertions which we are going to make. We shall be less open to the charge of procuring judgement by default. To give a satisfactory decision as to the truth it is necessary to be rather an arbitrator than a party to the dispute.

That the world was generated all are agreed, but, generation over, some say that it is eternal, others say that it is destructible like any other natural formation. Others again, with Empedocles of Acragas and Heraclitus of Ephesus, believe that it alternates, being sometimes as it is now and sometimes different and in a process of destruction, and that this continues without end.

Now to assert that it was generated and yet is eternal is to assert the impossible; for we cannot reasonably attribute to anything any characteristics but those which observation detects in many or all instances. But in this case the facts point the other way: generated things are seen always to be destroyed. Further, a thing whose present state had no beginning and which could not have been other than it was at any previous moment throughout its entire duration, cannot possibly be changed. For there will have to be some cause of change, and if this had been present earlier it would have been possible for that which could not be otherwise to

[8] 'Duration', αἰών, is derived from 'always existing', ἀεὶ ὤν.

be otherwise. Suppose that the world was formed out of elements which were formerly otherwise. Then if their condition was always so and could not have been otherwise, the world could never have come into being. And if the world did come into being, then, clearly, their condition must have been capable of change and not eternal: after combination therefore they will be dispersed, just as in the past after dispersion they came into combination, and this process either has been or could have been, indefinitely repeated. But if this is so, the world cannot be indestructible, and it does not matter whether the change of condition has actually occurred or remains a possibility.

Some of those who hold that the world, though indestructible, was yet generated, try to support their case by a parallel which is illusory. They say that in their statements about its generation they are doing what geometricians do when they construct their figures, not implying that the universe really had a beginning, but for didactic reasons facilitating understanding by exhibiting the object, like the figure, as in course of formation. The two cases, as we said, are not parallel; for, in the construction of the figure, when the various steps are completed the same figure forthwith results; but in these other demonstrations what results is not the same. Indeed it cannot be so; for antecedent and consequent, as assumed, are in contradiction. The ordered, it is said, arose out of the unordered; and the same thing cannot be at the same time both ordered and unordered; there must be a process and a lapse of time separating the two states. In the figure, on the other hand, there is no temporal separation. It is clear that the universe cannot be at once eternal and generated.

To say that the universe alternately combines and dissolves is no more paradoxical than to make it eternal but varying in shape. It is as if one were to think that there was now destruction and now existence when from a child a man is generated, and from a man a child. For it is clear that when the elements come together the result is not a chance system and combination, but the very same as before—especially on the view of those who hold this theory, since they say that the contrary is the cause of each state. So that if the totality of body, which is a continuum, is now in this order or disposition and now in that, and if the combination of the whole is a world or heaven, then it will not be the world that comes into being and is destroyed, but only its dispositions.

If the world is one, it is impossible that it should be, as a whole, first generated and then destroyed, never to reappear; since before it came into being there was always present the combination prior to it, and that, we hold, could never change if it was never generated. If, on the other hand, the worlds are infinite in number the view is more plausible. But whether this is, or is not, impossible will be clear from what follows. For there are some who think it possible both for the ungenerated to be destroyed and for the generated to persist undestroyed. (This is held in the *Timaeus*, where Plato says that the heaven, though it was generated, will none the less exist for the rest of time.) So far as the heaven is concerned we have answered this view with arguments appropriate to the nature of the heaven: on the general question we shall attain clearness when we examine the matter universally.

11 · We must first distinguish the senses in which we use the words 280b1 'ungenerated' and 'generated', 'destructible' and 'indestructible'. These have many uses, and though it may make no difference to the argument, yet some indeterminacy of thought must result from treating as indivisible something which is divided in many ways. The character which is the ground of the predication will always remain obscure.

The word 'ungenerated' then is used in one sense whenever something now is, which formerly was not, no process of becoming or change being involved. Such is the case, according to some, with contact and motion, since there is no process of coming to be in contact or in motion.

It is used in another sense, when something which is capable of coming or of having come to be does not exist; such a thing is ungenerated in the sense that its generation is a possibility. It is also applied where there is general impossibility of any generation such that the thing now is which then was not. (And 'impossibility' has two uses: first, where it is untrue to say that the thing can ever come into being, and secondly, where it cannot do so easily, quickly, or well.) In the same way the word 'generated' is used, first, where what formerly was not afterwards is, whether a process of becoming was or was not involved, so long as that which then was not, now is; secondly, of anything capable of existing, 'capable' being defined with reference either to truth or to facility; thirdly, of anything to which the passage from not being to being belongs, whether already actual, if its existence is due to a process of becoming, or not yet actual but possible. The uses of the words 'destructible' and 'indestructible' are similar. 'Destructible' is applied to that which formerly was and afterwards either is not or might not be, whether a period of being destroyed and changed intervenes or not; and sometimes we apply the word to that which a process of destruction may cause not to be; and also in a third sense, to that which is easily destructible, to the 'easily-destroyed', so to speak. Of the indestructible the same account holds good. It is either that which now is and now is not, without any process of destruction, like contact, which without being destroyed afterwards is not, though formerly it was; or that which is but might not be, or which will at some time not be, though it now is. For you exist now and so does the contact; yet both are destructible, because a time will come when it will not be true of you that you exist, nor of these things that they are in contact. Thirdly in its most proper use, it is that which is, but is incapable of any destruction such that the thing which now is later ceases to be or might cease to be. And indestructible is also used of that which is destroyed with difficulty. 281a1

This being so, we must ask what we mean by 'possible' and 'impossible'. For in its most proper use the predicate 'indestructible' is given because it is impossible that the thing should be destroyed, i.e. exist at one time and not at another. And 'ungenerated' also involves impossibility when used for that which cannot be generated, in such fashion that, while formerly it was not, later it is. An instance is a commensurable diagonal. Now when a thing can move or lift weights, we refer always to the maximum. We speak, for instance, of a power to lift a hundred talents or walk a hundred stades—though if it can effect the maximum it can also effect any part of the maximum—since we feel obliged in defining the power to give the limit or maximum. A thing, then, which is capable of a certain amount as maximum must also be capable of that which lies within it. If, for example, a man can lift a hundred talents, he can also lift two, and if he can walk a hundred stades, he can also walk two. But the power is of the maximum, and a thing said, with reference to its maximum, to be incapable of so much is also incapable of any greater amount. It is, for instance, clear that a person who cannot walk a thousand stades will also be unable to walk a thousand and one. This point need not trouble us, for we may take it as settled that what is, in the strict sense, possible is determined by a limiting maximum. Now perhaps the objection might be raised that there is no necessity in this, since he who sees a stade need not see the measures contained in it, while, on the contrary, he who can see a dot or hear a small sound will perceive what is greater. This, however, does not touch our argument. The maximum may be determined either in the power or in its object. The meaning of this is plain. Superior sight is sight of the smaller body, but superior speed is that of the greater body.

12 · Having established these distinctions we can now proceed to the sequel. If there are things capable both of being and of not being, there must be some definite maximum time of their being and not being; a time, I mean, during which the thing can be and a time during which it can fail to be. And this is true in every category, whether the thing is, for example, a man, or white, or three cubits long, or whatever it may be. For if the time is not definite in quantity, but longer than any that can be suggested and shorter than none, then it will be possible for one and the same thing to be for infinite time and not to be for another infinity. This, however, is impossible.

Let us take our start from this point. The impossible and the false have not the same significance. One use of 'impossible' and 'possible', and 'false' and 'true', is hypothetical. It is impossible, for instance, on a certain hypothesis that the triangle should have its angles equal to two right angles, and on another the diagonal is commensurable. But there are also things possible and impossible, false and true, absolutely. Now it is one thing to be absolutely false, and another thing to be absolutely impossible. To say that you are standing when you are not standing is to assert a falsehood, but not an impossibility. Similarly to say that a man who is playing the harp, but not singing, is singing, is to say what is false but not impossible. To say, however, that you are at once standing and sitting, or that the diagonal is commensurable, is to say what is not only false but also impossible. Thus it is not the same thing to make a false and to make an impossible hypothesis; and from the impossible hypothesis impossible results follow. A man has, it is true, the capacity at once of sitting and of standing, because when he possesses the one he also possesses the other; but it does not follow that he can at the same time sit and stand, but at different times. But if a thing has for infinite time more than one capacity, another time is impossible and the times must coincide. Thus if anything which exists for infinite time is destructible, it will have the capacity of not being.

Now if it exists for infinite time let this capacity be actualized; and it will be in actuality at once existent and non-existent. Thus a false conclusion would follow because a false assumption was made; but if what was assumed had not been impossible its consequence would not have been impossible.

Anything then which always exists is absolutely imperishable. It is also ungenerated, since if it was generated it will have the power for some time of not being. For as that which formerly was, but now is not, or is capable at some future time of not being, is destructible, so that which is capable of formerly not having been is generated. But in the case of that which always is, there is no time for such a capacity of not being, whether the supposed time is finite or infinite; for its capacity of being must include the finite time since it covers infinite time.

It is therefore impossible that one and the same thing should be capable of always existing and of always not-existing. And not always existing, the contradictory, is also excluded. Thus it is impossible for a thing always to exist and yet to be destructible. Nor, similarly, can it be generated. For of two terms if the second cannot be present without the first, and the first is impossible, so too is the second. What always is, then, since it is incapable of ever not being, cannot possibly be generated. But since the contradictory of 'that which is always capable of being' is 'that which is not always capable of being'; while 'that which is always capable of not being' is the contrary, whose contradictory in turn is 'that which is not always capable of not being', it is necessary that the contradictories of both terms should be predicable of one and the same thing, and thus that, intermediate between what always is and what always is not, there should be that to which being and not-being are both possible; for the contradictory of each will at times be true of it unless it always exists. Hence that which not always is not will sometimes be and sometimes not be; and it is clear that this is true also of that which cannot always be but sometimes is and therefore sometimes is not. One thing, then, will have the power of being and of not being, and thus be intermediate between the other two.

Expressed universally our argument is as follows. Let there be two attributes, A and B, not capable of being present in any one thing together, while either A or C and either B or D are capable of being present in everything. Then C and D must be predicated of everything of which neither A nor B is predicated. Let E lie between A and B; for that which is neither of two contraries is a mean between them. In E both C and D must be present; for either A or C is present everywhere and therefore in E. Since then A is impossible, C must be present, and the same argument holds of D.

Neither that which always is, therefore, nor that which always is not is either generated or destructible. And clearly whatever is generated or destructible is not eternal. If it were, it would be at once capable of always being and capable of not always being; but it has already been shown that this is impossible. Surely then whatever is ungenerated and in being must be eternal, and whatever is indestructible and in being must equally be so. (I use the words 'ungenerated' and 'indestructible' in their proper sense, 'ungenerated' for that which now is and could not at some previous time have been truly said not to be; 'indestructible' for that which now is and cannot at any future time be truly said not to be.) If, again, the two terms follow one another, if the ungenerated is indestructible, and the indestructible ungenerated, then the eternal follows each of them: anything ungenerated is eternal and anything indestructible is eternal. This is clear too from the definition of the terms. Whatever is destructible must be generated; for it is either ungenerated or generated, but, if ungenerated, it is by hypothesis indestructible. Whatever, further, is generated must be destructible. For it is either destructible or indestructible, but, if indestructible, it is by hypothesis ungenerated.

If, however, 'indestructible' and 'ungenerated' do not follow one another, there is no necessity that either the ungenerated or the indestructible should be eternal. But they must follow one another, for the following reasons. The terms 'generated' and 'destructible' follow one another; this is obvious from our former remarks, since between what always is and what always is not there is an intermediate which neither follows, and that intermediate is the generated and destructible. For whatever is either of these is capable both of being and of not being for a definite time: in either case, I mean, there is a certain period of time during which the thing is and another during which it is not. Anything therefore which is generated or destructible must be intermediate. Now let *A* be that which always is and *B* that which always is not, *C* the generated, and *D* the destructible. Then *C* must be intermediate between *A* and *B*. For in their case there is no time in the direction of either limit, in which either *A* is not or *B* is. But for the generated there must be such a time either actually or potentially, though not for *A* and *B* in either way. *C* then will be, and also not be, for a limited length of time, and this is true also of *D*. Therefore each is both generated and destructible. Therefore 'generated' and 'destructible' follow one another. Now let *E* stand for the ungenerated, *F* for the generated, *G* for the indestructible, and *H* for the destructible. As for *F* and *H*, it has been shown that they follow one another. But when terms stand to one another as these do, *F* and *H* following, *E* and *F* never predicated of the same thing but one or other of everything, and *G* and *H* likewise, then *E* and *G* must follow one another. For suppose that *E* does not follow *G*; then *F* will, since either *E* or *F* is predicable of everything. But of that of which *F* is predicated *H* will be predicable also. *H* will then follow *G*; but this we saw to be impossible. And the same argument shows that *G* follows *E*.

Now the relation of the ungenerated (*E*) to the generated (*F*) is the same as that of the indestructible (*G*) to the destructible (*H*). To say then that there is no reason why anything should not be generated and yet indestructible or ungenerated and yet destroyed, to imagine that in the one case generation and in the other case destruction occurs once for all, is to destroy part of the data. For everything is capable of acting or being acted upon, of being or not being, either for an infinite, or for a definitely limited space of time; and the infinite time is only a possible alternative because it is after a fashion defined, as a length of time which cannot be exceeded. But infinity in one direction is neither infinite nor defined. Further, why, after always existing, was the thing destroyed, why, after an infinity of not being, was it generated, at one moment rather than another? If there is no reason and the moments are infinite in number, it is clear that a generated or destructible thing existed for an infinite time. It has therefore for an infinite time the capacity of not being (since the capacity of being and the capacity of not being will be present together), if destructible, in the time before destruction, if generated, in the time after generation. If then we assume the two capacities to be actualized, opposites will be present together. Further, this will be equally present at every moment, so that the thing will have for an infinite time the capacity both of being and of not being; but this has been shown to be impossible. Again, if the capacity is present prior to the activity, it will be present for all time, even while the thing was as yet ungenerated and non-existent but capable of being generated. At the time, then, when it was not, at that same time it had the capacity of being, both of being then and of being thereafter, and therefore for an infinity of time.

It is clear also on other grounds that it is impossible that the destructible should not at some time be destroyed. For otherwise it will always be at once destructible and in actuality indestructible, so that it will be at the same time capable of always existing and of not always existing. Thus the destructible is at some time actually destroyed. The generable, similarly, has been generated; for it is capable of having been generated and thus also of not always existing.

We may also see in the following way how impossible it is either for a thing which is generated to be thenceforward indestructible, or for a thing which is ungenerated and has always hitherto existed to be destroyed. Nothing that is by chance can be indestructible or ungenerated, since the products of chance and fortune are opposed to what is, or comes to be, always or for the most part, while anything which exists for a time infinite either absolutely or from a certain point, is in existence either always or for the most part. That which is by chance, then, is by nature such as to exist at one time and not at another. But in things of that character the contradictory states proceed from one and the same capacity, the matter of the thing being the cause equally of its existence and of its non-existence. Hence opposites would be present together in actuality.

Further, it cannot truly be said of a thing now that it exists last year, nor could it be said last year that it exists now. It is therefore impossible for what once did not exist later to be eternal. For in its later state it will possess the capacity of not existing, only not of not existing at a time when it exists—since then it exists in actuality—but of not existing last year or in the past. Now suppose it to be in actuality what it is capable of being. It will then be true to say now that it does not exist last year. But this is impossible. No capacity relates to being in the past, but always being in the present or future. It is the same with the notion of an eternity of existence followed later by non-existence. In the later state the capacity will be present for that which is not there in actuality. Actualize, then, the capacity. It will be true to say now that this exists last year or in the past generally.

Considerations not general but proper to the subject also show it to be impossible that what was formerly eternal should later be destroyed or that what formerly was not should later be eternal. Whatever is destructible or generated is always alterable. Now alteration is due to contraries, and the things which compose the natural body are the very same that destroy it.

BOOK II

1 · That the heaven as a whole neither came into being nor admits of destruction, as some assert, but is one and eternal, with no end or beginning of its total duration, containing and embracing in itself the infinity of time, we may convince ourselves not only by the arguments already set forth but also by a consideration of the views of those who differ from us in providing for its generation. If our view is a possible one, and the manner of generation which they assert is impossible, this fact will have great weight in convincing us of the immortality and eternity of the world. Hence it is well to persuade oneself of the truth of the ancient and truly traditional theories, that there is some immortal and divine thing which possesses movement, but movement such as has no limit and is rather itself the limit of all other movement. A limit is a thing which contains; and this motion, being perfect, contains those imperfect motions which have a limit and a cessation, having itself no beginning or end, but unceasing through the infinity of time, and of other movements, to some the cause of their beginning, of others receiving the cessation. The ancients gave to the Gods the heaven or upper place, as being alone immortal; and our present argument testifies that it is indestructible and ungenerated. Further, it is unaffected by any mortal discomfort, and, in addition, effortless; for it needs no constraining necessity to keep it to its path, and prevent it from moving with some other movement more natural to itself. Such a constrained movement would necessarily involve effort—the more so, the more eternal it were—and would be inconsistent with perfection. Hence we must not believe the old tale which says that the world needs some Atlas to keep it safe—a tale composed, it would seem, by men who, like later thinkers, conceived of all the upper bodies as earthy and endowed with weight, and therefore supported it in their fabulous way upon animate necessity. We must no more believe that than follow Empedocles when he says that the world, by being whirled round, received a movement quick enough to overpower its own downward tendency, and thus has been kept from destruction all this time. Nor, again, is it possible that it should persist eternally by the necessitation of a soul. For a soul could not live in such conditions painlessly or happily, since the movement involves constraint, being imposed on the first body, whose natural motion is different, and imposed continuously. It must therefore be uneasy and devoid of all rational satisfaction; for it could not even, like the soul of mortal animals, take recreation in the bodily relaxation of sleep. An Ixion's lot must needs possess it, without end or respite. If then, as we said, the view already stated of the first motion is a possible one, it is not only more appropriate so to conceive of its eternity, but also on this hypothesis alone are we able to advance a theory consistent with our premonitions of divinity. But of this enough for the present.

2 · Since there are some who say that there is a right and a left in the heaven, with those who are known as Pythagoreans—to whom indeed the view really belongs—we must consider whether, if we are to apply these principles to the body of the universe, we should follow their statement of the matter or find a better way. At the start we may say that, if right and left are applicable, there are prior

principles which must first be applied. These principles have been analysed in the discussion of the movements of animals,[9] for the reason that they are proper to animal nature. For in some animals we find all such distinctions of parts as this of right and left clearly present, and in others some; but in plants we find only above and below. Now if we are to apply to the heaven such a distinction of parts, we must expect, as we have said, to find in it also that distinction which in animals is found first of them all. The distinctions are three, namely, above and below, front and its opposite, right and left—all these three oppositions we expect to find in the perfect body—and each may be called a principle. Above is the principle of length, right of breadth, front of depth. Or again we may connect them with the various movements, taking principle to mean that part, in a thing capable of movement, from which movement first begins. Growth starts from above, locomotion from the right, sense-movement from in front (for front is simply the part to which the senses are directed). Hence we must not look for above and below, right and left, front and back, in every kind of body, but only in those which, being animate, have a principle of movement within themselves. For in no inanimate thing do we observe a part from which movement originates. Some do not move at all, some move, but not indifferently in any direction; fire, for example, only upward, and earth only to the centre. It is true that we speak of above and below, right and left, in these bodies relatively to ourselves. The reference may be to our own right hands, as with the diviner, or to some similarity to our own members, such as the parts of a statue possess; or we may take the contrary spatial order, calling right that which is to our left, and left that which is to our right. We observe, however, in the things themselves none of these distinctions; indeed if they are turned round we proceed to speak of the opposite parts as right and left, above and below, front and back. Hence it is remarkable that the Pythagoreans should have spoken of these two principles, right and left, only, to the exclusion of the other four, which have as good a title as they. There is no less difference between above and below or front and back in animals generally than between right and left. The difference is sometimes only one of function, sometimes also one of shape; and while the distinction of above and below is characteristic of all animate things, whether plants or animals, that of right and left is not found in plants. Further, inasmuch as length is prior to breadth, if above is the principle of length, right of breadth, and if the principle of that which is prior is itself prior, then above will be prior to right (for things are called in order of generation prior in several ways). If, in addition, above is the region from which movement originates, right the region in which it starts, front the region to which it is directed, then on this ground too above has the character of a principle as compared with the other forms of position. Thus they may fairly be criticized, first, for omitting the more fundamental principles, and secondly, for thinking that the two they mentioned were attributable equally to everything.

Since we have already determined that functions of this kind belong to things which possess a principle of movement, and that the heaven is animate and possesses a principle of movement, clearly the heaven must also exhibit above and

[9]See *Progression of Animals* 4–5.

below, right and left. We need not be troubled by the question, arising from the spherical shape of the world, how there can be a distinction of right and left within it, all parts being alike and all for ever in motion. We must think of the world as of something in which right differs from left in shape as well as in other respects, which subsequently is included in a sphere. The difference of function will persist, but will appear not to by reason of the regularity of shape. In the same fashion must we conceive of the beginning of its movement. For even if it never began to move, yet it must posses a principle from which it would have begun to move if it had begun, and from which it would begin again if it came to a stand. Now by its length I mean the interval between its poles, one pole being above and the other below; for two hemispheres are specially distinguished from all others by the immobility of the poles. Further, by 'transverse' in the universe we commonly mean, not above and below, but a direction crossing the line of the poles, which, by implication, is length; for transverse motion is motion crossing motion up and down. Of the poles, that which we see above us is the lower region, and that which we do not see is the upper. For right in anything is, as we say, the region in which locomotion originates, and the rotation of the heaven originates in the region from which the stars rise. So this will be the right, and the region where they set the left. If then they begin from the right and move round to the right, the upper must be the unseen pole. For if it is the pole we see, the movement will be leftward, which we deny to be the fact. Clearly then the invisible pole is above. And those who live there are in the upper hemisphere and to the right, while we are in the lower and to the left. This is just the opposite of the view of the Pythagoreans, who make us above and on the right side and those in the other hemisphere below and on the left side; the fact being the exact opposite. Relatively, however, to the secondary revolution, I mean that of the planets, we are above and on the right and they are below and on the left. For the principle of their movement has the reverse position, since the movement itself is the contrary of the other; hence it follows that we are at its beginning and they at its end. Here we may end our discussion of the parts determined by the three dimensions and defined by their position.

3 · Since circular motion is not the contrary of the reverse circular motion, we must consider why there is more than one motion, though we have to pursue our inquiries at a distance—a distance created not so much by our spatial position as by the fact that our senses enable us to perceive very few of the attributes of the heavenly bodies. But let not that deter us. The reason must be sought in the following facts. Everything which has a function exists for its function. The activity of God is immortality, i.e. eternal life. Therefore the movement of God must be eternal. But such is the heaven, viz. a divine body, and for that reason to it is given the circular body whose nature it is to move always in a circle. Why, then, is not the whole body of the heaven of the same character as that part? Because there must be something at rest at the centre of the revolving body; and of that body no part can be at rest, either elsewhere or at the centre. It could do so only if the body's natural movement were towards the centre. But the circular movement is natural, since

otherwise it could not be eternal; for nothing unnatural is eternal. The unnatural is subsequent to the natural, being a derangement of the natural which occurs in the course of its generation. Earth then has to exist; for it is earth which is at rest at the centre. (At present we may take this for granted: it will be explained later.) But if earth must exist, so must fire. For, if one of a pair of contraries naturally exists, the other, if it is really contrary, exists also naturally, and has a nature of its own (for the matter of contraries is the same). Also, the positive is prior to its privation (warm, for instance, to cold), and rest and heaviness stand for the privation of lightness and movement. But further, if fire and earth exist, the intermediate bodies must exist also; for each element stands in a contrary relation to every other. (This, again, we will here take for granted and try later to explain.) With these four elements generation clearly is involved, since none of them can be eternal; for contraries interact with one another and destroy one another. Further, it is unreasonable that a movable body should be eternal, if its movement cannot be naturally eternal: and these bodies possess movement. Thus we see that generation is necessarily involved. But if so, there must be at least one other motion; for a single movement of the whole heaven would necessitate an identical relation of the elements of bodies to one another. This matter also will be cleared up in what follows; but for the present so much is clear, that the reason why there is more than one circular body is the necessity of generation, which follows on the presence of fire, which, with that of the other bodies, follows on that of earth; and earth is required because eternal movement in one body necessitates eternal rest in another.

4 · The shape of the heaven is of necessity spherical; for that is the shape most appropriate to its substance and also by nature primary.

First, let us consider generally which shape is primary among planes and solids alike. Every plane figure must be either rectilinear or curvilinear. Now the rectilinear is bounded by more than one line, the curvilinear by one only. But since in any kind the one is naturally prior to the many and the simple to the complex, the circle will be the first of plane figures. Again, if by complete, as previously defined,[10] we mean a thing outside which nothing can be found, and if addition is always possible to the straight line but never to the circular, clearly the line which embraces the circle is complete. If then the complete is prior to the incomplete, it follows on this ground also that the circle is primary among figures. And the sphere holds the same position among solids. For it alone is embraced by a single surface, while rectilinear solids have several. The sphere is among solids what the circle is among plane figures. Further, those who divide bodies into planes and generate them out of planes seem to bear witness to the truth of this. Alone among solids they leave the sphere undivided, as not possessing more than one surface; for the division into surfaces is not just dividing a whole by cutting into its parts, but division into parts different in form. It is clear, then, that the sphere is first of solid figures.

[10] See *Physics* 207a8.

If, again, one orders figures according to their numbers, it is most reasonable to arrange them in this way. The circle corresponds to the number one, the triangle, being the sum of two right angles, to the number two. But if one is assigned to the triangle, the circle will not be a figure at all.

Now the first figure belongs to the first body, and the first body is that at the farthest circumference. It follows that the body which revolves with a circular movement must be spherical. The same then will be true of the body continuous with it; for that which is continuous with the spherical is spherical. The same again holds of the bodies between these and the centre. Bodies which are bounded by the spherical and in contact with it must be, as wholes, spherical; and the lower bodies are contiguous with the sphere above them. The sphere then will be spherical throughout; for every body within it is contiguous and continuous with spheres.

Again, since the whole seems—and has been assumed—to revolve in a circle, and since it has been shown that outside the farthest circumference there is neither void nor place, from these grounds also it will follow necessarily that the heaven is spherical. For if it is to be rectilinear in shape, it will follow that there is place and body and void without it. For a rectilinear figure as it revolves never continues in the same room, but where formerly was body, is now none, and where now is none, body will be in a moment because of the changing positions of the corners. Similarly, if the world had some other figure with unequal radii, if, for instance, it were lentiform, or oviform, in every case we should have to admit space and void outside the moving body, because the whole body would not always occupy the same room.

Again, if the motion of the heaven is the measure of all movements in virtue of being alone continuous and regular and eternal, and if, in each kind, the measure is the minimum, and the minimum movement is the swiftest, then the movement of the heaven must be the swiftest of all movements. Now of lines which return upon themselves the line which bounds the circle is the shortest; and that movement is the swiftest which follows the shortest line. Therefore, if the heaven moves in a circle and moves more swiftly than anything else, it must necessarily be spherical.

Corroborative evidence may be drawn from the bodies whose position is about the centre. If earth is enclosed by water, water by air, air by fire, and these similarly by the upper bodies—which while not continuous are yet contiguous with them—and if the surface of water is spherical, and that which is continuous with or embraces the spherical must itself be spherical, then on these grounds also it is clear that the heavens are spherical. But the surface of water is seen to be spherical if we take as our starting-point the fact that water naturally tends to collect in the more hollow places—and the more hollow are those nearer the centre. Draw from the centre the lines *AB*, *AC*, and let them be joined by the straight line *BC*. The line *AD*, drawn to the base of the triangle, will be shorter than either of the radii. Therefore the place in which it terminates will be more hollow. The water then will collect there until equality is established. But the line *AE* is equal to the radii. Thus water lies at the ends of the radii, and there will it rest; but the line which connects the extremities of the radii is circular: therefore the surface of the water *BEC* is spherical.

It is plain from the foregoing that the universe is spherical. It is plain, further, that it is so accurately turned that no manufactured thing nor anything else within the range of our observation can even approach it. For the matter of which these are composed does not admit of anything like the same regularity and finish as the substance of the enveloping body; since with each step away from earth the matter manifestly becomes finer in the same proportion as water is finer than earth.

5 · Now there are two ways of moving along a circle, from *A* to *B* or from *A* to *C*, and we have already explained that these movements are not contrary to one another. But nothing which concerns the eternal can be a matter of chance or spontaneity, and the heaven and its circular motion are eternal. We must therefore ask why this motion takes one direction and not the other. Either this is itself a principle or there is a principle behind it. It may seem evidence of excessive folly or excessive zeal to try to provide an explanation of some things, or of everything, admitting no exception. The criticism, however, is not always just: one should first consider what reason there is for speaking, and also what kind of certainty is looked for, whether human merely or of a more cogent kind. When any one shall succeed in finding proofs of greater precision, gratitude will be due to him for the discovery, but at present we must be content with what seems to be the case. If nature always follows the best course possible, and, just as upward movement is the superior form of rectilinear movement, since the upper region is more divine than the lower, so forward movement is superior to backward, then front and back exhibits, like right and left, as we said before and as the difficulty just stated itself suggests, the distinction of prior and posterior, which provides a reason and so solves our difficulty. Supposing that nature is ordered in the best way possible, this may stand as the reason of the fact mentioned. For it is best to move with a movement simple and unceasing, and, further, in the superior of two possible directions.

6 · We have next to show that the movement of the heaven is regular and not irregular. This applies to the first heaven and the first movement; for the lower spheres exhibit a composition of several movements into one. If the movement is uneven, clearly there will be acceleration, maximum speed, and retardation, since these appear in all irregular motions. The maximum may occur either at the starting-point or at the goal or between the two; and we expect natural motion to reach its maximum at the goal, unnatural motion at the starting-point, and missiles midway between the two. But circular movement, having no beginning or limit or middle without qualification, has neither whence nor whither nor middle; for in time it is eternal, and in length it returns upon itself without a break. If then its movement has no maximum, it can have no irregularity, since irregularity is produced by retardation and acceleration. Further, since everything that is moved is moved by something, the cause of the irregularity of movement must lie either in the mover or in the moved or in both. For if the mover moved not always with the same force, or if the moved were altered and did not remain the same, or if both were to change, the result might well be an irregular movement in the moved. But none of these possibilities can occur in the case of the heavens. As to that which is

moved, we have shown that it is primary and simple and ungenerated and indestructible and generally unchanging; and it is far more reasonable to ascribe those attributes to the mover. It is the primary that moves the primary, the simple the simple, the indestructible and ungenerated that which is indestructible and ungenerated. Since then that which is moved, being a body, is nevertheless unchanging, how should the mover, which is incorporeal, be changed?

For if irregularity occurs, there must be change either in the movement as a whole, from fast to slow and slow to fast, or in its parts. That there is no irregularity in the parts is obvious, since, if there were, some divergence of the stars would have taken place before now in the infinity of time, as one moved slower and another faster; but no alteration of their intervals is ever observed. Nor again is a change in the movement as a whole admissible. Retardation is always due to incapacity, and incapacity is unnatural. The incapacities of animals, age, decay, and the like, are all unnatural, due, it seems, to the fact that the whole animal complex is made up of materials which differ in respect of their proper places, and no single part occupies its own place. If therefore that which is primary contains nothing unnatural, being simple and unmixed and in its proper place and having no contrary, then it has no place for incapacity, nor, consequently, for retardation or (since acceleration involves retardation) for acceleration. Again, it is unreasonable that the mover should first show incapacity for an infinite time, and capacity afterwards for another infinity. For clearly nothing which, like incapacity, is unnatural ever continues for an infinity of time; nor does the unnatural endure as long as the natural, or any form of incapacity as long as the capacity. But if the movement is retarded it must necessarily be retarded for an infinite time. Equally impossible is perpetual acceleration or perpetual retardation. For such movement would be infinite and indefinite; but every movement, in our view, proceeds from one point to another and is definite in character. Again, suppose one assumes a minimum time in less than which the heaven could not complete its movement. For, as a given walk or a given exercise on the harp cannot take any and every time, but every performance has its definite minimum time which is unsurpassable, so, one might suppose, the movement of the heaven could not be completed in any and every time. But in that case perpetual acceleration is impossible (and, equally, perpetual retardation; for the argument holds of both and each), if we may take acceleration to proceed by identical or increasing additions of speed and for an infinite time. The remaining possibility is to say that the movement exhibits an alternation of slower and faster; but this is a mere fiction and quite unreasonable. Further, irregularity of this kind would be particularly unlikely to pass unobserved, since contrast makes observation easy.

That there is one heaven, then, only, and that it is ungenerated and eternal, and further that its movement is regular, has now been sufficiently explained.

7 · We have next to speak of the stars, as they are called, of their composition, shape, and movements. It would be most reasonable and consequent upon what has been said that each of the stars should be composed of that substance

in which their path lies, since, as we said, there is an element whose natural movement is circular. In so saying we are only following the same line of thought as those who say that the stars are fiery because they believe the upper body to be fire, the presumption being that a thing is composed of the same stuff as that in which it is situated. The warmth and light which proceed from them are caused by the friction set up in the air by their motion. Movement tends to create fire in wood, stone, and iron; and with even more reason should it have that effect on air, a substance which is closer to fire than these. An example is that of missiles, which as they move are themselves fired so strongly that leaden balls are melted; and if they are fired the surrounding air must be similarly affected. Now while the missiles are heated by reason of their motion in air, which is turned into fire by the agitation produced by their movement, the upper bodies are carried on a moving sphere, so that, though they are not themselves fired, yet the air underneath the sphere of the revolving body is necessarily heated by its motion, and particularly in that part where the sun is attached to it. Hence warmth increases as the sun gets nearer or higher or overhead. Of the fact, then, that the stars are neither fiery nor move in fire, enough has been said.

8 · Since changes evidently occur not only in the position of stars but also in that of the whole heaven, there are three possibilities: either both are at rest, or both are in motion, or the one is at rest and the other in motion.

That both should be at rest is impossible; for, if the earth is at rest, the hypothesis does not account for the phenomena; and we take it as granted that the earth is at rest. It remains either that both are moved, or that the one is moved and the other at rest.

On the view, first, that both are in motion, we have the absurdity that the stars and the circles move with the same speed, i.e. that the pace of every star is that of the circle in which it moves. For star and circle are seen to come back to the same place at the same moment; from which it follows that the star has traversed the circle and the circle has completed its own movement, i.e. traversed its own circumference, at one and the same moment. But it is unreasonable that the pace of each star should be exactly proportioned to the size of its circle. That the pace of each circle should be proportionate to its size is not absurd but inevitable; but that the same should be true of the movement of the stars contained in the circles is quite unreasonable. For if the star which moves on the greater circle is necessarily swifter, clearly if the stars shifted their position so as to exchange circles, the slower would become swifter and the swifter slower. But this would show that their movement was not their own, but due to the circles. If, on the other hand, the arrangement was a chance combination, the coincidence in every case of a greater circle with a swifter movement of the star contained in it is unreasonable. In one or two cases it might not inconceivably fall out so, but to imagine it in every case alike is a mere fiction. Besides, chance has no place in that which is natural, and what happens everywhere and in every case is no matter of chance.

The same absurdity is equally plain if it is supposed that the circles stand still and that it is the stars themselves which move. For it will follow that the outer stars are the swifter, and that the pace of the stars corresponds to the size of circles.

Since, then, we cannot reasonably suppose either that both are in motion or that the star alone moves, it remains that the circles should move, while the stars are at rest and move with the circles to which they are attached. Only on this supposition are we involved in no absurd consequence. For, in the first place, the quicker movement of the larger circle is reasonable when all the circles are attached
290a1 to the same centre. Whenever bodies are moving with their proper motion, the larger moves quicker. It is the same here with the revolving bodies; for the arc intercepted by two radii will be larger in the larger circle, and hence it is reasonable that the revolution of the larger circle should take the same time as that of the smaller. And secondly, the fact that the heavens do not break in pieces follows not only from this but also from the proof already given of the continuity of the whole.

Again, since the stars are spherical, as our opponents assert and we may consistently admit, inasmuch as we construct them out of the spherical body, and since the spherical body has two movements proper to itself, namely rolling and spinning, it follows that if the stars have a movement of their own, it will be one of these. But neither is observed. Suppose them to *spin*. They would then stay where they were, and not change their place, as, by observation and general consent, they do. Further, it would be reasonable for them all to exhibit the same movement; but the only star which appears to possess this movement is the sun, at sunrise or sunset, and this appearance is due not to the sun itself but to the distance from which we observe it. The visual ray being excessively prolonged becomes weak and wavering. The same reason probably accounts for the apparent twinkling of the fixed stars and the absence of twinkling in the planets. The planets are near, so that the visual ray reaches them in its full vigour, but when it comes to the fixed stars it is quivering because of the distance and its excessive extension; and its tremor produces an appearance of movement in the star; for it makes no difference whether movement is set up in the ray or in the object of vision.

On the other hand, it is also clear that the stars do not *roll*. For rolling involves rotation; but the 'face', as it is called, of the moon is always seen. Therefore, since any movement of their own which the stars possessed would presumably be one proper to themselves, and no such movement is observed in them, clearly they have no movement of their own.

There is, further, the absurdity that nature has bestowed upon them no organ appropriate to such movement. For nature leaves nothing to chance, and would not, while caring for animals, overlook things so precious. Indeed, nature seems deliberately to have stripped them of everything which makes self-originated progression possible, and to have removed them as far as possible from things which have organs of movement. This is just why it seems reasonable that the whole
290b1 heaven and every star should be spherical. For while of all shapes the sphere is the most convenient for movement in one place, making possible, as it does, the swiftest and most self-contained motion, for forward movement it is the most unsuitable, least of all resembling shapes which are self-moved, in that it has no dependent or

projecting part, as a rectilinear figure has, and is in fact as far as possible removed in shape from ambulatory bodies. Since, therefore, the heavens have to move in one place, and the stars are not required to move themselves forward, it is reasonable that both should be spherical—a shape which best suits the movement of the one and the immobility of the other.

9 · From all this it is clear that the theory that the movement of the stars produces a harmony, i.e. that the sounds they make are concordant, in spite of the grace and originality with which it has been stated, is nevertheless untrue. Some thinkers suppose that the motion of bodies of that size must produce a noise, since on our earth the motion of bodies far inferior in size and in speed of movement has that effect. Also, when the sun and the moon, they say, and all the stars, so great in number and in size, are moving with so rapid a motion, how should they not produce a sound immensely great? Starting from this argument and from the observation that their speeds, as measured by their distances, are in the same ratios as musical concordances, they assert that the sound given forth by the circular movement of the stars is a harmony. Since, however, it appears unaccountable that we should not hear this music, they explain this by saying that the sound is in our ears from the very moment of birth and is thus indistinguishable from its contrary silence, since sound and silence are discriminated by mutual contrast. What happens to men, then, is just what happens to coppersmiths, who are so accustomed to the noise of the smithy that it makes no difference to them. But, as we said before, melodious and poetical as the theory is, it cannot be a true account of the facts. There is not only the absurdity of our hearing nothing, the ground of which they try to remove, but also the fact that no effect other than sensitive is produced upon us. Excessive noises, we know, shatter the solid bodies even of inanimate things: the noise of thunder, for instance, splits rocks and the strongest of bodies. But if the moving bodies are so great, and the sound which penetrates to us is proportionate to their size, that sound must needs reach us in an intensity many times that of thunder, and the force of its action must be immense. Indeed the reason why we do not hear, and show in our bodies none of the effects of violent force, is easily given: it is that there is no noise. But not only is the explanation evident; it is also a corroboration of the truth of the views we have advanced. For the very difficulty which made the Pythagoreans say that the motion of the stars produces a concord corroborates our view. Bodies which are themselves in motion, produce noise and friction; but those which are attached or fixed to a moving body, as the parts to a ship, can no more create noise, than a ship on a river moving with the stream. Yet by the same argument one might say it was absurd that on a large vessel the motion of mast and poop should not make a great noise, and the like might be said of the movement of the vessel itself. But sound is caused when a moving body is enclosed in an unmoved body, and cannot be caused by one enclosed in, and continuous with, a moving body and creating no friction. We may say, then, in this matter that if the heavenly bodies moved in a generally diffused mass of air or fire, as every one supposes, their motion would necessarily cause a noise of tremendous strength and such a noise

would necessarily reach and shatter us. Since, therefore, this effect is evidently not produced, it follows that none of them can move with the motion either of animate nature or of constraint. It is as though nature had foreseen the result, that if their movement were other than it is, nothing on this earth could maintain its character.

That the stars are spherical and are not self-moved, has now been explained.

10 · With their order—I mean the movement of each, as involving the priority of some and the posteriority of others, and their distances from each other—astronomy may be left to deal, since the astronomical discussion is adequate. This discussion shows that the movements of the several stars depend, as regards the varieties of speed which they exhibit, on their distances. It is established that the outermost revolution of the heavens is a simple movement and the swiftest of all, and that the movement of all other bodies is composite and relatively slow, for the reason that each is moving on its own circle with the reverse motion to that of the heavens. This at once makes it reasonable that the body which is nearest to that first simple revolution should take the longest time to complete its circle, and that which is farthest from it the shortest, the others taking a longer time the nearer they are and a shorter time the farther away they are. For it is the nearest body which is most strongly influenced, and the most remote, by reason of its distance, which is least affected, the influence on the intermediate bodies varying, as the mathematicians show, with their distance.

11 · With regard to the shape of each star, the most reasonable view is that they are spherical. It has been shown that it is not in their nature to move themselves, and, since nature does nothing without reason or in vain, clearly she will have given things which possess no movement a shape particularly unadapted to movement. Such a shape is the sphere, since it possesses no instrument of movement. Clearly then their mass will have the form of a sphere. Again, what holds of one holds of all, and the evidence of our eyes shows us that the moon is spherical. For how else should the moon as it waxes and wanes show for the most part a crescent-shaped or gibbous figure, and only at one moment a half-moon? And astronomical arguments give further confirmation; for no other hypothesis accounts for the crescent shape of the sun's eclipses. One, then, of the heavenly bodies being spherical, clearly the rest will be spherical also.

12 · There are two difficulties, which may very reasonably here be raised, of which we must now attempt to state what seems to be the case; for we regard the zeal of one whose thirst after philosophy leads him to accept even slight indications where it is very difficult to see one's way, as a proof rather of modesty than of over-confidence.

Of many such problems one of the strangest is the problem why we find the greatest number of movements in the intermediate bodies, and not, rather, in each successive body a variety of movement proportionate to its distance from the primary motion. For we might reasonably expect, since the primary body shows one motion only, that the body which is nearest to it should move with the fewest movements, say two, and the one next after that with three, or some similar arrangement. But the opposite is the case. The movements of the sun and moon are fewer than those of some of the planets. Yet these planets are farther from the centre and thus nearer to the primary body than they, as observation has itself in some cases revealed. For we have seen the moon, half-full, pass beneath the planet Mars, which vanished on its shadow side and came forth by the bright and shining part. Similar accounts of other stars are given by the Egyptians and Babylonians, whose observations have been kept for very many years past, and from whom much of our evidence about particular stars is derived.

A second difficulty which may with equal justice be raised is this. Why is it that the primary motion includes such a multitude of stars that their whole array seems to defy counting, while of the other stars each one is separated off, and in no case do we find two or more attached to the same motion?

On these questions it is well that we should seek to increase our understanding, though we have but little to go upon, and are placed at so great a distance from the facts in question. Nevertheless if we base our consideration on such things, we shall not find this difficulty by any means insoluble. We think of the stars as mere bodies, and as units with a serial order indeed but entirely inanimate; but we should rather conceive them as enjoying life and action. On this view the facts cease to appear surprising. For it is plausible that the best-conditioned of all things should have its good without action, that that which is nearest to it should achieve it by little and simple action, and that which is farther removed by a complexity of actions, just as with men's bodies one is in good condition without exercise at all, another after a short walk, while another requires running and wrestling and hard training, and there are yet others who however hard they worked themselves could never secure this good, but only some substitute for it. To succeed often or in many things is difficult. For instance, to throw ten thousand Chians[11] with the dice would be impossible, but to throw one or two is comparatively easy. In action, again, when *A* has to be done to get *B*, *B* to get *C*, and *C* to get *D*, one step or two present little difficulty, but as the series extends the difficulty grows. We must, then, think of the action of the stars as similar to that of animals and plants. For on our earth it is man that has the greatest variety of actions—for there are many goods that man can secure; hence his actions are various and directed to ends beyond them—while the perfectly conditioned has no need of action, since it is itself the end, and action always requires two terms, end and means. The lower animals have less variety of action than man; and plants perhaps have little action and of one kind only. For either they have but one attainable good (as indeed man has), or, if several, each contributes directly to their ultimate good. One thing then has and enjoys the ultimate good, other things attain to it, one immediately by few steps, another by many, while yet another does not even attempt to secure it but is satisfied to reach a point not far removed from that consummation. Thus, taking health as the end, there will be one thing that always possesses health, others that attain it, one by

[11] Snake's eyes.

reducing flesh, another by running and thus reducing flesh, another by taking steps to enable himself to run, thus further increasing the number of movements, while another cannot attain health itself, but only running or reduction of flesh, so that one or other of these is for such a being the end. For while it is clearly best for any being to attain the real end, yet, if that cannot be, the nearer it is to the best the better will be its state. It is for this reason that the earth moves not at all and the bodies near to it with few movements. For they do not attain the final end, but only come as near to it as their share in the divine principle permits. But the first heaven finds it immediately with a single movement, and the bodies intermediate between the first and last heavens attain it indeed, but at the cost of a multiplicity of movement.

As to the difficulty that into the one primary motion is crowded a vast multitude of stars, while of the other stars each has been separately given special movements of its own, there is in the first place this reason for regarding the arrangement as a reasonable one. In thinking of the life and principle of the several heavens one must regard the first as far superior to the others. Such a superiority would be reasonable. For this single first motion has to move many of the divine bodies, while the numerous other motions move only one each, since each single planet moves with a variety of motions. Thus, then, nature makes matters equal and establishes a certain order, giving to the single motion many bodies and to the single body many motions. And there is a second reason why the other motions have each only one body, in that each of them except the last, i.e. that which contains the one star, is really moving many bodies. For this last sphere moves with many others, to which it is fixed, each sphere being actually a body; so that its movement will be a joint product. Each sphere, in fact, has its particular natural motion, to which the general movement is, as it were, added. But the force of any limited body is only adequate to moving a limited body.

The characteristics of the stars which move with a circular motion, in respect of substance and shape, movement and order, have now been sufficiently explained.

13 · It remains to speak of the earth, of its position, of the question whether it is at rest or in motion, and of its shape.

As to its *position* there is some difference of opinion. Most people—all, in fact, who regard the whole heaven as finite—say it lies at the centre. But the Italian philosophers known as Pythagoreans take the contrary view. At the centre, they say, is fire, and the earth is one of the stars, creating night and day by its circular motion about the centre. They further construct another earth in opposition to ours to which they give the name counter-earth. In all this they are not seeking for theories and causes to account for the phenomena, but rather forcing the phenomena and trying to accommodate them to certain theories and opinions of their own. But there are many others who would agree that it is wrong to give the earth the central position, looking for confirmation rather to theory than to the phenomena. Their view is that the most precious place befits the most precious thing; but fire, they say, is more precious than earth, and the limit than the intermediate, and the circumference and the centre are limits. Reasoning on this basis they take the view that it is not earth that lies at the centre of the sphere, but rather fire. The Pythagoreans have a further reason. They hold that the most important part of the 293b1 world, which is the centre, should be most strictly guarded, and name the fire which occupies that place the 'Guard-house of Zeus', as if the word 'centre' were quite unequivocal, and the centre of the mathematical figure were always the same with that of the thing or the natural centre. But it is better to conceive of the case of the whole heaven as analogous to that of animals, in which the centre of the animal and that of the body are different. For this reason they have no need to be so disturbed about the world, or to call in a guard for its centre: rather let them look for the centre in the other sense and tell us what it is like and where nature has set it. That centre will be something primary and precious; but to the mere position we should give the last place rather than the first. For the middle is what is defined, and what defines it is the limit, and that which contains or limits is more precious than that which is limited, seeing that the latter is the matter and the former the substance of the system.

As to the position of the earth, then, this is the view which some advance, and the views advanced concerning its *rest or motion* are similar. For here too there is no general agreement. All who deny that the earth lies at the centre think that it revolves about the centre, and not the earth only but, as we said before, the counter-earth as well. Some of them even consider it possible that there are several bodies so moving, which are invisible to us owing to the interposition of the earth. This, they say, accounts for the fact that eclipses of the moon are more frequent than eclipses of the sun; for in addition to the earth each of these moving bodies can obstruct it. Indeed, as in any case the earth is not actually a centre but distant from it a full hemisphere, there is no more difficulty, they think, in accounting for the phenomena on their view that we do not dwell at the centre, than on the view that the earth is in the middle. Even as it is, there is nothing to suggest that we are removed from the centre by half the diameter of the earth. Others, again, say that the earth, which lies at the centre, is rolled, and thus in motion, about the axis of the whole heaven. So it stands written in the *Timaeus*.[12]

There are similar disputes about the *shape* of the earth. Some think it is spherical, others that it is flat and drum-shaped. For evidence they bring the fact 294a1 that, as the sun rises and sets, the part concealed by the earth shows a straight and not a curved edge, whereas if the earth were spherical the line of section would have to be circular. In this they leave out of account the great distance of the sun from the earth and the great size of the circumference, which, seen from a distance on these apparently small circles appears straight. Such an appearance ought not to make them doubt the circular shape of the earth. But they have another argument. They say that because it is at rest, the earth must necessarily have this shape.

There are many different ways in which the movement or rest of the earth has been conceived. The difficulty must have occurred to every one. It would indeed be

[12] Plato, *Timaeus* 40B.

a complacent mind that felt no surprise that, while a little bit of earth, let loose in mid-air, moves and will not stay still, and the more there is of it the faster it moves, the whole earth, free in mid-air, should show no movement at all. Yet here is this great weight of earth, and it is at rest. And again, from beneath one of these moving fragments of earth, before it falls, take away the earth, and it will continue its downward movement with nothing to stop it. The difficulty then, has naturally passed into a commonplace of philosophy; and one may well wonder that the solutions offered are not seen to involve greater absurdities than the problem itself.

By these considerations some, like Xenophanes of Colophon, have been led to assert that the earth below us is infinite, [saying that it has 'pushed its roots to infinity'][13] in order to save the trouble of seeking for the cause. Hence the sharp rebuke of Empedocles, in the words 'if the deeps of the earth are endless and endless the ample ether—such is the vain tale told by many a tongue, poured from the mouths of those who have seen but little of the whole'.[14] Others say the earth rests upon water. This, indeed, is the oldest theory that has been preserved, and is attributed to Thales of Miletus. It was supposed to stay still because it floated like wood and other similar substances, which are so constituted as to rest upon water but not upon air. As if the same account had not to be given of the water which carries the earth as of the earth itself! It is not the nature of water, any more than of earth, to stay in mid-air: it must have something to rest upon. Again, as air is lighter than water, so is water than earth: how then can they think that the naturally lighter substance lies below the heavier? Again, if the earth as a whole is capable of floating upon water, that must obviously be the case with any part of it. But observation shows that this is not the case. Any piece of earth goes to the bottom, the quicker the larger it is. These thinkers seem to push their inquiries some way into the problem, but not so far as they might. It is what we are all inclined to do, to direct our inquiry not to the matter itself, but to the views of our opponents; for even when inquiring on one's own one pushes the inquiry only to the point at which one can no longer offer any opposition. Hence a good inquirer will be one who is ready in bringing forward the objections proper to the genus, and that he will be when he has gained an understanding of all the differences.

Anaximenes and Anaxagoras and Democritus give the flatness of the earth as the cause of its staying still. Thus, they say, it does not cut, but covers like a lid, the air beneath it. This seems to be the way of flat-shaped bodies; for even the wind can scarcely move them because of their power of resistance. The same immobility, they say, is produced by the flatness of the surface which the earth presents to the air which underlies it (while the air, not having room enough to change its place, rests on the compressed mass underneath), like the water in a clepsydra. And they adduce an amount of evidence to prove that air, when cut off and at rest, can bear a considerable weight.

Now, first, if the shape of the earth is not flat, its flatness cannot be the cause of its immobility. But in their own account it is rather the size of the earth than its flatness that causes it to remain at rest. For the reason why the air is so closely

[13]Allan excises the bracketed clause.

[14]Frag. 39 Diels-Kranz.

confined that it cannot find a passage, and therefore stays where it is, is its great amount; and this amount is great because the body which cuts it off, the earth, is very large. This result, then, will follow, even if the earth is spherical, so long as it retains its size. So far as their arguments go, the earth will still be at rest.

In general, our quarrel with those who speak of movements in this way cannot be confined to the parts; it concerns the whole universe. One must decide at the outset whether bodies have a natural movement or not, whether there is no natural but only constrained movement. Seeing, however, that we have already decided this matter to the best of our ability, we are entitled to treat our results as representing fact. Bodies which have no natural movement, have no constrained movement; and where there is no natural and no constrained movement there will be no movement at all. This is a conclusion, the necessity of which we have already decided, and we have seen further that rest also will be impossible, since rest, like movement, is either natural or constrained. But if there is any natural movement, constraint will not be the sole principle of motion or of rest. If, then, it is by constraint that the earth now keeps its place, it must have come together at the centre because of the whirling. (The form of causation supposed they all borrow from observations of liquids and of air, in which the larger and heavier bodies always move to the centre of the whirl. This is why all those who try to generate the heavens say that the earth came together at the centre. They then seek a reason for its staying there; and some say, in the manner explained, that the reason is its size and flatness, others, with Empedocles, that the motion of the heavens, moving about it at a higher speed, prevents movement of the earth, as the water in a cup, when the cup is given a circular motion, though it is often underneath the bronze, is for this same reason prevented from moving with the downward movement which is natural to it.) But suppose both the whirl and its flatness (the air beneath being withdrawn) cease to prevent the earth's motion, where will the earth move to then? Its movement to the centre was constrained, and its rest at the centre is due to constraint; but there must be some motion which is natural to it. Will this be upward motion or downward or what? It must have some motion; and if upward and downward motion are alike to it, and the air above the earth does not prevent upward movement, then no more could air below it prevent downward movement. For the same cause must necessarily have the same effect on the same thing.

Further, against Empedocles there is another point which might be made. When the elements were separated off by Hate, what caused the earth to keep its place? Surely the whirl cannot have been then also the cause. It is absurd too not to perceive that, while the whirling movement may have been responsible for the original coming together of the parts of earth at the centre, the question remains, why *now* do all heavy bodies move to the earth. For the whirl surely does not come near us. Why, again, does fire move upward? Not, surely, because of the whirl. But if fire is naturally such as to move in a certain direction, clearly the same may be supposed to hold of earth. Again, it cannot be the whirl which determines the heavy and the light. Rather that movement caused the pre-existent heavy and light things to go to the middle and stay on the surface respectively. Thus, before ever the whirl began, heavy and light existed; and what can have been the ground of their distinction, or the manner and direction of their natural movements? In infinite space there can have been neither above nor below, and it is by these that heavy and light are determined.

It is to these causes that most writers pay attention; but there are some, Anaximander, for instance, among the ancients, who say that the earth keeps its place because of its indifference. Motion upward and downward and sideways were all, they thought, equally inappropriate to that which is set at the centre and indifferently related to every extreme point; and to move in contrary directions at the same time was impossible: so it must needs remain still. This view is ingenious but not true. The argument would prove that everything which is put at the centre must stay there. Fire, then, will rest at the centre; for the proof turns on no peculiar property of earth. But in any case it is superfluous. The observed facts about earth are not only that it remains at the centre, but also that it moves to the centre. The place to which any fragment of earth moves must necessarily be the place to which the whole moves; and in the place to which a thing naturally moves, it will naturally rest. The reason then is not in the fact that the earth is indifferently related to every extreme point; for this would apply to any body, whereas movement to the centre is peculiar to earth. Again it is absurd to look for a reason why the earth remains at the centre and not for a reason why fire remains at the extremity. If the extremity is the natural place of fire, clearly earth must also have a natural place. But suppose that the centre is not its place, and that the reason of its remaining there is this necessity of indifference—on the analogy of the hair which, it is said, however great the tension, will not break under it, if it be evenly distributed, or of the man who, though exceedingly hungry and thirsty, and both equally, yet being equidistant from food and drink, is therefore bound to stay where he is—even so, it still remains to explain why fire stays at the extremities. It is strange, too, to ask about things staying still but not about their motion,—why, I mean, one thing, if nothing stops it, moves up, and another thing to the centre. Again, their statements are not true. It happens, indeed, to be the case that a thing to which movement this way and that is equally inappropriate is obliged to remain at the centre. But so far as their argument goes, instead of remaining there, it will move, only not as a mass but in fragments. For the argument applies equally to fire. Fire, if set at the centre, should stay there, like earth, since it will be indifferently related to every point on the extremity. Nevertheless it will move, as in fact it always does move when nothing stops it, away from the centre to the extremity. It will not, however, move in a mass to a single point on the circumference—the only possible result on the lines of the indifference theory—but rather each corresponding portion of fire to the corresponding part of the extremity, each fourth part, for instance, to a fourth part of the circumference. For since no body is a point, it will have parts. The expansion, when the body increased the place occupied, would be on the same principle as the contraction, in which the place was diminished. Thus, for all the indifference theory shows to the contrary, the earth also would have moved in this manner away from the centre, unless the centre had been its natural place.

We have now outlined the views held as to the shape, position, and rest or movement of the earth.

14 · Let us first decide the question whether the earth moves or is at rest. For, as we said, there are some who make it one of the stars, and others who, setting it at the centre, suppose it to be rolled and in motion about the pole as axis. That both views are untenable will be clear if we take as our starting-point the fact that the earth's motion, whether the earth be at the centre or away from it, must needs be a constrained motion. It cannot be the movement of the earth itself. If it were, any portion of it would have this movement; but in fact every part moves in a straight line to the centre. Being, then, constrained and unnatural, the movement could not be eternal. But the order of the universe is eternal. Again, everything that moves with the circular movement, except the first sphere, is observed to be passed, and to move with more than one motion. The earth, then, also, whether it moves about the centre or is stationary at it, must necessarily move with two motions. But if this were so, there would have to be passings and turnings of the fixed stars. Yet no such thing is observed. The same stars always rise and set in the same parts of the earth.

Further, the natural movement of the earth, part and whole alike, is to the centre of the whole—whence the fact that it is now actually situated at the centre—but it might be questioned, since both centres are the same, which centre it is that portions of earth and other heavy things move to. Is this their goal because it is the centre of the earth or because it is the centre of the whole? The goal, surely, must be the centre of the whole. For fire and other light things move to the extremity of the area which contains the centre. It happens, however, that the centre of the earth and of the whole is the same. Thus they do move to the centre of the earth, but accidentally, in virtue of the fact that the earth's centre lies at the centre of the whole. That the centre of the earth is the goal of their movement is indicated by the fact that heavy bodies moving towards the earth do not move parallel but so as to make equal angles, and thus to a single centre, that of the earth. It is clear, then, that the earth must be at the centre and immovable, not only for the reasons already given, but also because heavy bodies forcibly thrown quite straight upward return to the point from which they started, even if they are thrown to an unlimited distance. From these considerations then it is clear that the earth does not move and does not lie elsewhere than at the centre.

From what we have said the explanation of the earth's immobility is also apparent. If it is the nature of earth, as observation shows, to move from any point to the centre, as of fire contrariwise to move from the centre to the extremity, it is impossible that any portion of earth should move away from the centre except by constraint. For a single thing has a single movement, and a simple thing a simple: contrary movements cannot belong to the same thing, and movement away from the centre is the contrary of movement to it. If then no portion of earth can move away from the centre, obviously still less can the earth as a whole so move. For it is the nature of the whole to move to the point to which the part naturally moves. Since, then, it would require a force greater than itself to move it, it must needs stay at the centre. This view is further supported by the contributions of mathematicians to astronomy, since the phenomena—the changes of the shapes by which the order of the stars is determined—are fully accounted for on the hypothesis that the earth lies at the centre. Of the position of the earth and of the manner of its rest or movement, our discussion may here end.

Its shape must necessarily be spherical. For every portion of earth has weight until it reaches the centre, and the jostling of parts greater and smaller would bring about not a waved surface, but rather compression and convergence of part and part until the centre is reached. The process should be conceived by supposing the earth to come into being in the way that some of the natural philosophers describe. Only they attribute the downward movement to constraint, and it is better to keep to the truth and say that the reason of this motion is that a thing which possesses weight is naturally endowed with a centripetal movement. When the mixture, then, was merely potential, the things that were separated off moved similarly from every side towards the centre. Whether the parts which came together at the centre were distributed at the extremities evenly, or in some other way, makes no difference. If, on the one hand, there were a similar movement from each quarter of the extremity to the single centre, it is obvious that the resulting mass would be similar on every side. For if an equal amount is added on every side the extremity of the mass will be everywhere equidistant from its centre, i.e. the figure will be spherical. But neither will it in any way affect the argument if there is not a similar accession of concurrent fragments from every side. For the greater quantity, finding a lesser in front of it, must necessarily drive it on, both having an impulse whose goal is the centre, and the greater weight driving the lesser forward till this goal is reached. In this we have also the solution of a possible difficulty. The earth, it might be argued, is at the centre and spherical in shape: if, then, a weight many times that of the earth were added to one hemisphere, the centre of the earth and of the whole will no longer be coincident. So that either the earth will not stay at the centre, or if it does, it might even now be at rest without being at the centre but at a place where it is its nature to move. Such is the difficulty. A short consideration will give us an easy answer, if we first give precision to our postulate that any body endowed with weight, of whatever size, moves towards the centre. Clearly it will not stop when its edge touches the centre. The greater quantity must prevail until its own centre occupies the centre. For that is the goal of its impulse. Now it makes no difference whether we apply this to a clod or arbitrary fragment of earth or to the earth as a whole. The fact indicated does not depend upon degrees of size but applies universally to everything that has the centripetal impulse. Therefore earth in motion whether in a mass or in fragments, necessarily continues to move until it occupies the centre equally every way, the less being forced to equalize itself by the greater owing to the forward drive of the impulse.

If the earth was generated, then, it must have been formed in this way, and so clearly its generation was spherical; and if it is ungenerated and has remained so always, its character must be that which the initial generation, if it had occurred, would have given it. But the spherical shape, necessitated by this argument, follows also from the fact that the motions of heavy bodies always make equal angles, and are not parallel. This would be the natural form of movement towards what is naturally spherical. Either then the earth is spherical or it is at least naturally spherical. And it is right to call anything that which nature intends it to be, and which belongs to it, rather than that which it is by constraint and contrary to nature. The evidence of the senses further corroborates this. How else would eclipses of the moon show segments shaped as we see them? As it is, the shapes which the moon itself each month shows are of every kind—straight, gibbous, and concave—but in eclipses the outline is always curved; and, since it is the interposition of the earth that makes the eclipse, the form of this line will be caused by the form of the earth's surface, which is therefore spherical. Again, our observations of the stars make it evident, not only that the earth is circular, but also that it is a circle of no great size. For quite a small change of position on our part to south or north causes a manifest alteration of the horizon. There is much change, I mean, in the stars which are overhead, and the stars seen are different, as one moves northward or southward. Indeed there are some stars seen in Egypt and in the neighbourhood of Cyprus which are not seen in the northerly regions; and stars, which in the north are never beyond the range of observation, in those regions rise and set. All of which goes to show not only that the earth is circular in shape, but also that it is a sphere of no great size; for otherwise the effect of so slight a change of place would not be so quickly apparent. Hence one should not be too sure of the incredibility of the view of those who conceive that there is continuity between the parts about the pillars of Hercules and the parts about India, and that in this way the ocean is one. As further evidence in favour of this they quote the case of elephants, a species occurring in each of these extreme regions, suggesting that the common characteristic of these extremes is explained by their continuity. Also, those mathematicians who try to calculate the size of the earth's circumference arrive at the figure 400,000 stades.[15] This indicates not only that the earth's mass is spherical in shape, but also that as compared with the stars it is not of great size.

BOOK III

1 · We have already discussed the first heaven and its parts, the moving stars within it, the matter of which these are composed and their nature, and we have also shown that they are ungenerated and indestructible. Now things that we call natural are either substances or functions and attributes of substances. As substances I class the simple bodies—fire, earth, and the other terms of the series—and all things composed of them; for example, the heaven as a whole and its parts, animals, again, and plants and their parts. By attributes and functions I mean the movements of these and of all other things in which they have power in themselves to cause movement, and also their alterations and reciprocal transformations. It is obvious, then, that the greater part of the inquiry into nature concerns bodies; for a natural substance is either a body or a thing which cannot come into existence without body and magnitude. This appears plainly from an analysis of the

[15]About 10,000 miles.

character of natural things, and equally from specialized studies. Since, then, we have spoken of the primary element, of its nature, and of its freedom from destruction and generation, it remains to speak of the other two. In speaking of them we shall be obliged also to inquire into generation and destruction. For if there is generation anywhere, it must be in these elements and things composed of them.

This is indeed the first question we have to ask: is generation a fact or not? Earlier speculation was at variance both with itself and with the views here put forward as to the true answer to this question. Some removed generation and destruction from the world altogether. Nothing that is, they said, is generated or destroyed, and our conviction to the contrary is an illusion. So maintained the school of Melissus and Parmenides. But however excellent their theories may otherwise be, anyhow they cannot be held to speak as students of nature. There may be things not subject to generation or any kind of movement, but if so they belong to another and a higher inquiry than the study of nature. They, however, had no idea of any form of being other than the substance of things perceived; and when they saw, what no one previously had seen, that there could be no knowledge or wisdom without some such unchanging entities, they naturally transferred what was true of them to things perceived. Others, perhaps intentionally, maintain precisely the contrary opinion to this. It had been asserted that everything in the world was subject to generation and nothing was ungenerated, but that after being generated some things remained indestructible while the rest were again destroyed. This had been asserted in the first instance by Hesiod and his followers, but afterwards outside his circle by the earliest natural philosophers. But what these thinkers maintained was that all else is being generated and is flowing, nothing having any stability, except one single thing which persists as the basis of all these transformations. So we may interpret the statements of Heraclitus of Ephesus and many others. And some subject all bodies whatever to generation, by means of the composition and separation of planes.

Discussion of the other views may be postponed. But this last theory which composes every body of planes is, as is seen at a glance, in many respects in plain contradiction with mathematics. It is, however, wrong to remove the foundations of a science unless you can replace them with others more convincing. And, secondly, the same theory which composes solids of planes clearly composes planes of lines and lines of points, so that a part of a line need not be a line. This matter has been already considered in our discussion of movement, where we have shown that an indivisible length is impossible.[16] But with respect to natural bodies there are impossibilities involved in the view which asserts indivisible lines, which we may briefly consider at this point. For the impossible consequences which result from this view in the mathematical sphere will reproduce themselves when it is applied to physical bodies, but there will be difficulties in physics which are not present in mathematics; for mathematics deals with an abstract and physics with a more concrete object. There are many attributes necessarily present in physical bodies

[16]See *Physics* VI 1.

which are necessarily absent from indivisibles. There can be nothing divisible in an indivisible thing, but the attributes of bodies are all divisible in one of two ways. They are divisible into kinds, as colour is divided into white and black, and they are divisible *per accidens* when that which has them is divisible. In this latter sense attributes which are simple are all divisible. Attributes of this kind will serve, therefore, to illustrate the impossibility of the view. It is impossible, if two parts of a thing have no weight, that the two together should have weight. But either all perceptible bodies or some, such as earth and water, have weight, as these thinkers would themselves admit. Now if the point has no weight, clearly the lines have not either, and, if they have not, neither have the planes. Therefore no body has weight. It is, further, manifest that the point cannot have weight. For while a heavy thing may always be heavier than something and a light thing lighter than something, a thing which is heavier or lighter than something need not be itself heavy or light, 299b1
just as a large thing is larger, but what is larger is not always large. A thing which, judged absolutely, is small may none the less be larger than other things. Whatever, then, is heavy and also heavier than something else, must be greater in weight. A heavy thing therefore is always divisible. But it is agreed that a point is indivisible. Again, suppose that what is heavy is a dense body, and what is light rare. Dense differs from rare in containing more matter in the same bulk. A point, then, if it may be heavy or light, may be dense or rare. But the dense is divisible while a point is indivisible. And if what is heavy must be either hard or soft, an impossible consequence is easy to draw. For a thing is soft if its surface can be pressed in, hard if it cannot; and if it can be pressed in it is divisible.

Moreover, no weight can consist of parts not possessing weight. For how, except by the merest fiction, can they specify the number and character of the parts which will produce weight? And, further, if it is weight by which one weight is greater than another, then every indivisible part possesses weight. For suppose that a body of four points possesses weight. A body composed of more than four points will be superior in weight to it, a thing which has weight. But what makes something heavier than a heavy thing must be heavy, just as what makes something whiter than a white thing must be white. Here the difference which makes the superior weight heavier is the single point which remains when the common number, four, is subtracted. A single point, therefore, has weight.

Further, to assume that the planes can only be put in linear contact would be ridiculous. For just as there are two ways of putting lines together, namely, end to end and side by side, so there must be two ways of putting planes together. Lines can be put together so that contact is linear by laying one along the other, though not by putting them end to end. But if in putting the planes together, superficial contact is also allowed there will be bodies which are not any element nor composed of elements, viz. bodies put together from planes put together in this way. Again, if it is the number of planes in a body that makes one heavier than another, as the *Timaeus*[17] explains, clearly the line and the point will have weight. For the cases 300a1

[17]See *Timaeus* 56B.

are, as we said before, analogous. But if the reason of differences of weight is not this, but rather the heaviness of earth and the lightness of fire, then some of the planes will be light and others heavy (which involves a similar distinction in the lines and the points); the earth-plane, I mean, will be heavier than the fire-plane. In general, the result is either that there is no magnitude at all, or that all magnitude could be done away with. For a point is to a line as a line is to a plane and as a plane is to a body. Now the various forms in passing into one another will each be resolved into its ultimate constituents. It might happen therefore that nothing existed except points, and that there was no body at all. A further consideration is that if time is similarly constituted, there would be, or might be, a time at which it was done away with. For the indivisible now is like a point in a line. The same consequences follow from composing the heaven of numbers, as some of the Pythagoreans do who make all nature out of numbers. For natural bodies are manifestly endowed with weight and lightness, but an assemblage of units can neither be composed to form a body nor possess weight.

2 · The necessity that each of the simple bodies should have a natural movement may be shown as follows. They manifestly move, and if they have no proper movement they must move by constraint; and the constrained is the same as the unnatural. Now an unnatural movement presupposes a natural movement which it contravenes, and which, however many the unnatural movements, is always one. For naturally a thing moves in one way, while its unnatural movements are manifold. The same may be shown from the fact of rest. Rest, also, must either be constrained or natural, constrained in a place to which movement was constrained, natural in a place to which movement was natural. Now manifestly there is a body which is at rest at the centre. If then this rest is natural to it, clearly motion to this place is natural to it. If, on the other hand, its rest is constrained, what is hindering its motion? Something, perhaps, which is at rest; but if so, we shall simply repeat the same argument; and either we shall come to an ultimate something to which rest where it is is natural, or we shall have an infinite process, which is impossible. The hindrance to its movement, then, we will suppose, is a moving thing—as Empedocles says that it is the vortex which keeps the earth still—: but in that case where would it have moved to? It could not move infinitely; for to traverse an infinite is impossible, and impossibilities do not happen. So the moving thing must stop somewhere, and there rest not by constraint but naturally. But a natural rest proves a natural movement to the place of rest.

Hence Leucippus and Democritus, who say that the primary bodies are in perpetual movement in the void or infinite, may be asked to explain the manner of their motion and the kind of movement which is natural to them. For if the various elements are constrained by one another to move as they do, each must still have a natural movement which the constrained contravenes, and the prime mover must cause motion not by constraint but naturally. If there is no ultimate natural cause of movement and each preceding term in the series is always moved by constraint, we shall have an infinite process. The same difficulty is involved even if it is supposed, as we read in the *Timaeus*,[18] that before the world was made the elements moved without order. Their movement must have been due either to constraint or to their nature. And if their movement was natural, careful consideration shows that there was already a world. For the prime mover must cause motion in virtue of its own natural movement, and the other bodies, moving without constraint, as they came to rest in their proper places, would fall into the order in which they now stand, the heavy bodies moving towards the centre and the light bodies away from it. But that is the order of their distribution in our world. There is a further question, too, which might be asked. Is it not possible that bodies in unordered movement should combine in some cases into combinations like those of which bodies of nature's composing are composed, such, I mean, as bones and flesh? This is what Empedocles asserts to have occurred under Love. 'Many a head', he says 'came to birth without a neck'.[19]

The answer to the view that there are infinite bodies moving in an infinite is that, if the cause of movement is single, they must move with a single motion, and therefore not without order; and if, on the other hand, the causes are of infinite variety, their motions too must be infinitely varied. For a finite number of causes would produce a kind of order, since absence of order is not proved by diversity of direction in motions: indeed, in the world we know, not all bodies, but only bodies of the same kind, have a common goal of movement. Again, disorderly movement means in reality unnatural movement, since the order proper to perceptible things is their nature. And there is also absurdity and impossibility in the notion that the disorderly movement is infinitely continued. For the nature of things is the nature which most of them possess for most of the time. Thus their view brings them into the contrary position that disorder is natural, and order or system unnatural. But no natural fact can originate in chance. This is a point which Anaxagoras seems to have thoroughly grasped; for he starts his cosmogony from unmoved things. The others, it is true, make things collect together somehow before they try to produce motion and separation. But it is unreasonable to start generation from an original state in which bodies are separated and in movement. Hence Empedocles begins after the process ruled by Love; for he could not have constructed the heaven by building it up out of bodies in separation, making them to combine by the power of Love, since our world has its constituent elements in separation, and therefore presupposes a previous state of unity and combination.

These arguments make it plain that every body has its natural movement, which is not constrained or contrary to its nature. We go on to show that there are certain bodies whose impetus must be that of weight and lightness. Of necessity, we assert, they must move, and a moved thing which has no natural impetus cannot move either towards or away from the centre. Suppose a body *A* without weight, and a body *B* endowed with weight. Suppose the weightless body to move the distance *CD*, while *B* in the same time moves the distance *CE*, which will be greater since the heavy thing must move further. Let the heavy body then be divided in the

[18] *Timaeus* 30A.
[19] Frag. 57 Diels-Kranz.

proportion *CE*:*CD* (for there is no reason why a part of *B* should not stand in this relation to the whole). Now if the whole moves the whole distance *CE*, the part must in the same time move the distance *CD*. A weightless body, therefore, and one which has weight will move the same distance, which is impossible. And the same 301b1 argument would fit the case of lightness. Again, a body which is in motion but has neither weight nor lightness, must be moved by constraint, and must continue its constrained movement infinitely. For there will be a force which moves it, and the smaller and lighter a body is the further will a given force move it. Now let *A*, the weightless body, be moved the distance *CE*, and *B*, which has weight, be moved in the same time the distance *CD*. Dividing the heavy body in the proportion *CE*:*CD*, we subtract from the heavy body a part which will in the same time move the distance *CE*, since the whole moved *CD*; for the relative speeds of the two bodies will be in inverse ratio to their respective sizes. Thus the weightless body will move the same distance as the heavy in the same time. But this is impossible. Hence, since the motion of the weightless body will cover a greater distance than any that is suggested, it will continue infinitely.

It is therefore obvious that every body must have a definite weight or lightness. But since a source of movement within the thing itself is its nature, while a force is a source of movement in something other than it or in itself *qua* other, and since movement is always due either to nature or to constraint, movement which is natural, as downward movement is to a stone, will be merely accelerated by an external force, while an unnatural movement will be due to the force alone. In either case the air is as it were instrumental to the force. For air is both light and heavy, and thus *qua* light produces upward motion, being propelled and set in motion by the force, and *qua* heavy produces a downward motion. In either case the force transmits the movement to the body by first, as it were, tying it up in the air. That is why a body moved by constraint continues to move even when that which gave the impulse ceases to accompany it. Otherwise, i. e. if the air were not endowed with this function, constrained movement would be impossible. And the natural movement of a body may be helped on in the same way. This discussion suffices to show that all bodies are either light or heavy, and how unnatural movement takes place.

From what has been said earlier it is plain that there cannot be generation either of everything or in an absolute sense of anything. It is impossible that 302a1 everything should be generated, unless a separate void is possible. For the place which is to be occupied by that which is coming to be when it has come to be, must have been previously occupied by void in which no body was. Now it is quite possible for one body to be generated out of another, air for instance out of fire, but in the absence of any pre-existing mass generation is impossible. That which is potentially a certain kind of body may, it is true, become such in actuality. But if the potential body was not already in actuality some other kind of body, the existence of a separate void must be admitted.

3 · It remains to say what bodies are subject to generation, and why. Since in every case knowledge depends on what is primary, and the elements are the primary

constituents of bodies, we must ask which of such bodies are elements, and why; and after that what is their number and character. The answer will be plain if we first explain what kind of substance an element is. An element, we take it, is a body into which other bodies may be analysed, present in them potentially or in actuality (which of these, is still disputable), and not itself divisible into bodies different in form. That, or something like it, is what all men in every case mean by element. Now if what we have described is an element, clearly there must be such bodies. For flesh and wood and all other similar bodies contain potentially fire and earth, since one sees these elements exuded from them; and, on the other hand, neither in potentiality nor in actuality does fire contain flesh or wood, or it would exude them. Similarly, even if there were only one elementary body, it would not contain them. For though it will be either flesh or bone or something else, that does not at once show that it contained these in potentiality: the further question remains, in what manner it becomes them. Now Anaxagoras opposes Empedocles' view of the elements. Empedocles says that fire and earth and the related bodies are elementary bodies of which all things are composed; but this Anaxagoras denies. His elements are the homoeomerous things, viz. flesh, bone, and the like. Earth and fire are mixtures, composed of them and all the other seeds, each consisting of a collection of all the homoeomerous bodies, separately invisible; and that explains why from these two bodies all others are generated. (To him fire and *aither* are the same thing.) But since every natural body has its proper movement, and movements are either simple or mixed, mixed in mixed bodies and simple in simple, there must obviously be simple bodies; for there are simple movements. It is plain, then, that there are elements, and why.

4 · The next question to consider is whether the elements are finite or infinite in number, and, if finite, what their number is. Let us first show reason for denying that their number is infinite, as some suppose. We begin with the view of Anaxagoras that all the homoeomerous bodies are elements. Any one who adopts this view misapprehends the meaning of element. Observation shows that even mixed bodies are often divisible into homoeomerous parts; examples are flesh, bone, wood, and stone. Since then the composite cannot be an element, not every homoeomerous body can be an element; only, as we said before, that which is not divisible into bodies different in form. But even taking 'element' as they do, they need not assert an infinity of elements, since the hypothesis of a *finite* number will give identical results. Indeed even two or three such bodies serve the purpose as well, as Empedocles' attempt shows. Again, even on their view it turns out that all things are not composed of homoeomerous bodies. They do not pretend that a face is composed of faces, or that any other natural conformation is composed of parts like itself. Obviously then it would be better to assume a finite number of principles. They should, in fact, be as few as possible, consistently with proving what has to be proved. This is the common demand of mathematicians, who always assume as principles things finite either in kind or in number. Again, if body is distinguished from body by the appropriate qualitative difference, and there is a limit to the

303a1 number of differences (for the difference lies in qualities apprehended by sense, which are in fact finite in number, though this requires proof), then manifestly there is necessarily a limit to the number of elements.

There is, further, another view—that of Leucippus and Democritus of Abdera—the implications of which are also unreasonable. The primary masses, according to them, are infinite in number and indivisible in mass: one cannot turn into many nor many into one; and all things are generated by their combination and involution. Now this view in a sense makes things out to be numbers or composed of numbers. The exposition is not clear, but this is its real meaning. And further, they say that since the atomic bodies differ in shape, and there is an infinity of shapes, there is an infinity of simple bodies. But they have never explained in detail the shapes of the various elements, except so far as to allot the sphere to fire. Air, water, and the rest they distinguished by the relative size of the atom, assuming that its nature was a sort of seed-bed for each and every element. Now, in the first place, they make the mistake already noticed. The principles which they assume are not limited in number, though such limitation would necessitate no other alteration in their theory. Further, if the differences of bodies are not infinite, plainly the elements will not be an infinity. Besides, a view which asserts atomic bodies must needs come into conflict with the mathematical sciences, in addition to invalidating many reputable opinions and phenomena of sense perception. But of these things we have already spoken in our discussion of time and movement.[20] They are also bound to contradict themselves. For if the elements are atomic, air, earth, and water cannot be differentiated by the relative sizes of their atoms, since then they could not be generated out of one another. The extrusion of the largest atoms is a process that will in time exhaust the supply; and it is by such a process that they account for the generation of water, air, and earth from one another. Again, even on their own presuppositions it does not seem as if the elements would be infinite in number. The atoms differ in figure, and all figures are composed of pyramids, rectilinear in the
303b1 case of rectilinear figures, while the sphere has eight pyramidal parts. The figures must have their principles, and, whether these are one or two or more, the simple bodies must be the same in number as they. Again, if every element has its proper movement, and a simple body has a simple movement, and the number of simple motions is not infinite, because the simple motions are only two and the number of places is not infinite, on these grounds also we should have to deny that the number of elements is infinite.

5 · Since the number of the elements must be limited, it remains to inquire whether there is more than one element. Some assume one only, which is according to some water, to others air, to others fire, to others again something finer than water and denser than air, an infinite body—so they say—embracing all the heavens.

Now those who decide for a single element, which is either water or air or a

[20]See *Physics* VI 1–2.

body finer than water and denser than air, and proceed to generate other things out of it by use of density and rarity, all alike fail to observe the fact that they are introducing something else prior to the element. Generation out of the elements is, as they say, synthesis, and generation into the elements is analysis, so that the body with the finer parts must have priority in the order of nature. But they say that fire is of all bodies the finest. Hence fire will be first in the natural order. And whether the finest body is fire or not makes no difference; anyhow it must be one of the other bodies that is primary and not that which is intermediate. Again, density and rarity, as instruments of generation, are equivalent to fineness and coarseness, since the fine is rare, and coarse in their use means dense. But fineness and coarseness, again, are equivalent to greatness and smallness, since a thing with small parts is fine and a thing with large parts coarse. For that which spreads itself out widely is fine, and a thing composed of small parts is so spread out. In the end, then, they distinguish the various other substances by the greatness and smallness of their parts. This method of distinction makes all judgement relative. There will be no absolute distinction between fire, water, and air, but one and the same body will be relatively to this fire, relatively to something else air. The same difficulty is involved equally in the view which recognizes several elements and distinguishes them by their greatness and smallness. The principle of distinction between bodies being quantity, the various sizes will be in a definite ratio, and whatever bodies are in this ratio to one another must be air, fire, earth, and water respectively. For the ratios of smaller bodies may be repeated among greater bodies.

Those who start from fire as the single element, while avoiding this difficulty, involve themselves in many others. Some of them give fire a particular shape, like those who make it a pyramid, and this on one of two grounds. The reason given may be—more crudely—that the pyramid is the most piercing of figures as fire is of bodies, or—more ingeniously—the position may be supported by the following argument. As all bodies are composed of that which has the finest parts, so all solid figures are composed of pyramids; but the finest body is fire, while among figures the pyramid is primary and finest; and the primary body must have the primary figure: therefore fire will be a pyramid. Others, again, express no opinion on the subject of its figure, but simply regard it as the body of the finest parts, which in combination will form other bodies, as if from the blowing together of pieces of dust. Both of these views involve the same difficulties. For if, on the one hand, they make the primary body an atom, the view will be open to the objections already advanced against the atomic theory. And further the theory is inconsistent with a regard for the facts of nature. For if all bodies are quantitatively commensurable, and the relative size of the various homoeomerous masses and of their several elements are in the same ratio, so that the total mass of water, for instance, is related to the total mass of air as the elements of each are to one another, and so on, and if there is more air than water and, generally, more of the finer body than of the coarser, obviously the element of water will be smaller than that of air. But the lesser quantity is contained in the greater. Therefore the air element is divisible. And the same could be shown of fire and of all bodies whose parts are relatively fine. If, on the other hand, the primary body is divisible, then those who give fire a special shape will have to say that a part of fire is not fire, because a pyramid is not composed of pyramids, and also that not every body is either an element or composed of elements, since a part of fire will be neither fire nor any other element. And those whose ground of distinction is size will have to recognize an element prior to the element, a regress which continues infinitely, since every body is divisible and that which has the smallest parts is the element. Further, they too will have to say that the same body is relatively to this fire and relatively to that air, to others again water and earth.

The common error of all views which assume a single element is that they allow only one natural movement, which is the same for every body. For it is a matter of observation that every natural body possesses a principle of movement. If then all bodies are one, all will have one movement. With this motion the greater their quantity the more they will move, just as fire, in proportion as its quantity is greater, moves faster with the upward motion which belongs to it. But the fact is that increase of quantity makes many things move the faster downward. For these reasons, then, as well as from the distinction already established of a plurality of natural movements, it is impossible that there should be only one element. But if the elements are not an infinity and not reducible to one, they must be several and finite in number.

6 · First we must inquire whether the elements are eternal or subject to generation and destruction; for when this question had been answered their number and character will be manifest. In the first place, they cannot be eternal. It is a matter of observation that fire, water, and every simple body undergo a process of analysis, which must either continue infinitely or stop somewhere. Suppose it infinite. Then the time occupied by the process will be infinite, and also that occupied by the reverse process of synthesis. For the processes of analysis and synthesis succeed one another in the various parts. It will follow that there are two infinite times which are mutually exclusive, the time occupied by the synthesis, which is infinite, being preceded by the period of analysis. There are thus two mutually exclusive infinites, which is impossible. Suppose, on the other hand, that the analysis stops somewhere. Then the body at which it stops will be either atomic or, as Empedocles seems to have intended, a divisible body which will yet never be divided. The foregoing arguments show that it cannot be an atom; but neither can it be a divisible body which analysis will never reach. For a smaller body is more easily destroyed than a larger; and a destructive process which succeeds in destroying, that is, in resolving into smaller bodies, a body of some size, cannot reasonably be expected to fail with the smaller body. Now in fire we observe a destruction of two kinds: it is destroyed by its contrary when it is quenched, and by itself when it dies out. But the effect is produced by a greater quantity upon a lesser, and the more quickly the smaller it is. The elements of bodies must therefore be subject to destruction and generation.

Since they are generated, they must be generated either from something incorporeal or from a body, and if from a body, either from one another or from something else. The theory which generates them from something incorporeal requires a separate void. For everything that comes to be comes to be in something, and that in which the generation takes place must either be incorporeal or possess body; and if it has body, there will be two bodies in the same place at the same time, viz. that which is coming to be and that which was previously there, while if it is incorporeal, there must be a separate void. But we have already shown that this is impossible. But, on the other hand, it is equally impossible that the elements should be generated from some kind of body. That would involve a body distinct from the elements and prior to them. But if this body possesses weight or lightness, it will be one of the elements; and if it has no tendency to movement, it will be an immovable or mathematical entity, and therefore not in a place at all. A place in which a thing is at rest is a place in which it might move, either by constraint, i.e. unnaturally, or in the absence of constraint, i.e. naturally. If, then, it is in a place and somewhere, it will be one of the elements; and if it is not in a place, nothing can come from it, since that which comes into being and that out of which it comes must needs be together. The elements therefore cannot be generated from something incorporeal nor from a body which is not an element, and the only remaining possibility is that they are generated from one another.

7 · We must, therefore, turn to the question, what is the manner of their generation from one another? Is it as Empedocles and Democritus say, or as those who resolve bodies into planes say, or is there yet another possibility?

What the followers of Empedocles and Democritus do, though without observing it themselves, is to reduce the generation of elements out of one another to an illusion. They make it a process of excretion from a body of what was in it all the time—as though generation required a vessel rather than a material—so that it involves no change of anything. And even if this were accepted, there are other implications equally unsatisfactory. We do not expect a mass of matter to be made heavier by compression. But they will be bound to maintain this, if they say that water is a body present in air and excreted from air, since air becomes heavier when it turns into water. Again, when the mixed body is divided, they can show no reason why one of the constituents must by itself take up more room than the body did; but when water turns into air, the room occupied is increased. The fact is that the finer body takes up more room, as is obvious in any case of transformation. As the liquid is converted into vapour or air the vessel which contains it is often burst because it does not contain room enough. Now, if there is no void at all, and if, as those who take this view say, there is no expansion of bodies, the impossibility of this is manifest; and if there is void and expansion, there is no accounting for the fact that the body which results from division occupies of necessity a greater space. It is inevitable, too, that generation of one out of another should come to a stop, since a finite quantum cannot contain an infinity of finite quanta. When earth produces water something is taken away from the earth, for the process of excretion. The same thing happens again when the residue produces water. But this can only go on for ever, if the finite body contains an infinity, which is impossible. Therefore the generation of elements out of one another will not always continue.

We have now explained that the mutual transformations of the elements cannot take place by means of excretion. The remaining alternative is that they should be generated by changing into one another. And this in one of two ways, either by change of shape, as the same wax takes the shape both of a sphere and of a cube, or, as some assert, by resolution into planes. Generation by change of shape would necessarily involve atomic bodies. For if the particles were divisible there would be a part of fire which was not fire and a part of earth which was not earth, for the reason that not every part of a pyramid is a pyramid nor of a cube a cube. But if the process is resolution into planes, the first difficulty is that the elements cannot all be generated out of one another. This they are obliged to assert, and do assert. It is absurd, because it is unreasonable that one element alone should have no part in the transformations, and also contrary to the observed data of sense, according to which all alike change into one another. In fact their explanation of the phenomena is not consistent with the phenomena. And the reason is that their ultimate principles are wrongly assumed: they had certain predetermined views, and were resolved to bring everything into line with them. It seems that perceptible things require perceptible principles, eternal things eternal principles, corruptible things corruptible principles; and, in general, every subject matter principles homogeneous with itself. But they, owing to their love for their principles, fall into the attitude of men who undertake the defence of a position in argument. In the confidence that the principles are true they are ready to accept any consequence of their application. As though some principles did not require to be judged from their results, and particularly from their final issue! And that issue, which in the case of productive knowledge is the product, in the knowledge of nature is the phenomena always and properly given by perception.

The result of their view is that earth has the best right to the name element, and is alone indestructible; for that which is indissoluble is indestructible and elementary, and earth alone cannot be dissolved into any body but itself. Again, in the case of those elements which do suffer dissolution, the 'suspension' of the triangles is unreasonable. But this takes place whenever one is dissolved into another, because of the numerical inequality of the triangles which compose them. Further, those who hold these views must needs suppose that generation does not start from a body. For what is generated out of planes cannot be said to have been generated from a body. And they must also assert that not all bodies are divisible, coming thus into conflict with our most accurate sciences, namely the mathematical, which assume that even the intelligible is divisible, while they, in their anxiety to save their hypothesis, cannot even admit this of every perceptible thing. For any one who gives each element a shape of its own, and makes this the ground of distinction between the substances, has to attribute to them indivisibility; since division of a pyramid or a sphere must leave somewhere at least a residue which is

not a sphere or a pyramid. Either, then, a part of fire is not fire, so that there is a body prior to the element—for every body is either an element or composed of 306b1
elements—or not every body is divisible.

8 · In general, the attempt to give a shape to each of the simple bodies is unsound, for the reason, first, that they will not succeed in filling the whole. It is agreed that there are only three plane figures which can fill a space, the triangle, the square, and the hexagon, and only two solids, the pyramid and the cube. But the theory needs more than these because the elements which it recognizes are more in number. Secondly, it is manifest that the simple bodies are often given a shape by the place in which they are included, particularly water and air. In such a case the shape of the element cannot persist; for, if it did, the contained mass would not be in continuous contact with the containing body; while, if its shape is changed, it will cease to be water, since the distinctive quality is shape. Clearly, then, their shapes are not fixed. Indeed, nature itself seems to offer corroboration to this theoretical conclusion. Just as in other cases the substratum must be formless and unshapen—for thus the 'all-receptive', as we read in the *Timaeus*,[21] will be best for modelling—so the elements should be conceived as a material for composite things; and that is why they can put off their qualitative distinctions and pass into one another. Further, how can they account for the generation of flesh and bone or any other continuous body? The elements alone cannot produce them because their collocation cannot produce a continuum. Nor can the composition of planes; for this produces the elements themselves, not bodies made up of them. Any one then who insists upon an exact statement of this kind of theory, instead of assenting after a passing glance at it, will see that it removes generation from the world.

Further, the very properties, powers, and motions, to which they paid particular attention in allotting shapes, show the shapes not to be in accord with the bodies. Because fire is mobile and productive of heat and combustion, some made it a sphere, others a pyramid. These shapes, they thought, were the most mobile because they offer the fewest points of contact and are the least stable of any; they were also the most apt to produce heat and combustion, because the one is angular 307a1
throughout while the other has the most acute angles, and the angles, they say, produce heat and combustion. Now, in the first place, with regard to movement both are in error. These may be the figures best adapted to movement; they are not, however, well adapted to the movement of fire, which is an upward and rectilinear movement, but rather to that form of circular movement which we call rolling. Earth, again, they call a cube because it is stable and at rest. But it rests only in its own place, not anywhere; from any other it moves if nothing hinders, and fire and the other bodies do the same. The obvious inference, therefore, is that fire and each several element is in a foreign place a sphere or a pyramid, but in its own a cube. Again, if the possession of angles makes a body produce heat and combustion, every element produces heat, though one may do so more than another. For they all

[21] *Timaeus* 51A.

possess angles, the octahedron and dodecahedron as well as the pyramid; and Democritus makes even the sphere a kind of angle, which cuts things because of its mobility. The difference, then, will be one of degree; and this is plainly false. They must also accept the inference that the mathematical solids produce heat and combustion, since they too possess angles and contain atomic spheres and pyramids, especially if there are, as they allege, atomic magnitudes. Anyhow if these functions belong to some of these things and not to others, they should explain the difference, instead of speaking in quite general terms as they do. Again, combustion of a body produces fire, and fire is a sphere or a pyramid. The body, then, is turned into spheres or pyramids. Let us grant that these figures may reasonably be supposed to cut and break up bodies; still it remains quite inexplicable that a pyramid must needs produce pyramids or a sphere spheres. One might as well postulate that a knife or a saw divides things into knives or saws. It is also ridiculous to think only of division when allotting fire its shape. Fire is generally thought of as combining and connecting rather than as separating. For though it separates bodies different in kind, it combines those which are the same; and the combining is essential to it, the functions of connecting and uniting being a mark of fire, while the separating is incidental. For the expulsion of the foreign body is an incident in the compacting of the homogeneous. In choosing the shape, then, they should have thought either of both functions or preferably of the combining function. In addition, since hot and cold are contrary powers, it is impossible to allot any shape to the cold. For the shape given must be the contrary of that given to the hot, but there is no contrariety between figures. That is why they have all left the cold out, though properly either all or none should have their distinguishing figures. Some of them, however, do attempt to explain this power, and they contradict themselves. A body of large particles, they say, is cold because instead of penetrating through the passages it crushes. Clearly, then, that which is hot is that which penetrates these passages, or in other words that which has fine particles. It results that hot and cold are distinguished not by the figure but by the size of the particles. Again, if the pyramids are unequal in size, the large ones will not be fire, and that figure will produce not combustion but its contrary.

From what has been said it is clear that the difference of the elements does not depend upon their shape. Now the most important differences of bodies are those of property, function, and power; for every natural body has, we maintain, its own functions, properties, and powers. Our first business, then, will be to speak of these, and that inquiry will enable us to explain the differences of each from each.

BOOK IV

1 · We have now to consider the heavy and the light. We must ask what the bodies so called are, how they are constituted, and what is the reason of their possessing these powers. The consideration of these questions is a proper part of the theory of movement, since we call things heavy and light because they have the

power of being moved naturally in a certain way. (The activities corresponding to these powers have not been given any name, unless it is thought that 'impetus' is such a name.) But because the inquiry into nature is concerned with movement, and these things have in themselves some spark (as it were) of movement, all inquirers avail themselves of these powers, though in all but a few cases without exact discrimination. We must then first look at whatever others have said, and formulate the questions which require settlement in the interests of this inquiry, before we go on to state our own view of the matter.

Things are called heavy and light both without qualification and in relation to something else. Of two heavy things, such as wood and bronze, we say that the one is relatively light, the other relatively heavy. Our predecessors have not dealt at all with the absolute use of the terms, but only with the relative. I mean, they do not explain what the heavy is or what the light is, but only the relative heaviness and lightness of things possessing weight. This can be made clearer as follows. There are things whose constant nature it is to move away from the centre, while others move constantly towards the centre; and of these movements that which is away from the centre I call upward movement and that which is towards it I call downward movement. (The view, urged by some, that there is no up and no down in the heaven, is absurd. There can be, they say, no up and no down, since the universe is similar every way, and from any point on the earth's surface a man by advancing far enough will come to stand foot to foot with himself. But the extremity of the whole, which we call 'above', is in position above and in nature primary. And since the universe has an extremity and a centre, it must clearly have an up and down. Common usage is thus correct, though inadequate. And the reason of its inadequacy is that men think that the universe is not similar every way. They recognize only the hemisphere which is over us. But if they went on to think of the world as formed on this pattern all round, with a centre identically related to each point on the extremity, they would have to admit that the extremity was above and the centre below.) By absolutely light, then, we mean that which moves upward or to the extremity, and by absolutely heavy that which moves downward or to the centre. By lighter or relatively light we mean that one, of two bodies endowed with weight and equal in bulk, which is exceeded by the other in the speed of its natural downward movement.

2 · Those of our predecessors who have entered upon this inquiry have for the most part spoken of light and heavy things only in the sense in which one of two things both endowed with weight is said to be the lighter. And this treatment they consider a sufficient analysis also of the notions of absolute heaviness and absolute lightness, to which their account does not apply. This, however, will become clearer as we advance. One use of the terms 'lighter' and 'heavier' is that which is set forth in writing in the *Timaeus*,[22] that the body which is composed of the greater number of identical parts is relatively heavy, while that which is composed of a smaller

[22] *Timaeus* 63C.

number is relatively light. As a larger quantity of lead or of bronze is heavier than a smaller—and this holds good of all homogeneous masses, the superior weight always depending upon a numerical superiority of equal parts–in precisely the same way, they assert, lead is heavier than wood. For all bodies, in spite of the general opinion to the contrary, are composed of identical parts and of a single material. But this analysis says nothing of the absolutely heavy and light. The facts are that fire is always light and moves upward, while earth and all earthy things move downwards or towards the centre. It cannot then be the fewness of the triangles (of which, in their view, all these bodies are composed) which disposes fire to move upward. If it were, the greater the quantity of fire the slower it would move, owing to the increase in weight due to the increased number of triangles. But the palpable fact, on the contrary, is that the greater the quantity, the lighter the mass is and the quicker its upward movement; and, similarly, in the reverse movement from above downward, the small mass will move quicker and the large slower. Further, since to be lighter is to have fewer of these homogeneous parts and to be heavier is to have more, and air, water, and fire are composed of the same triangles, the only difference being in the number of such parts, which must therefore explain any distinction of relatively light and heavy between these bodies, it follows that there must be a certain quantum of air which is heavier than water. But the facts are directly opposed to this. The larger the quantity of air the more readily it moves upward, and any portion of air without exception will rise up out of the water.

So much for one view of the distinction between light and heavy. To others the analysis seemed insufficient; and their views on the subject, though they belong to an older generation, have an air of novelty. It is apparent that there are bodies which, when smaller in bulk than others, yet exceed them in weight. It is therefore obviously insufficient to say that bodies of equal weight are composed of an equal number of primary parts; for that would give equality of bulk. Those who maintain that the primary or atomic parts, of which bodies endowed with weight are
309a1 composed, are planes, cannot so speak without absurdity; but those who regard them as solids are in a better position to assert that of such bodies the larger is the heavier. But since in composite bodies the weight obviously does not correspond in this way to the bulk, the lesser bulk being often seen to be superior in weight (as, for instance, if one be wool and the other bronze), there are some who think and say that the cause is to be found elsewhere. The void, they say, which is imprisoned in bodies, lightens them and sometimes makes the larger body the lighter. The reason is that there is more void. And this would also account for the fact that a body composed of a number of solid parts equal to, or even smaller than, that of another is sometimes larger in bulk than it. In short, generally and in every case a body is relatively light when it contains a relatively large amount of void. This is the way they put it themselves, but their account requires an addition. Relative lightness must depend not only on an excess of void, but also on a defect of solid; for if the ratio of solid to void exceeds a certain proportion, the relative lightness will disappear. Thus fire, they say, is the lightest of things just for this reason that it has the most void. But it would follow that a large mass of gold, as containing more void

than a small mass of fire, is lighter than it, unless it also contains many times as much solid. The addition is therefore necessary.

Of those who deny the existence of a void some, like Anaxagoras and Empedocles, have not tried to analyse the notions of light and heavy at all; and those who, while still denying the existence of a void, have attempted this, have failed to explain why there are bodies which are absolutely heavy and light, or in other words why some always move upward and others downward. The fact, again, that the body of greater bulk is sometimes lighter than smaller bodies is one which they have passed over in silence, and what they have said gives no obvious suggestion for reconciling their views with the phenomena.

But those who attribute the lightness of fire to its containing so much void are necessarily involved in practically the same difficulties. For though fire be supposed to contain less solid than any other body, as well as more void, yet there will be a certain quantum of fire in which the amount of solid or plenum is in excess of the solids contained in some small quantity of earth. They may reply that there is an excess of void also. But the question is, how will they discriminate the absolutely heavy? Presumably, either by its excess of solid or by its defect of void. On the former view there could be an amount of earth so small as to contain less solid than a large mass of fire. And similarly, if the distinction rests on the amount of void, there will be body, lighter than the absolutely light, which nevertheless moves downward as constantly as the other moves upward. But that cannot be so, since the absolutely light is always lighter than bodies which have weight and move downward, while, on the other hand, that which is lighter need not be light, because in common speech we distinguish a lighter and a heavier (viz. water and earth) among bodies endowed with weight. Again, the suggestion of a certain ratio between the void and the solid in a body is no more equal to solving the problem before us. This manner of speaking will issue in a similar impossibility. For any two portions of fire, small or great, will exhibit the same ratio of solid to void; but the upward movement of the greater is quicker than that of the less, just as the downward movement of a mass of gold or lead, or of any other body endowed with weight, is quicker in proportion to its size. This, however, should not be the case if the ratio is the ground of distinction between heavy things and light. There is also an absurdity in attributing the upward movement of bodies to a void which does not itself move. If, however, it is the nature of a void to move upward and of a plenum to move downward, and therefore each causes a like movement in other things, there was no need to raise the question why composite bodies are some light and some heavy; they had only to explain why these two things are themselves light and heavy respectively and to give, further, the reason why the plenum and the void are not eternally separated. It is also unreasonable to imagine a place for the void, as if the void were not itself a kind of place. But if the void is to move, it must have a place out of which and into which the change carries it. Also what is the cause of its movement? Not, surely, its voidness; for it is not the void only which is moved, but also the solid.

Similar difficulties are involved in all other methods of distinction, whether they account for the relative lightness and heaviness of bodies by distinctions of size, or proceed on any other principle, so long as they attribute to each the same matter, or even if they recognize more than one matter, so long as that means only a pair of contraries. If there is a single matter, as with those who compose things of triangles, nothing can be absolutely heavy or light; and if there is one matter and its contrary—the void, for instance, and the plenum—no reason can be given for the relative lightness and heaviness of the bodies intermediate between the absolutely light and heavy when compared either with one another or with these themselves. The view which bases the distinction upon differences of size is more like a mere fiction than those previously mentioned, but, in that it is able to make distinctions between the four elements, it is in a stronger position for meeting the foregoing difficulties. Since, however, it imagines that these bodies which differ in size are all of one nature, it implies, equally with the view that there is but one matter, that there is nothing absolutely light and nothing which moves upward (except as being passed by other things or forced up by them); and since a multitude of small atoms are heavier than a few large ones, it will follow that much air or fire is heavier than a little water or earth, which is impossible.

3 · These, then, are the views which have been advanced by others and the terms in which they state them. We may begin our own statement by settling a question which to some has been the main difficulty—the question why some bodies move always and naturally upward and others downward, while others again move both upward and downward. After that we will inquire into light and heavy and the explanation of the various properties connected with them. The local movement of each body into its own place must be regarded as similar to what happens in connexion with other forms of generation and change. There are, in fact, three kinds of movement, affecting respectively the size, the form, and the place of a thing, and in each it is observable that change proceeds from a contrary to a contrary or to something intermediate: it is never the change of any chance subject in any chance direction, nor, similarly, is the relation of the mover to its object fortuitous: the thing altered is different from the thing increased, and precisely the same difference holds between that which produces alteration and that which produces increase. In the same manner it must be thought that that which produces local motion and that which is so moved are not fortuitously related. Now, that which produces upward and downward movement is that which produces weight and lightness, and that which is moved is that which is potentially heavy and light, and the movement of each body to its own place is motion towards its own form. (It is best to interpret in this sense the old saying that 'like moves to like'. For the words are not in every sense true to fact. If one were to remove the earth to where the moon now is, the various fragments of earth would each move not towards it but to the place in which it now is. In general, when a number of similar and undifferentiated bodies are moved with the same motion this result is necessarily produced, viz. that the place which is the natural goal of the movement of each single part is also that of the whole. But since the place of a thing is the boundary of that which contains it, and

all things that move upward or downward are contained by the extremity and the centre, and this boundary comes to be, in a sense, the form of that which is contained, for something to move to its own place is for it to move to its like. For the successive members of the series are like one another: water, I mean, is like air and air like fire, and between intermediates the relation may be converted, though not between them and the extremes; thus air is like water, but water is like earth; for the relation of each outer body to that which is next within it is that of form to matter.) Thus to ask why fire moves upward and earth downward is the same as to ask why the healable, when moved and changed *quâ* healable, attains health and not whiteness; and similar questions might be asked concerning any other subject of alteration. Of course the subject of increase, when changed *quâ* increasable, attains not health but a superior size. The same applies in the other cases. One thing changes in quality, another in quantity: and so in place, a light thing goes upward, a heavy thing downward. The only difference is that in the last case, viz. that of the heavy and the light, the bodies are thought to have a principle of change within themselves, while the subjects of healing and increase are thought to be moved purely from without. Sometimes, however, even they change of themselves, i.e. in response to a slight external movement reach health or increase, as the case may be. And since the same thing which is healable is also receptive of disease, it depends on whether it is moved *quâ* healable or *quâ* liable to disease whether the motion is towards health or towards disease. But the reason why the heavy and the light appear more than these things to contain within themselves the principle of their movements is that their matter is nearest to substance. This is indicated by the fact that locomotion belongs to bodies only when isolated from other bodies, and is generated last of the several kinds of movement; in order of being then it will be first. Now whenever air comes into being out of water, light out of heavy, it goes to the upper place. It is forthwith light: becoming is at an end, and in that place it has being. Obviously, then, it is a potentiality, which, in its passage to actuality, comes into that place and quantity and quality which belong to its actuality. And the same fact explains why what is already actually fire or earth moves, when nothing obstructs it, towards its own place. For motion is equally immediate in the case of nutriment, when nothing hinders, and in the case of the thing healed, when nothing stays the healing. But the movement is also due to the original creative force and to that which removes the hindrance or off which the moving thing rebounded, as was explained in our opening discussions, where we tried to show how none of these things moves itself.[23] The reason of the various motions of the various bodies, and the meaning of the motion of a body to its own place, have now been explained.

4 · We have now to speak of the distinctive properties of these bodies and of the various properties connected with them. In accordance with general conviction we may distinguish the absolutely heavy, as that which sinks to the bottom of all things, from the absolutely light, which is that which rises to the surface of all

[23]See *Physics* VIII 4.

things. I use the term 'absolutely' with reference to the genus and to those bodies which do not combine lightness and heaviness. It is apparent, I mean, that fire, in whatever quantity, so long as there is no external obstacle, moves upward, and earth downward; and, if the quantity is increased, the movement is the same, though swifter. But the heaviness and lightness of bodies which combine these qualities is different from this, since while they rise to the surface of some bodies they sink to the bottom of others. Such are air and water. Neither of them is absolutely either light or heavy. Both are lighter than earth—for any portion of either rises to the surface of it—but heavier than fire, since a portion of either, whatever its quantity, sinks to the bottom of fire; compared together, however, the one has absolute weight, the other absolute lightness, since air in any quantity rises to the surface of water, while water in any quantity sinks to the bottom of air. Now other bodies are severally light and heavy, and evidently in them the attributes are due to the difference of their uncompounded parts: that is to say, according as the one or the other happens to preponderate the bodies will be heavy and light respectively. Therefore we need only speak of these parts, since they are primary and all else consequential; and in so doing we shall be following the advice which we gave to those who attribute heaviness to the presence of plenum and lightness to that of void. It is due to the properties of the elementary bodies that a body which is regarded as light in one place is regarded as heavy in another, and vice versa. In air, for instance, a talent's weight of wood is heavier than a mina of lead, but in water the wood is the lighter. The reason is that all the elements except fire have weight and all but earth lightness. Earth, then, and bodies in which earth preponderates, must needs have weight everywhere, while water is heavy anywhere but in earth, and air is heavy when not in water or earth. In its own place each of these bodies has weight except fire, even air. Of this we have evidence in the fact that a bladder when inflated weighs more than when empty. A body, then, in which air preponderates over earth and water, may well be lighter than something in water and yet heavier than it in air, since such a body does not rise in air but rises to the surface in water.

The following account will make it plain that there are absolutely light and absolutely heavy things. And by absolutely light I mean one which of its own nature always moves upward, by absolutely heavy one which of its own nature always moves downward, if no obstacle is in the way. There are, I say, these two kinds of body, and it is not the case, as some maintain, that all bodies have weight. Others indeed agree with us that there is a heavy body, which moves uniformly towards the centre. But there is also similarly a light body. For we see with our eyes, as we said before, that earthy things sink to the bottom of all things and move towards the centre. But the centre is a fixed point. If therefore there is some body which rises to the surface of all things—and we observe fire to move upward even in air itself, while the air remains at rest—clearly this body is moving towards the extremity. It cannot then have any weight. If it had, there would be another body in which it sank; and if that were so, there would be another which moved to the extremity and thus rose to the surface of all moving things. In fact, however, we have no evidence of such a body. Fire, then, has no weight. Neither has earth any lightness, since it sinks to the bottom of all things, and that which sinks moves to the centre. That there is a centre towards which the motion of heavy things, and away from which that of light things is directed, is manifest in many ways. First, because no movement can continue to infinity. For what cannot be can no more come-to-be than be, and movement is a coming-to-be in one place from another. Secondly, like the upward movement of fire, the downward movement of earth and all heavy things makes equal angles on every side with the earth's surface; it must therefore be directed towards the centre. Whether it is really the centre of the earth and not rather that of the whole to which it moves, may be left to another inquiry, since these are coincident.[24] But since that which sinks to the bottom of all things moves to the centre, necessarily that which rises to the surface of all things moves to the extremity of the region in which the movement of these bodies takes place. For the centre is opposed as contrary to the extremity, as that which always sinks is opposed to that which rises to the surface. This also gives a reasonable ground for the duality of heavy and light in the spatial duality centre and extremity. Now there is also the intermediate region to which each name is given in opposition to the other extreme. For that which is intermediate between the two is in a sense both extremity and centre. For this reason there is another heavy and light; namely, water and air. But in our view the container pertains to form and the contained to matter; and this distinction is present in every genus. Alike in the sphere of quality and in that of quantity there is that which corresponds rather to form and that which corresponds to matter. In the same way, among spatial distinctions, the above belongs to the determinate, the below to matter. The same holds, consequently, also of the matter itself of that which is heavy and light: as potentially possessing the one character, it is matter for the heavy, and as potentially possessing the other, for the light. It is the same matter, but its being is different, as that which is receptive of disease is the same as that which is receptive of health, though in being different from it, and therefore diseasedness is different from healthiness.

5 · A thing then which has the one kind of matter is light and always moves upward, while a thing which has the opposite matter is heavy and always moves downward. Bodies composed of kinds of matter different from these but having relatively to each other the character which these have absolutely, possess both the upward and the downward motion. Hence air and water each have both lightness and weight, and water sinks to the bottom of all things except earth, while air rises to the surface of all things except fire. But since there is one body only which rises to the surface of all things and one only which sinks to the bottom of all things, there must needs be two other bodies which sink in some bodies and rise to the surface of others. The kinds of matter, then must be as numerous as these bodies, i.e. four, but though they are four there must be a common matter of all—particularly if they pass into one another—which in each is in being different. There is no reason why

[24]See above, II 14.

312b1 there should not be one or more intermediates between the contraries, as in the case of colour; for 'intermediate' and 'mean' are capable of more than one application.

Now in its own place every body endowed with both weight and lightness has weight—whereas earth has weight everywhere—but they only have lightness among bodies to whose surface they rise. Hence when a support is withdrawn such a body moves downward until it reaches the body next below it, air to the place of water and water to that of earth. But if the fire above air is removed, it will not move upward to the place of fire, except by constraint; and in that way water also may be drawn up, when the upward movement of air which has had a common surface with it is swift enough to overpower the downward impulse of the water. Nor does water move upward to the place of air, except in the manner just described. Earth is not so affected at all, because a common surface is not possible to it. Hence water is drawn up into the vessel to which fire is applied, but not earth. As earth fails to move upward, so fire fails to move downward when air is withdrawn from beneath it; for fire has no weight even in its own place, as earth has no lightness. The other two move downward when the body beneath is withdrawn because, while the absolutely heavy is that which sinks to the bottom of all things, the relatively heavy sinks to its own place or to the surface of the body in which it rises, since it is similar in matter to it.

It is plain that one must suppose as many distinct species of matter as there are bodies. For if there is a single matter of all things, as, for instance, the void or the plenum or extension or the triangles, either all things will move upward or all things will move downward, and the second motion will be abolished. And so, either there will be no absolutely light body, if superiority of weight is due to superior size or number of the constituent bodies or to the fullness of the body (but the contrary is a matter of observation, and it has been shown that the downward and upward movements are equally constant and universal); or, if the matter in question is the void or something similar, which moves uniformly upward, there will be nothing to move uniformly downward. Further, it will follow that the intermediate bodies move downward in some cases quicker than earth; for air in sufficiently large quantity will contain a larger number of triangles or solids or particles. It is, however, manifest that no portion of air whatever moves downward. And the same reasoning applies to lightness, if that is supposed to depend on superiority of quantity of matter. But if the kinds of matter are two, it will be difficult to make the intermediate bodies behave as air and water behave. Suppose, for example, that the
313a1 two asserted are void and plenum. Fire, then, as moving upward, will be void, earth, as moving downward, plenum; and in air, it will be said, fire preponderates, in water, earth. There will then be a quantity of water containing more fire than a little air, and a large amount of air will contain more earth than a little water; consequently we shall have to say that air in a certain quantity moves downward more quickly than a little water. But such a thing has never been observed anywhere. Necessarily, then, as fire goes up because it has something, e.g. void, which other things do not have, and earth goes downward because it has plenum, so air goes to its own place above water because it has something else, and water goes

downward because of some special kind of body. But if the two bodies are one matter, or two matters both present in each, there will be a certain quantity of each at which water will excel a little air in the upward movement and air excel water in the downward movement, as we have already often said.

6 · The shape of bodies will not account for their moving upward or downward in general, though it will account for their moving faster or slower. The reasons for this are not difficult to see. For the problem thus raised is why a flat piece of iron or lead floats upon water, while smaller and less heavy things, so long as they are round or long—a needle, for instance—sink down; and sometimes a thing floats because it is small, as with gold dust and the various earthy and dusty materials which throng the air. With regard to these questions, it is wrong to accept the explanation offered by Democritus. He says that the warm bodies moving up out of the water hold up heavy bodies which are broad, while the narrow ones fall 313b1
through, because the bodies which offer resistance to them are not numerous. But this would be even more likely to happen in air—an objection which he himself raises. His reply to the objection is feeble. He says that the 'drive' (meaning by drive the movement of the upward moving bodies) is not uniform in direction. But since some continua are easily divided and others less easily, and things which produce division differ similarly in the ease with which they produce it, the explanation must be found in this fact. It is the easily bounded, in proportion as it is easily bounded, which is easily divided; and air is more so than water, water than earth. Further, the smaller the quantity in each kind, the more easily it is divided and disrupted. Thus the reason why broad things keep their place is because they cover so wide a surface and the greater quantity is less easily disrupted. Bodies of the opposite shape sink down because they occupy so little of the surface, which is therefore easily parted. And these considerations apply with greater force to air, since it is more easily divided than water. But since there are two factors, the force responsible for the downward motion of the heavy body and the disruption-resisting force of the continuous surface, there must be some ratio between the two. For in proportion as the force applied by the heavy thing towards disruption and division exceeds that which resides in the continuum, the quicker will it force its way down; only if the force of the heavy thing is the weaker, will it ride upon the surface.

We have now finished our examination of the heavy and the light and of the properties connected with them.

ON GENERATION AND CORRUPTION

H. H. Joachim

BOOK I

314a1 1 · Our next task is to study coming-to-be and passing-away. We are to distinguish the causes, and to state the definitions, of these processes considered in general—as they apply uniformly to all the things that come-to-be and pass-away by nature. Further, we are to study growth and alteration. We must inquire what each of them is; and whether alteration has the same nature as coming-to-be, or whether to these different names there correspond two separate processes with distinct natures.

On this question, indeed, the early philosophers are divided. Some of them assert that the so-called unqualified coming-to-be is alteration, while others maintain that alteration and coming-to-be are distinct. For those who say that the universe is one something (i.e. those who generate all things out of one thing) are bound to assert that coming-to-be is alteration, and that whatever comes-to-be in the proper sense of the term is being altered; but those who make the matter of things more than one must distinguish coming-to-be from alteration. To this latter class belong Empedocles, Anaxagoras, and Leucippus. And yet Anaxagoras failed to understand his own utterance. He *says,* at all events, that coming-to-be and passing-away are the same as being altered; yet, in common with other thinkers, he affirms that the elements are many. Thus Empedocles holds that the corporeal elements are four, while all the elements—including those which initiate movement—are six in number; whereas Anaxagoras agrees with Leucippus and Democritus that the elements are infinite.

(Anaxagoras posits as elements the 'homoeomeries', viz. bone, flesh, marrow, and everything else which is such that part and whole are synonymous; while Democritus and Leucippus say that there are indivisible bodies, infinite both in number and in the varieties of their shapes, of which everything else is composed—the compounds differing one from another according to their constituents and to the positions, and groupings of their constituents.)

TEXT: H. H. Joachim, *Aristotle on Coming-to-be and Passing-away,* Clarendon Press, Oxford, 1922

For the views of the school of Anaxagoras seem diametrically opposed to those of the followers of Empedocles. Empedocles says that Fire, Water, Air, and Earth are four elements, and are thus simple, rather than flesh, bone, and bodies which, like these, are 'homoeomeries'. But the followers of Anaxagoras regard the 'homoeomeries' as simple and elements, whilst they affirm that Earth, Fire, Water, and Air are composite; for each of these is (according to them) a seed-bed of the 'homoeomeries'.

Those, then, who construct all things out of a single element, must maintain 314b1 that coming-to-be and passing-away are alteration. For they must affirm that the underlying something always remains identical and one; and change of such a kind is what we call altering. Those, on the other hand, who make the ultimate kinds of things more than one, must maintain that alteration is distinct from coming-to-be; for coming-to-be and passing-away result from the consilience and the dissolution of the many kinds. That is why Empedocles too uses language to this effect, when he says 'There is no coming-to-be of anything, but only a mingling and a divorce of what has been mingled'.[1] Thus it is clear that their account in these terms is in accordance with their assumption, and that they do in fact so describe things; nevertheless, they too must recognize alteration as a fact distinct from coming-to-be, though it is impossible for them to do so consistently with what they say.

That we are right in this criticism is easy to perceive. For while the substance of the thing remains unchanged, we *see* it altering just as we *see* in it the changes of magnitude called growth and diminution. Nevertheless, the statements of those who posit more principles than one make alteration impossible. For the affections in respect of which we say that alteration occurs (I mean, e.g., hot-cold, white-black, dry-moist, soft-hard, and so forth) are differences characterizing the elements. Empedocles says:

> The sun everywhere bright to see, and hot;
> The rain everywhere dark and cold;[2]

and he characterizes his remaining elements in a similar manner. Since, therefore, it is not possible for Fire to become Water, or Water to become Earth, neither will it be possible for anything white to become black, or anything soft to become hard; and the same argument applies to all the other qualities. Yet this is what alteration essentially is.

It follows, as an obvious corollary, that a single matter must always be assumed as underlying the contraries in any change—whether change of place, or growth and diminution, or alteration; further, that the being of this matter and the being of alteration must stand and fall together. For if the change is alteration, then the *substratum* is a single element; i.e. all things which admit of change into one 315a1 another have a single matter. And, conversely, if the *substratum* is one, there is alteration.

[1] Frag. 8 Diels-Kranz.
[2] Frag. 21, lines 3 and 5, Diels-Kranz.

Empedocles, indeed, seems to contradict his own statements as well as the phenomena. For he denies that any one of his elements comes-to-be out of any other, insisting on the contrary that they are the things out of which everything else comes-to-be; and yet (having brought the entirety of existing things, except Strife, together into one) he maintains, simultaneously with this denial, that each thing once more comes-to-be out of the One. Hence it was clearly out of a One that *this* came-to-be Water, and *that* Fire, various portions of it being separated off by certain characteristic differences or affections—as indeed he calls the sun white and hot, and the earth heavy and hard. If, therefore, these differences be taken away (for they can be taken away, since they came-to-be), it will clearly be inevitable for Earth to come-to-be out of Water and Water out of Earth, and for each of the other elements to undergo a similar transformation—not only *then*, but also *now*—if they change their affections. And, to judge by what he says, they *can* be attached to things and *can* again be separated from them, especially since Strife and Love are still fighting with one another. It was owing to this same conflict that the elements were generated from a One at the former period for presumably Fire, Earth, and Water had no distinctive existence at all while merged in one.

It is not clear either whether we should regard as his first principle the One or the Many—i.e. Fire and Earth, and the bodies co-ordinate with these. For the One is an element in so far as it underlies the process as matter—as that out of which Earth and Fire come-to-be through a change due to the motion. On the other hand, in so far as the One results from *composition* (by a consilience of the Many), whereas they result from *disintegration*, the Many are more elementary than the One, and prior to it in their nature.

2 · We have therefore to discuss the whole subject of unqualified coming-to-be and passing-away; we have to inquire whether they do or do not occur and, if they occur, to explain how they occur. We must also discuss the remaining forms of movement, viz. growth and alteration. For Plato only investigated the conditions under which things come-to-be and pass-away; and he discussed not *all* coming-to-be, but only that of the elements. He asked no questions as to how flesh or bones, or any of the other similar things, come-to-be; nor again did he examine the conditions under which alteration or growth are attributable to things.

In general, no one except Democritus has applied himself to any of these matters in a more than superficial way. Democritus, however, does seem not only to 315b1 have thought about all the problems, but also to be distinguished from the outset by his method. For, as we are saying, none of the other philosophers made any definite statement about growth, except such as any amateur might have made. They said that things grow by the accession of like to like, but they did not proceed to explain the manner of this accession. Nor did they give any account of combination; and they neglected almost every single one of the remaining problems, offering no explanation, e.g., of action or passion—how in natural actions one thing acts and the other undergoes action. Democritus and Leucippus, however, postulate the 'figures', and make alteration and coming-to-be result from them. They explain coming-to-be and passing-away by their dissociation and association, but alteration by their grouping and position. And since they thought that the truth lay in the appearance, and the appearances are conflicting and infinitely many, they made the 'figures' infinite in number. Hence—owing to the changes of the compound—*the same* thing seems different to different people: it is transposed by a small additional ingredient, and appears utterly other by the transposition of a single constituent. For Tragedy and Comedy are both composed of *the same* letters.

Since almost all our predecessors think that coming-to-be is distinct from alteration, and that, whereas things alter by change of their affections, it is by association and dissociation that they come-to-be and pass-away, we must concentrate our attention on these theses. For they lead to many well-grounded dilemmas. If, on the one hand, coming-to-be *is* association, many impossible consequences result; and yet there are other arguments, not easy to unravel, which force the conclusion upon us that coming-to-be cannot possibly be anything else. If, on the other hand, coming-to-be *is not* association, either there is no such thing as coming-to-be at all or it is alteration; or else we must endeavour to unravel this dilemma too—and a stubborn one we shall find it.

The starting-point, in dealing with all these difficulties, is this: 'Do things come-to-be and alter and grow, and undergo the contrary changes, because the primary things are indivisible magnitudes? Or is no magnitude indivisible?' For the answer we give to this question makes the greatest difference. And again, if the primary things are indivisible magnitudes, are these *bodies*, as Democritus and Leucippus maintain? Or are they *planes*, as is asserted in the *Timaeus*?

To resolve bodies into planes and no further—this, as we have also remarked elsewhere, is in itself unreasonable. Hence there is more to be said for the view that there are indivisible bodies. Yet even these involve much that is unreasonable. Still, as we have said, it is possible to construct alteration and coming-to-be with them, if one transposes *the same* by 'turning' and 'intercontact', and by the varieties of the figures, as Democritus does. (His denial of the reality of colour is a corollary from this position; for, according to him, things get coloured by 'turning'.) But the possibility of such a construction no longer exists for those who divide bodies into planes. For nothing except solids results from putting planes together: they do not even attempt to generate any affection from them.

Lack of experience diminishes our power of taking a comprehensive view of the admitted facts. Hence those who dwell in intimate association with nature and its phenomena are more able to lay down principles such as to admit of a wide and coherent development; while those whom devotion to abstract discussions has rendered unobservant of the facts are too ready to dogmatize on the basis of a few observations. The rival treatments of the subject now before us will serve to illustrate how great is the difference between a scientific and a dialectical method of inquiry. For, whereas the one school argues that there must be atomic magnitudes because otherwise The Triangle will be more than one, Democritus would appear to have been convinced by arguments appropriate to the subject, i.e. drawn from the science of nature. Our meaning will become clear as we proceed.

For to suppose that a body (i.e. a magnitude) is divisible through and through, and that this division is possible, involves a difficulty. What will there be in the body which escapes the division?

If it is divisible through and through, and if this division is possible, then it might *be*, at one and the same moment, *divided* through and through, even though the dividings had not been effected simultaneously; and the actual occurrence of this result would involve no impossibility. Hence whenever a body is by nature divisible through and through, whether by bisection, or generally by any method whatever nothing impossible will have resulted if it has actually been divided—for if it has been divided into innumerable parts, themselves divided innumerable times, nothing impossible will have resulted, though perhaps nobody in fact could so divide it.

Since, therefore, the body is divisible through and through, let it have been divided. What, then, will remain? A magnitude? No: that is impossible, since then there will be something not divided, whereas *ex hypothesi* the body was divisible *through and through*. But if it be admitted that neither a body nor a magnitude will remain, and yet division is to take place, the body will *either* consist of points (and its constituents will be without magnitude) *or* it will be absolutely nothing. If the latter, then it might both come-to-be out of nothing and exist as a composite of nothing; and thus presumably the whole body will be nothing but an appearance. But if it consists of points, it will not possess any magnitude. For when the points were in contact and coincided to form a single magnitude, they did not make the whole any bigger (since, when the body was divided into two or more parts, the whole was not a bit smaller or bigger than it was before the division); hence, even if all the points be put together, they will not make any magnitude.

But suppose that, as the body is being divided, something like sawdust is
316b1 produced, and that in this sense a body comes away from the magnitude, even then the same argument applies. For in what sense is that divisible? But if what came away was not a body but a separable form or affection, and if the magnitude *is* points or contacts thus qualified, it is absurd that a magnitude should consist of things which are not magnitudes. Moreover, *where* will the points be? And are they motionless or moving? And every contact is always a contact of two somethings, i.e. there is always something besides the contact or the division or the point.

These, then, are the difficulties resulting from the supposition that any and every body, whatever its size, is divisible through and through. There is, besides, this further consideration. If, having divided a piece of wood or anything else, I put it together, it is again equal to what it was, and is one. Clearly this is so, whatever the point at which I cut the wood. The wood, therefore, has been divided *potentially* through and through. What, then, is there in the wood besides the division? For even if we suppose there is some affection, yet how is the wood dissolved into such constituents and how does it come-to-be out of them? Or how are such constituents separated?

Since, therefore, it is impossible for magnitudes to consist of contacts or points, there must be indivisible bodies and magnitudes. Yet, if we *do* postulate the latter, we are confronted with equally impossible consequences, which we have examined in other works. But we must try to disentangle these perplexities, and must therefore formulate the whole problem over again.

On the one hand, then, it is in no way absurd that every perceptible body should be indivisible as well as divisible at any and every point. For the second predicate will attach to it *potentially*, but the first *actually*. On the other hand, it would seem to be impossible for a body to be potentially divisible at all points simultaneously. For if it were possible, then it might actually occur, with the result, not that the body would simultaneously be actually *both* (indivisible and divided), but that it would be simultaneously divided at any and every point. Consequently, nothing will remain and the body will have passed-away into what is incorporeal; and so it might come-to-be again either out of points or absolutely out of nothing. And how is that possible?

But now it is obvious that a body is in fact divided into separable magnitudes which are smaller at each division—into magnitudes which fall apart from one another and are actually separated. Hence the process of dividing a body part by part is not a breaking up which could continue *ad infinitum;* nor can a body be simultaneously divided at every point (for that is not possible) but only up to a certain limit. The necessary consequence—especially if coming-to-be and passing-away are to take place by association and dissociation respectively—is that a body must contain atomic magnitudes which are invisible.

Such is the argument which is believed to establish the necessity of atomic 317a1
magnitudes: we must now show that it conceals a faulty inference, and exactly where it conceals it.

For, since no point is contiguous to another point, magnitudes are divisible through and through in one sense, and yet not in another. When, however, it is admitted that a magnitude is divisible through and through, it is thought that there is a point not only anywhere, but also everywhere, in it: hence it follows that the magnitude must be divided away into nothing. For there is a point everywhere within it, so that it consists either of contacts or of points. But it is only *in one sense* that the magnitude is divisible through and through, viz. in so far as there is one point *anywhere* within it and all its points are *everywhere* within it if you take them singly. But there are not more points than one *anywhere* within it, for the points are not consecutive; hence it is not divisible through and through. For if it were, then, if it be divisible at its centre, it will be divisible also at a contiguous point. But it is not so divisible; for position is not contiguous to position, nor point to point (i.e. division or composition).

Hence there are both association and dissociation, though neither into, and out of, atomic magnitudes (for that involves many impossibilities), nor so that division takes place through and through—for this would have resulted if point had been contiguous to point; but dissociation takes place into small (i.e. relatively small) parts, and association takes place out of relatively small parts.

It is wrong, however, to suppose, as some assert, that coming-to-be in the unqualified and complete sense is defined by association and dissociation, while the change that takes place in what is continuous is alteration. On the contrary, this is where the whole error lies. For unqualified coming-to-be and passing-away are not effected by association and dissociation. They take place when a thing changes, from *this* to *that*, as a whole. But they suppose that all such change is alteration; whereas in fact there is a difference. For in that which underlies the change there is a factor corresponding to the definition and there is a material factor. When, then, the change is in these factors, there will be coming-to-be or passing-away; but when it is in the thing's affections and accidental, there will be alteration.

Dissociation and association make a thing susceptible to passing-away. For if water has first been dissociated into smallish drops, air comes-to-be out of it more quickly; while, if drops of water have first been associated, air comes-to-be more slowly. This will become clearer in the sequel. Meantime, so much may be taken as established—viz. that coming-to-be cannot be association of the kind some assert it to be.

3 · Now that we have established that we must first consider whether there is anything which comes-to-be and passes-away in the unqualified sense; or whether nothing comes-to-be in this strict sense, but everything always comes-to-be *something* and *out of something*—I mean, e.g., comes-to-be healthy out of being ill and ill out of being healthy, comes-to-be small out of being big and big out of being
317b1 small, and so on in every other instance. For if there is to be coming-to-be without qualification, something must—without qualification—come-to-be out of not-being, so that it would be true to say that not-being is an attribute of some things. For *qualified* coming-to-be is a process out of *qualified* not-being (e.g. out of not-white or not-beautiful), but *unqualified* coming-to-be is a process out of *unqualified* not being.

Now 'unqualified' means either the primary within each category, or the universal, i.e. the all-comprehensive. Hence, if it signifies the primary, there will be a coming-to-be of a substance out of not-substance. But that which is not a substance or a 'this' clearly cannot possess predicates drawn from any of the other categories either—e.g. we cannot attribute to it any quality, quantity, or position. Otherwise, properties would admit of existence in separation from substances. If, on the other hand, it means what is not in any sense at all, it will be a universal negation of all forms of being, so that what comes-to-be will have to come-to-be out of nothing.

Although we have rehearsed and settled these problems at greater length in another work,[3] we must mention them briefly here too.

In one sense things come-to-be out of that which has no being without qualification; yet in another sense they come-to-be always out of what is. For there must pre-exist something which *potentially* is, but *actually* is not; and this something is spoken of both as being and as not-being.

These distinctions may be taken as established; but even then it is extraordinarily difficult to see how there can be unqualified coming-to-be (whether we suppose it to occur out of what potentially is, or in some other way), and we must recall this problem for further examination. For the question might be

[3] See *Physics* I 6–9.

raised whether substance (i.e. the 'this') comes-to-be at all. Is it not rather the 'such', the 'so great', or the 'somewhere', which comes-to-be? And the same question might be raised about 'passing-away' also. For if a substantial thing comes-to-be, it is clear that there will be (not actually, but potentially) a substance, out of which its coming-to-be will proceed and into which the thing that is passing-away will necessarily change. Then will any predicate belonging to the remaining categories attach *actually* to this? In other words, will that which is only potentially a 'this' (which only potentially *is*), while without qualification it is not a 'this' (i.e. *is not*), possess, e.g., any determinate size or quality or position? For if it possesses none, but all of them potentially, the result is that a being, which is not a determinate being, is capable of separate existence; and *in addition* that coming-to-be proceeds out of nothing pre-existing—a thesis which, more than any other, preoccupied and alarmed the earliest philosophers. On the other hand if, although it is not a 'this somewhat' or a substance, it is to possess some of the remaining determinations quoted above, then (as we said) properties will be separable from substances.

We must therefore concentrate all our powers on the discussion of these difficulties and on the solution of a further question—viz. What is the cause of the perpetuity of coming-to-be? Why is there always unqualified, as well as *partial,* coming-to-be?

Now the cause is either the source from which, as we say, the movement originates, or the matter. It is the material cause that we have here to state. For, as to the other cause, we have already explained (in our treatise on Motion)[4] that it involves something immovable through all time and something always being moved. And the treatment of the first of these—of the immovable source—belongs to the province of the other and prior philosophy; while as regards that which sets everything else in motion by being itself continuously moved, we shall have to explain later[5] which amongst the particular causes exhibits this character. But at present we are to state the cause classed under the head of matter, to which it is due that passing-away and coming-to-be never fail to occur in nature. For perhaps, if we succeed in clearing up this question, it will simultaneously become clear what account we ought to give of that which perplexed us just now, i.e. of *unqualified* passing-away and coming-to-be.

Our new question too—viz. What is the cause of the unbroken continuity of coming-to-be?—is sufficiently perplexing, if in fact what passes-away vanishes into what is not and what is not is nothing (since what is not is neither a thing, nor possessed of a quality or quantity, nor in any place). If, then, some one of the things which are is constantly disappearing, why has not the universe been used up long ago and vanished away—assuming of course that the material of all the several comings-to-be was finite? For, presumably, the unfailing continuity of coming-to-be cannot be attributed to the infinity of the material. That is impossible; for nothing is *actually* infinite, and potentially things are infinite by way of division; so

[4]See *Physics* 258^{b}10ff.
[5]Below, II 10.

that we should have to suppose there is only one kind of coming-to-be, viz. one which never fails, such that what comes-to-be is on each successive occasion smaller than before. But in fact this is not what we see occurring.

Why, then, is this form of change necessarily ceaseless? Is it because the passing-away of *this* is a coming-to-be of *something else*, and the coming-to-be of *this* a passing-away of *something else*?

The cause implied in this solution must be considered adequate to account for coming-to-be and passing-away in their general character as they occur in all existing things alike. Yet, if the same process is a coming-to-be of *this* but a passing-away of *that*, and a passing-away of *this* but a coming-to-be of *that*, why are some things said to come-to-be and pass-away without qualification, but others only with a qualification?

This question must be investigated once more, for it demands some explanation. For we say 'it is now passing-away' without qualification, and not merely '*this* is passing-away'; and we call *this* change coming-to-be, and *that* passing-away, without qualification. And so-and-so comes-to-be something, but does not come-to-be without qualification; for we say that the student comes-to-be learned, not comes-to-be without qualification.

318b1 Now we often divide terms into those which signify a 'this somewhat' and those which do not. And the issue we are investigating results from this; for it makes a difference *into what* the changing thing changes. Perhaps, e.g., the passage into Fire is coming-to-be *unqualified*, but passing-away-of something (e.g. of Earth); whilst the coming-to-be of Earth is *qualified* (not *unqualified*) coming-to-be, though *unqualified* passing-away (e.g. of Fire). This would be the case on the theory set forth by Parmenides; for he says that the things into which change takes place are two, and he asserts that these two, viz. *what is* and *what is not*, are Fire and Earth. Whether we postulate these, or other things of a similar kind, makes no difference. For we are trying to discover not what undergoes these changes, but what is their characteristic manner. The passage, then, into what without qualification is not is unqualified passing-away, while the passage into what is without qualification is unqualified coming-to-be. Hence however they are characterized—whether as Fire and Earth, or as some other couple—the one of them will be a being and the other a not-being.

We have thus stated one way in which *unqualified* will be distinguished from *qualified* coming-to-be and passing-away; but they are also distinguished according to the material of the changing thing. For a material, whose constitutive differences signify more a 'this somewhat', is itself more a substance while a material, whose constitutive differences signify privation, is more not-being. (Suppose, e.g., that the hot is a positive predication, i.e. a form, whereas cold is a privation, and that Earth and Fire differ from one another by these constitutive differences.)

The opinion, however, which most people are inclined to prefer, is that the distinction depends upon the difference between the perceptible and the imperceptible. Thus, when there is a change into perceptible material, people say there is coming-to-be; but when there is a change into invisible material, they call it passing-away. For they distinguish what is and what is not by their perceiving and not perceiving, just as what is knowable is and what is unknowable is not—perception on their view having the force of knowledge. Hence, just as they deem themselves to live and to be in virtue of their perceiving or their capacity to perceive, so too they deem the things to be *qua* perceived or perceptible—and in this they are in a sense on the track of the truth, though what they actually say is not true.

Thus unqualified coming-to-be and passing-away turn out to be different according to common opinion from what they are in truth. For Wind and Air are in truth more a 'this somewhat' or a 'form' than Earth. But they are less real to perception—which explains why things are commonly said to 'pass-away' without qualification when they change into Wind and Air, and to 'come-to-be' when they change into what is tangible, i.e. into Earth.

We have now explained why there is unqualified coming-to-be (though it is a passing-away-of-something) and unqualified passing-away (though it is a coming-to-be-of-something). For this distinction depends upon a difference in the material—upon whether the material is or is not a substance, *or* upon whether it is more or less substantial, *or* upon whether the material out of which and into which the change occurs is more or less perceptible.

But why are some things said to come-to-be without qualification, and others only to come-to-be so-and-so, in cases different from the one we have been considering where two things come-to-be reciprocally out of one another? For at present we have explained no more than why, when two things change reciprocally into one another, we do not attribute coming-to-be and passing-away *uniformly* to them both, although every coming-to-be is a passing-away of something else and every passing-away some other thing's coming-to-be. But the question subsequently formulated involves a different problem—viz. why, although the learning thing is said to come-to-be learned but not to come-to-be without qualification, yet the growing thing *is* said to come-to-be.

The distinction here turns upon the difference of the Categories. For some things signify a *this somewhat,* others a *such,* and others a *so-much.* Those things, then, which do not signify substance, are not said to come-to-be without qualification, but only to come-to-be so-and-so. Nevertheless, in all changing things alike, we speak of coming-to-be when the thing comes-to-be something in *one* of the two columns—e.g. in substance, if it comes-to-be fire but not if it comes-to-be earth; and in quality, if it comes-to-be learned but not when it comes-to-be ignorant.

We have explained why some things come-to-be without qualification, but not others—both in general, and also when the changing things are substances; and we have stated that the *substratum* is the material cause of the continuous occurrence of coming-to-be, because it is such as to change from contrary to contrary and because, in substances, the coming-to-be of one thing is always a passing-away of another, and the passing-away of one thing is always another's coming-to-be. But there is no need even to discuss why coming-to-be continues though things are constantly being destroyed. For just as people speak of a passing-away without qualification when a thing has passed into what is imperceptible and what is not, so also they speak of a coming-to-be out of a not-being when a thing emerges from an imperceptible. Whether, therefore, the *substratum* is or is not something, what comes-to-be emerges out of a not-being; so that a thing comes-to-be out of a not-being just as much as passes-away into what is not. Hence it is reasonable enough that coming-to-be should never fail. For coming-to-be is a passing-away of what is not and passing-away is a coming-to-be of what is not.

But what about that which without qualification is not? Is it one of the two contrary poles of the change—e.g. is earth (i.e. the heavy) a not-being, but fire (i.e. the light) a being? Or, on the contrary, does what is include earth as well as fire, whereas what is not is matter—the matter of earth and fire alike? And again, is the matter of each different? Or is it the same, since otherwise they would not come-to-be reciprocally out of one another, i.e. contraries out of contraries? For these things—fire, earth, water, air—are characterized by the contraries.

4 · Perhaps the solution is that their matter is in one sense the same, but in another sense different. For that which underlies them, whatever its nature may be is the same; but its being is not the same. So much, then, on these topics. Next we must state what the difference is between coming-to-be and alteration—for we maintain that these changes are distinct from one another.

Since, then, we must distinguish the *substratum,* and the property whose nature it is to be predicated of the *substratum;* and since change of each of these occurs; there is alteration when the *substratum* is perceptible and persists, but changes in its own properties, the properties in question being either contraries or intermediates. The body, e.g., although persisting as the same body, is now healthy and now ill; and the bronze is now spherical and at another time angular, and yet remains the same bronze. But when nothing perceptible persists in its identity as a *substratum,* and the thing changes as a whole (when e.g. the seed as a whole is converted into blood, or water into air, or air as a whole into water), such an occurrence is a coming-to-be of one substance and a passing-away of the other—especially if the change proceeds from an imperceptible something to something perceptible (either to touch or to all the senses), as when water comes-to-be out of, or passes-away into, air; for air is pretty well imperceptible. If, however, in such cases, any property (being one of a pair of contraries) persists, in the thing that has come-to-be, the same as it was in the thing which has passed-away—if, e.g., when water comes-to-be out of air, both are transparent or cold—the *second* thing, into which the *first* changes, must not be a property of this. Otherwise the change will be alteration.

Suppose, e.g., that *the musical man* passed-away and *an unmusical man* came-to-be, and that *the man* persists as something identical. Now, if musicalness (and unmusicalness) had not been in itself a property of the man, these changes would have been a coming-to-be of unmusicalness and a passing-away of musicalness; but in fact a property of the persistent thing. (Hence these are properties of the man, and of *musical man* and *unmusical man,* there is a passing-away and a coming-to-be.) Consequently such changes are alteration.

When the change from contrary to contrary is *in quantity,* it is growth and diminution; when it is *in place,* it is locomotion; when it is in property, i.e. *in quality,* it is alteration; but when nothing persists of which the resultant is a property (or an 320a1 accident in any sense of the term), it is coming-to-be, and the converse change is passing-away.

5 · Matter, in the most proper sense of the term, is to be identified with the *substratum* which is receptive of coming-to-be and passing-away; but the *substratum* of the remaining kinds of change is also, in a certain sense, matter, because all these *substrata* are receptive of contrarieties of some kind. So much, then, as an answer to the questions whether coming-to-be occurs or not, and how it occurs, and what alteration is; but we have still to treat of growth. We must explain wherein growth differs from coming-to-be and from alteration, and what is the process of growing and the process of diminishing in each and all of the things that grow and diminish.

Hence our first question is this: Do these changes differ from one another solely because of a difference in their respective spheres? In other words, do they differ because, while a change from *this* to *that* (viz. from potential *substance* to actual *substance*) is coming-to-be, a change in the sphere of *magnitude* is growth and one in the sphere of *quality* is alteration—both growth and alteration being changes from what is potentially to what is actually? Or is there also a difference in the manner of the change, since it is evident that, whereas neither what is altering nor what is coming-to-be necessarily changes its place, what is growing or diminishing does, though in a different manner from that in which the moving thing does? For that which is being moved changes its place as a whole; but the growing thing changes its place like a metal that is being beaten, retaining its position as a whole while its parts change their places. (But not in the same way as the parts of a sphere; for they change their places while the whole continues to occupy an equal place, but the parts of the growing thing change over an ever-increasing place and the parts of the diminishing thing over an ever-diminishing area.)

It is clear, then, that these changes—the changes of that which is coming-to-be, of that which is altering, and of that which is growing—differ *in manner* as well as *in sphere*. But how are we to conceive the sphere of the change which is growth and diminution? The sphere of growing and diminishing is believed to be magnitude. Are we to suppose that body and magnitude come-to-be out of something which, though potentially magnitude and body, is actually incorporeal and devoid of magnitude? And since this description may be understood in two different ways, in which of these two ways are we to apply it to the process of growth? Is the matter, out of which growth takes place, separate and existing alone by itself, or contained in another body?

Perhaps it is impossible for growth to take place in either of these ways. For since the matter is separate, either it will occupy no place (as if it were a point), or it 320b1 will be a void, i.e. a non-perceptible body. But the first of these is impossible, and in the second the matter must be *in* something. For since what comes-to-be out of it will always be somewhere, it too must be somewhere—either intrinsically or indirectly. But if it is to be in something and yet remains separate in such a way that it is in no sense a part of that body (neither intrinsically nor accidentally, many impossibilities will result. It is as if we were to suppose that when, e.g., air comes-to-be out of water the process were due not to a change of the water, but to the matter of the air being contained in the water as in a vessel. For there is nothing to prevent an indeterminate number of matters being thus contained in the water, so that they might come-to-be actually; and we do not in fact see air coming-to-be out of water in this fashion, viz. withdrawing out of it and leaving it to persist.

It is therefore better to suppose that in all instances of coming-to-be the matter is inseparable, being numerically identical and one, though not one in definition. But the same reasons also forbid us to regard the matter of the body as points or lines. The matter is that of which points and lines are limits, and it is something that can never exist without quality and without form.

Now it is no doubt true, as we have also established elsewhere, that one thing comes-to-be (in the unqualified sense) out of another thing; and further it is true that the efficient cause of its coming-to-be is either an actual thing (which is the same as the effect either *generically* or *specifically,* as e.g. fire is the efficient cause of fire or one man of another), or an actuality (for what is hard does not come-to-be through what is hard).[6] Nevertheless, since there is also a matter out of which corporeal substance itself comes-to-be (corporeal substance, however, already characterized as such-and-such a determinate body, for there is no such thing as body in general), this same matter is also the matter of magnitude and quality—being separable from these matters in definition, but not separable in place unless qualities are, in their turn, separable.

It is evident, from the preceding discussion of difficulties, that growth is not a change out of something which, though potentially a magnitude, actually possesses no magnitude. For, if it were, the void would exist in separation; but we have explained in a former work[7] that this is impossible. Moreover, a change of that kind is not peculiarly distinctive of growth, but characterizes coming-to-be in general. For growth is an increase, and diminution is a lessening, of the magnitude which is there already—that, indeed, is why the growing thing must possess some magnitude. Hence growth must not be regarded as a process from a matter without magnitude to an actuality of magnitude; for this would be a body's coming-to-be rather than its growth.

We must therefore come to closer quarters and as it were grapple with our
321a1 enquiry from its beginning to determine the precise character of the growing and diminishing whose causes we are investigating.

It is evident that any and every part of the growing thing has increased, and that similarly in diminution every part has become smaller; also that a thing grows by the accession, and diminishes by the departure, of something. Hence it must grow by the accession either of something incorporeal or of a body. Now, if it grows by the accession of something incorporeal, there will exist *separate* a void; but (as we have stated before) it is impossible for *a matter of magnitude* to exist separate. If, on the other hand, it grows by the accession of a body, there will be two

[6] Joachim excises the parenthetical sentence. (In the Oxford Translation he preferred to transpose it to follow '. . . either *generically*' in line 19.)

[7] See *Physics* IV 6–9.

bodies—that which grows and that which increases it—in the same place; and this too is impossible.

But neither is it open to us to say that growth or diminution occurs in the way in which e.g. air is generated from water. For, although the volume has then become greater, the change will not be growth, but a coming-to-be of the one—viz. of that into which the change is taking place—and a passing-away of the contrasted body. It is not a *growth* of either. Nothing grows in the process; unless indeed there be something common to both things (to that which is coming-to-be and to that which passed-away), e.g. body, and this grows. The water has not grown, nor has the air; but the former has passed-away and the latter has come-to-be, and—if anything has grown—there has been a growth of body. Yet this too is impossible. For our account of growth must preserve the characteristics of that which is growing and diminishing. And these characteristics are three: any and every part of the growing magnitude is made bigger (e.g. if flesh grows, every particle of the flesh gets bigger); by the accession of something; and thirdly in such a way that the growing thing is preserved and persists. For whereas a thing does not persist in the processes of unqualified coming-to-be or passing-away, that which grows or alters persists in its identity through the altering and through the growing or diminishing, though the quality (in alteration) and the size (in growth) do not remain the same. Now if the generation of air from water is to be regarded as growth, a thing might grow without the accession (and without the persistence) of anything, and diminish without the departure of anything—and that which grows need not persist. But this characteristic must be preserved; for the growth we are discussing has been assumed to be thus characterized.

One might raise a further difficulty. What is that which grows? Is it that to which something is added? If, e.g., a man grows in his shin, is it the shin which is greater—but not that whereby he grows, viz. not the food? Then why have not both grown? For when A is added to B, both A and B are greater, as when you mix wine with water; for each ingredient is alike increased in volume. Perhaps the explanation is that the substance of the one remains unchanged, but the substance of the other (viz. of the food) does not. For indeed, even in the mixture of wine and water, it is the prevailing ingredient which is said to have increased in volume. We say, e.g., that the wine has increased, because the whole mixture acts as wine but not as 321b1
water. A similar principle applies also to alteration. Flesh is said to have been altered if, while its character and essence remain, some property which was not there before, now qualifies it in its own right; on the other hand, that whereby it has been altered may have undergone no change, though sometimes it too has been affected. The altering agent, however, and the source of the process are in the growing thing and in that which is being altered; for the mover is in these. No doubt what has come in, may sometimes expand as well as the body that has consumed it (that is so, e.g., if, after having come in, it is converted into wind), but when it has undergone this change it has passed-away; and the mover is not in it.

We have now developed the difficulties sufficiently and must therefore try to find a solution of the problem while preserving the theses that the growing thing persists, that it grows by the accession (and diminishes by the departure) of something, further that every perceptible particle of it has become either larger or smaller, the growing body is not void and that yet there are not two magnitudes in the same place, and that it does not grow by the accession of something incorporeal.

We must grasp the cause after previously determining, first, that the non-homoeomerous parts grow by the growth of the homoeomerous parts (for every organ is composed of these); and secondly, that flesh, bone, and every such part—like every other thing which has its form in matter—has a twofold nature; for the form as well as the matter is called flesh or bone.

Now, that any and every part should grow—and grow by the accession of something—is possible in respect of form, but not in respect of matter. For we must think of the process as being like what happens when a man measures water with the same measure; for what comes-to-be is always different. And it is in this sense that the matter of the flesh grows, some flowing out and some flowing in; not in the sense that fresh matter accedes to every particle of it. There is, however, an accession to every part of its figure or form.

That growth has taken place proportionally, is more manifest in the non-homoeomerous parts—e.g. in the hand. For *there* the fact that the matter is distinct from the form is more manifest than in flesh and the homoeomeries. That is why there is a greater tendency to suppose that a corpse still possesses flesh and bone than that it still has a hand or an arm.

Hence in one sense it is true that any and every part of the flesh has grown; but in another sense it is false. For there has been an accession to every part of the flesh in respect to its form, but not in respect to its matter. The whole, however, has become larger because of the accession of something, which is called food and is contrary to flesh, and the transformation of this food into the same form as that of flesh—as if, e.g., moist were to accede to dry and, having acceded, were to be transformed and to become dry. For in one sense like grows by like, but in another sense by unlike.

One might discuss what must be the character of that whereby a thing grows. Clearly it must be potentially that which is growing—potentially flesh, e.g., if it is flesh that is growing. Actually, therefore, it must be other than the growing thing. This, then, has passed-away and come-to-be flesh. But it has not been transformed into flesh alone by itself (for that would have been a coming-to-be, not a growth); rather, the growing thing has done so *by* the food. In what way, then, has the food been modified by the growing thing? Perhaps we should say that it has been mixed with it, as if one were to pour water into wine and the wine were able to convert the new ingredient into wine. And as fire lays hold of the inflammable, so the active principle of growth, dwelling in the growing thing (i.e. in that which is actually flesh), lays hold of an acceding food which is potentially flesh and converts it into actual flesh. The acceding food, therefore, must be *together with* the growing thing; for if it were apart from it, the change would be a coming-to-be. For it is possible to produce fire by piling logs on to the already burning fire. That is growth. But when the logs themselves are set on fire, that is coming-to-be.

Quantity in general does not come-to-be any more than animal which is neither man nor any other of the specific forms of animal—the universal in this case corresponds to the quantity in that. But what does come-to-be in growth is flesh or bone—or a hand or arm and their homoeomeries. Such things come-to-be, then, by the accession not of a quantity of flesh but of a quantity of something. In so far as this acceding food is potentially the double result—e.g. is potentially a quantity of flesh—it produces growth; for it is bound to become actually both *a quantity* and *flesh*. But in so far as it is potentially flesh only, it nourishes; for it is thus that nutrition and growth differ by their definition. That is why a body's nutrition continues so long as it is kept alive (even when it is diminishing), though not its growth; and why nutrition, though the same as growth, is yet different from it in its being. For in so far as that which accedes is potentially a quantity of flesh it tends to increase flesh; whereas, in so far as it is potentially flesh only, it is nourishment.

The form is a kind of power in matter—a duct, as it were. If, then, a matter accedes which is potentially a duct and also potentially possesses determinate quantity, then these ducts will become bigger. But if it is no longer able to act just as water, continually mixed in greater and greater quantity with wine, in the end makes the wine watery and converts it into water—then it will cause a diminution of the *quantum;* though still the form persists.

6 · We must first investigate the *matter,* i.e. the so-called elements. We must ask whether they really are elements or not, i.e. whether each of them is eternal or whether there is a sense in which they come-to-be; and, if they do come-to-be, whether all of them come-to-be in the same manner, reciprocally out of one another, or whether one amongst them is something primary. Hence we must begin by explaining certain matters about which the statements now current are vague.

For all those who generate the elements as well as those who generate the bodies that are compounded of the elements—make use of dissociation and association, and of action and passion. Now association is combination; but the meaning of combining has not been clearly explained. Again, without an agent and a patient there cannot be altering any more than there can be dissociating and associating. For not only those who postulate a plurality of elements employ their reciprocal action and passion to generate the compounds: those who derive things from a single element are equally compelled to introduce acting. And in this respect Diogenes is right when he argues that unless all things were derived from one, reciprocal action and passion could not occur. The hot thing, e.g., would not be cooled and the cold thing in turn be warmed; for heat and cold do not change reciprocally into one another, but what changes (it is clear) is the *substratum.* Hence, whenever there is action and passion between things, that which underlies them must be a single something. No doubt, it is not true to say that *all* things are of this character; but it is true of all things between which there is reciprocal action and passion.

But if we must investigate action and passion and combination, we must also investigate contact. For action and passion (in the proper sense of the terms) can only occur between things which are such as to touch one another; nor can things enter into combination at all unless they have come into a certain kind of contact. Hence we must give a definite account of these three things—of contact, combination, and acting.

Let us start as follows. All things which admit of combination must be capable of reciprocal contact; and the same is true of any two things, of which one acts and the other suffers action in the proper sense of the terms. For this reason we must treat of contact first.

Now no doubt, just as every other name is used in many senses (in some cases homonymously, in others one use being derived from other and prior uses), so too is it with contact. Nevertheless contact *in the proper sense* applies only to things which have position. And position belongs only to those things which also have a place; for in so far as we attribute contact to the mathematical things, we must also attribute place to them, whether they exist in separation or in some other fashion. Assuming, therefore, that to touch is—as we have defined it in a previous work[8]—to have the extremes together, only those things will touch one another which, being separate magnitudes and possessing position, have their extremes together. And since position belongs only to those things which also have a place, while the primary differentiation of place is the above and the below (and the similar pairs of opposites), all things which touch one another will have weight or lightness—*either* both these qualities *or* one or the other of them. But bodies which are heavy or light are such as to act and suffer action. Hence it is clear that those things are by nature such as to touch one another, which (being separate magnitudes) have their extremes together and are able to move, and be moved by, one another.

The manner in which the mover moves the moved is not always the same: whereas one kind of mover can only impart motion by being itself moved, another kind can do so though remaining itself unmoved. Clearly therefore we must recognize a corresponding variety in speaking of the acting thing too; for the mover is said to act and the acting thing to impart motion. Nevertheless there is a difference and we must draw a distinction. For not every mover can act, if we are to contrast agent with patient and patient is to be applied only to those things whose motion is a quality—i.e. a quality, like white or hot, in respect to which they are altered: on the contrary, moving is wider than acting. Still, so much, at any rate, is clear: the things which are such as to impart motion in one sense will touch the things which are such as to be moved by them, but in another sense they will not. But the definition of touching in general applies to things which, having position, are such that one is able to impart motion and the other to be moved, while reciprocal touching holds between two things, one able to impart motion and the other able to be moved in such a way that action and passion are predicable of them.

As a rule, no doubt, if A touches B, B touches A. For indeed practically all the movers within our ordinary experience impart motion by being moved: in their case, what touches must, and evidently does, touch something which touches it. Yet it is possible—as we sometimes say—for the mover merely to touch the moved, and that which touches need not touch a thing which touches it. Nevertheless it is commonly supposed that touching must be reciprocal, because movers which belong to the same kind as the moved impart motion by being moved. Hence if anything imparts motion without itself being moved, it may touch the moved and yet itself be

[8]See *Physics* 226b21-3.

touched by nothing—for we say sometimes that the man who grieves us touches us, but not that we touch him.

7 · The account just given may serve to define the contact which occurs in 323b1
the things of nature. Next in order we must discuss action and passion. Our predecessors' theories on the subject are conflicting. For most thinkers are unanimous in maintaining that like is always unaffected by like, because (as they argue) neither is more apt than the other either to act or to suffer action, since all the properties which belong to the one belong identically and in the same degree to the other; and that unlikes, i.e. differents, are by nature such as to act and suffer action reciprocally. For even when the smaller fire is destroyed by the greater, it suffers this effect (they say) owing to its contrariety—since the great is contrary to the small. But Democritus dissented from all the other thinkers and maintained a theory peculiar to himself. He asserts that agent and patient are identical, i.e. like. It is not possible (he says) that others, i.e. differents, should suffer action from one another: on the contrary, even if two things, being others, do act in some way on one another, this happens to them not *qua* others but *qua* possessing an identical property.

Such, then, are the views, and it looks as if the statements of their advocates were in manifest conflict. But the reason of this conflict is that each group is in fact stating *a part,* whereas they ought to have taken a view of the subject *as a whole.* For if two things are like—absolutely and in all respects without difference from one another—it is reasonable to infer that neither is in any way affected by the other. Why, indeed, should the one of them tend to act any more than the other? Moreover, if like can be affected by like, a thing can also be affected by itself; and yet if that were so—if like tended in fact to act *qua* like—there would be nothing indestructible or immovable, for everything would move itself. And the same consequence follows if the two things are absolutely other, i.e. in no respect identical. Whiteness could not be affected in any way by a line nor a line by whiteness—except perhaps accidentally, viz. if the line happened to be white or black; for unless two things either are, or are composed of, contraries, neither drives the other out of its natural condition. But since only those things which either involve a contrariety or are contraries—and not any things selected at random—are such as to suffer action and to act, agent and patient must be like (i.e. identical) in kind and yet unlike (i.e. contrary) in species. (For by nature body is affected by body, flavour by flavour, colour by colour, and so in general what belongs to any kind by a member of the same kind—the reason being that contraries are in every 324a1
case within a single identical kind, and it is contraries which reciprocally act and suffer action.) Hence agent and patient must be in one sense identical, but in another sense other than (i.e. unlike) one another. And since patient and agent are generically identical (i.e. like) but specifically unlike, while it is contraries that exhibit this character: it is clear that contraries and their intermediates are such as to suffer action and to act reciprocally—for indeed it is these that constitute the entire sphere of passing-away and coming-to-be.

We can now understand why fire heats and the cold thing cools, and in general why the active thing assimilates to itself the patient. For agent and patient are contrary to one another, and coming-to-be is a process into the contrary: hence the patient *must* change into the agent, since it is only thus that coming-to-be will be a process into the contrary. And, again, it is intelligible that the advocates of both views, although their theories are not the same, are yet in contact with the nature of the facts. For sometimes we speak of the *substratum* as suffering action (e.g. of the man as being healed, being warmed and chilled, and similarly in all the other cases), but at other times we say what is cold is being warmed, what is sick is being healed: and in both these ways of speaking we express the truth, since in one sense it is the matter, while in another sense it is the contrary, which suffers action. (We make the same distinction in speaking of the agent; for sometimes we say that the man, but at other times that what is hot, produces heat.) Now the one group of thinkers supposed that agent and patient must possess something identical because they fastened their attention on the matter; while the other group maintained the opposite because their attention was concentrated on the contraries.

We must conceive the same account to hold of action and passion as that which is true of being moved and imparting motion. For things are called movers in two ways. Both that which contains the origin of the motion is thought to impart motion (for the origin is first amongst the causes), and also that which is last in relation to the moved thing and to the coming-to-be. A similar distinction holds also of the agent; for we speak both of the doctor and of the wine as healing. Now, in motion, there is nothing to prevent *the first mover* being unmoved (indeed, as regards some this is actually necessary) although *the last mover* always imparts motion by being itself moved; and, in action, there is nothing to prevent *the first agent* being unaffected, while *the last agent* only acts by suffering action itself. For if things have not the same matter, the agent acts without being affected; thus the art of healing produces health without itself being acted upon in any way by that which is
324b1 being healed. But the food, in acting, is itself in some way acted upon: for, in acting, it is simultaneously heated or cooled or otherwise affected. Now the art of healing corresponds to an origin, while the food corresponds to the last (i.e. contiguous) mover.

Those active powers, then, whose forms are not embodied in matter, are unaffected; but those whose forms are in matter are such as to be affected in acting. For we maintain that one and the same matter is *equally*, so to say, the basis of either of the two opposed things—being as it were a kind; and that *that which can be hot* must be made hot, provided the heating agent is there, i.e. comes near. Hence (as we have said) some of the active powers are unaffected while others are such as to be affected; and what holds of motion is true also of the active powers. For as in motion the first mover is unmoved, so among the active powers the first agent is unaffected.

The active power is a cause in the sense of that from which the process originates; but the end, for the sake of which it takes place, is not active. (That is why *health* is not active, except metaphorically.) For when the agent is there, the patient *becomes* something; but when states are there, the patient no longer *becomes* but already *is*—and forms (i.e. ends) are a kind of state. As to the matter, it (*qua* matter) is passive. Now fire contains the hot embodied in matter; but a hot separate from matter (if such a thing existed) could not suffer any action. Perhaps, indeed, it is impossible that the hot should exist in separation from matter; but if there are any entities thus separable, what we are saying would be true of them.

We have thus explained what action and passion are, what things exhibit them, why they do so, and in what manner. We must go on to discuss how it is possible for action and passion to take place.

8 · Some philosophers think that the last agent—the agent in the strictest sense—enters in through certain pores, and so the patient suffers action. It is in this way, they assert, that we see and hear and exercise all our other senses. Moreover, according to them, things are seen through air and water and other transparent bodies, because such bodies possess pores, invisible indeed owing to their minuteness, but close-set and arranged in rows—the more transparent the body, the more so.

Such was the theory which some philosophers (including Empedocles) advanced in regard to the structure of certain bodies. They do not restrict it to the bodies which act and suffer action; but combination too, they say, takes place only between bodies whose pores are in reciprocal symmetry. The most systematic theory, however, and one that applied to all bodies, was advanced by Leucippus and Democritus: and, in maintaining it, they took as their starting-point what naturally comes first.

For some of the older philosophers thought that what is must of necessity be one and immovable. The void, they argue, is not; but unless there is a void with a separate being of its own, what is cannot be moved—nor again can it be many, since there is nothing to keep things apart. And they hold that the view that the universe is not continuous but consists of separate things in contact is no different from the view that there are many (and not one) and a void. For if it is divisible through and through, there is no one, and no many either, but the Whole is void; while to maintain that it is divisible at some points, but not at others, looks like an arbitrary fiction. For up to what limit is it divisible? And for what reason is part of the Whole indivisible, i.e. a *plenum*, and part divided? Further, they maintain, it is equally necessary to deny the existence of motion.

Arguing in this way, therefore, they were led to transcend sense-perception, and to disregard it on the ground that one ought to follow reason; and so they assert that the universe is one and immovable. Some of them add that it is infinite, since the limit (if it had one) would be a limit against the void.

There were, then, certain thinkers who, for the reasons we have stated, enunciated views of this kind about the truth . . . Moreover,[9] although these opinions appear to follow logically, yet to believe them seems next door to madness when one considers the facts. For indeed no lunatic seems to be so far out of his senses as to suppose that fire and ice are one: it is only between what *is* right, and what *seems* right from habit, that some people are mad enough to see no difference.

[9]'One or more arguments against the Eleatic theory appear to have dropped out' (Joachim).

Leucippus, however, thought he had a theory which harmonized with sense-perception and would not abolish either coming-to-be and passing-away or motion and the multiplicity of things. Making these concessions to the phenomena and conceding to the Monists that there could be no motion without a void, he states that void is not-being, and no part of what is is not-being; for what is in the strict sense of the term is an absolute *plenum*. This *plenum*, however, is not one: on the contrary, it is a many infinite in number and invisible owing to the minuteness of their bulk. The many move in the void (for there is a void); and by coming together they produce coming-to-be, while by separating they produce passing-away. Moreover, they act and suffer action wherever they chance to be in contact (for they are not thereby one), and they generate by being put together and becoming intertwined. From the genuinely one, on the other hand, there never could have come-to-be a multiplicity, nor from the genuinely many a one: that is impossible. But just as Empedocles and some of the other philosophers say that things suffer action through their pores, so all alteration and all passion take place in this way, breaking-up (i.e. passing-away) being affected by means of the void, and so too growth—solids creeping in to fill the void places.

Empedocles too is practically bound to adopt the same theory as Leucippus. For he must say that there are certain solids which, however, are indivisible—unless there are continuous pores all through the body. But this is impossible; for *then* there will be nothing solid beside the pores but all of it will be void. It is necessary, therefore, for his contiguous things to be indivisible, while the intervals between them—which he calls pores—must be void. But this is precisely Leucippus's theory of action and passion.

Such, approximately, are the accounts of the manner in which some things act while others suffer action. And as regards the Atomists, it is not only clear what their explanation is: it is also obvious that it stands in tolerable consistency with the assumptions they employ. But this is less clear in the case of the other thinkers. It is not clear, for instance, how, on the theory of Empedocles, there is to be passing-away as well as alteration. For the primary bodies of the Atomists—the primary constituents of which bodies are composed, and the ultimate elements into which they are dissolved—are indivisible, differing from one another only in figure. In the philosophy of Empedocles, on the other hand, it is evident that all the other bodies down to the elements have their coming-to-be and their passing-away; but it is not clear how the elements themselves, severally in their aggregated masses, come-to-be and pass-away. Nor is it possible for Empedocles to explain how they do so, since he does not assert that Fire too (and similarly every one of his other elements) possesses elementary constituents of itself, as Plato does in the *Timaeus*.[10] For Plato differs from Leucippus inasmuch as the indivisibles of Leucippus are solids, while those of Plato are planes, and are characterized by an infinite variety of figures, while the characterizing figures employed by Plato are limited in number—though *both* hold that the elements are indivisible and are determined by figures. Thus the comings-to-be and the dissociations result from the indivisibles *according to*

[10]See *Timaeus* 53Aff.

Leucippus through the void and through contact (for it is at the point of contact that each of the composite bodies is divisible), but *according to Plato* in virtue of contact alone, since he denies there is a void.

Now we have discussed indivisible planes in our earlier discussions.[11] But with regard to the assumption of indivisible solids, although we must not now enter upon a detailed study of its consequences, let us make a short digression.

They are committed to the view that every indivisible is incapable alike of being acted upon (for nothing can suffer action except through the void) and of producing a quality—no indivisible can be either hard or cold. Yet it is surely absurd that an exception is made of the hot—the hot being assigned as peculiar to the spherical figure; for, that being so, its contrary also (the cold) is bound to belong to another of the figures. If, however, these properties (heat and cold) do belong to the indivisibles, it is a further absurdity that they should not possess heaviness and lightness, and hardness and softness. And yet Democritus says that the more any indivisible exceeds, the heavier it is—so that clearly it will also be hotter. But if *that* is their character, it is impossible they should not be affected by one another: the slightly hot indivisible, e.g., will suffer action from one which far exceeds it in heat. Again, if any indivisible is hard, there must also be one which is soft; but the soft derives its very name from the fact that it suffers a certain action—for soft is that which yields to pressure. But further, not only is it absurd that no property except figure should belong to the indivisibles: it is also absurd that, if other properties do belong to them, one only of these additional properties should attach to each—e.g. that *this* indivisible should be cold and *that* indivisible hot. For, on that supposition, their nature would not even be uniform. And it is equally impossible that more than one of these additional properties should belong to the single indivisible. For, being *indivisible,* it will possess these properties in the same point—so that, if it suffers action by being chilled, it will also, *qua* chilled, act or suffer action in some other way. And the same line of argument applies to all the other properties too; for the difficulty we have just raised confronts all who advocate indivisibles (whether solids or planes), since their indivisibles cannot become either rarer or denser inasmuch as there is no void in them. It is a further absurdity that there should be small indivisibles, but not large ones. For it is in fact reasonable that larger bodies should be more liable to fracture than the small ones, since they (viz. the large bodies) are easily broken up because they collide with many other bodies. But why should indivisibility *as such* be the property of small, rather than of large, bodies? Again, is the nature of all those solids uniform, or do they differ from one another—as if, e.g., some of them were fiery, others earthy in their bulk? For if all of them are uniform in nature, what is it that separated one from another? Or why, when they come into contact, do they not coalesce into one, as drops of water run together when drop touches drop (for the two cases are precisely parallel)? On the other hand if they differ, how are they characterized? It is clear, too, that *these,* rather than the figures, ought to be postulated as principles and causes from which the phenomena result. Moreover, if they differed in nature, they would both act and suffer action on

[11] See esp. *On the Heavens* III 1.

coming into reciprocal contact. Again, what is it which sets them moving? For if their mover is other than themselves, they are such as to suffer action. If, on the other hand, each of them sets itself in motion, either it will be divisible (imparting motion here, being moved there), or contrary properties will attach to it in the same respect and its matter will be identical in potentiality as well as numerically identical.

As to the thinkers who explain modification of property through the movement in the pores, if this is supposed to occur notwithstanding the fact that the pores are filled their postulate of pores is superfluous. For if the whole body suffers action under these conditions, it would suffer action in the same way even if it had no pores but were just its own continuous self. Moreover, how can their account of vision through a *medium* be correct? It is impossible to penetrate the transparent bodies at their contacts or through their pores if every pore be full. For how will that differ from having no pores at all? The body will be uniformly full throughout. But, further, even if these passages, though they must *contain* bodies, are void, the same consequence will follow once more. And if they are too minute to admit any body, it is ridiculous to suppose there is a 'minute' void and yet to deny the existence of a big one of whatever size, or to imagine 'the void' means anything else than a body's place—whence it clearly follows that to every body there will correspond a void of equal bulk.

As a general criticism we must urge that to postulate pores is superfluous. For if the agent produces no effect by touching the patient, neither will it produce any by passing through its pores. On the other hand, if it acts by contact, then—even without pores—some things will suffer action and others will act, provided they are by nature adapted for reciprocal action and passion. Our arguments have shown that it is either false or futile to advocate pores in the sense in which some thinkers conceive them. But since bodies are divisible through and through the postulate of pores is ridiculous; for, *qua* divisible, a body can fall into separate parts.

9 · Let us explain the way in which things possess the power of generating, and of acting and suffering action; and let us start from the principle we have often enunciated. For, assuming, the distinction between that which is *potentially* and that which is *actually* such-and-such, it is the nature of the first, in so far as it is what it is, to suffer action *through and through,* not merely to be susceptible in some parts while insusceptible in others. But its susceptibility varies in degree, according as it is more or less such-and-such, and one would be more justified in speaking of pores in this connexion—just as in metals there are veins of susceptible stuff stretching continuously through the substance.

327a1 So long, indeed, as any body is naturally coherent and one, it is insusceptible. So, too, bodies are insusceptible so long as they are not in contact either with one another or with other bodies which are by nature such as to act and suffer action. (To illustrate my meaning: Fire heats not only when in contact, but also from a distance. For the fire heats the air, and the air—being by nature such as both to act and suffer action—heats the body.) But the supposition that a body suffers action in some parts, but not in others ⟨is only possible for those who hold an erroneous view concerning the divisibility of magnitudes. For us⟩[12] the following account results from the distinctions we established at the beginning. For if magnitudes are not divisible through and through—if, on the contrary, there are indivisible solids or planes—then indeed nothing would be susceptible through and through: but neither would anything be continuous. Since, however, this is false, i.e. since every body is divisible, there is no difference between having been divided into parts which remain in contact and being divisible. For if a body *can* be separated at the contacts (as some say), then, even though it has not yet been divided, it will be in a state of dividedness—for it *can* be divided, since nothing impossible results. And in general it is absurd that passion should occur in this manner *only,* viz. by the bodies being split. For this theory abolishes alteration; but we see the same body *liquid* at one time and *solid* at another, without losing its continuity. It has suffered this change not by division and composition, nor yet by 'turning' and 'intercontact' as Democritus asserts; for it has passed from the liquid to the solid state without any reordering or transposition in its nature. Nor are there contained within it those hard (i.e. congealed) particles indivisible in their bulk; on the contrary, it is liquid—and again, solid and congealed—uniformly all through. This theory, it must be added, makes growth and diminution impossible also. For if there is to be *apposition* (instead of the growing thing having changed as a whole, either by the admixture of something or by its own transformation), increase of size will not have resulted in any and every part.

So much, then, to establish that things generate and are generated, act and suffer action, reciprocally; and to distinguish the way in which these processes *can* occur from the (impossible) way in which some say they occur.

10 · But we have still to explain combination, for that was the third of the subjects we originally proposed to discuss. Our explanation will proceed on the same method as before. We must inquire: What is combination, and what is that which can combine? Of what things, and under what conditions, is combination a property? And, further, does combination exist in fact, or is it false to assert its existence?

For, according to some thinkers, it is impossible for one thing to be combined with another. They argue that if the combined constituents continue to exist and 327b1
are unaltered, they are no more combined now than they were before, but are in the same condition; while if *one* has been destroyed, the constituents have not been combined—on the contrary, one constituent *is* and the other *is not,* whereas combination demands uniformity of condition in them both; and on the same principle even if *both* the combining constituents have been destroyed as the result of their coalescence, *they* cannot be combined since *they* have no being at all.

What we have in this argument is, it would seem, a demand for the precise distinction of combination from coming-to-be and passing-away (for it is obvious that combination, if it exists, must differ from these processes) and for the precise distinction of the combinable from that which is such as to come-to-be and

[12] Joachim marks a lacuna in the Greek text after τῇ δὲ μή, line 6: the words within pointed brackets are his attempt to fill in the gap.

pass-away. As soon, therefore, as these distinctions are clear, the difficulties raised by the argument would be solved.

Now we do not speak of the wood as combined with the fire, nor of its burning as a combining either of its particles with one another or of itself with the fire: what we say is that the fire is coming-to-be, but the wood is passing-away. Similarly, we speak neither of the food as combining with the body, nor of the shape as combining with the wax and thus fashioning the lump. Nor can body combine with white, nor (to generalize) properties and states with things; for we see them persisting unaltered. But again white and knowledge cannot be combined either, nor anything else which is not separable. (Indeed, this is a blemish in the theory of those who assert that once all things were together and combined. For not everything can combine with everything. On the contrary, both of the constituents that are combined must originally have existed in separation; but no property can have separate existence.)

Since, however, some things *are potentially* while others *are actually,* the constituents can be in a sense and yet not-be. The compound may *be actually* other than the constituents from which it has resulted; nevertheless each of them may still *be potentially* what it was before they were combined, and both of them may survive undestroyed. (For this was the difficulty that emerged in the previous argument; and it is evident that the combining constituents not only coalesce, having formerly existed in separation, but also can again be separated out from the compound.) The constituents, therefore, neither *persist actually,* as body and white persist; nor are they *destroyed* (either one of them or both), for their potentiality is preserved. Hence these difficulties may be dismissed; but the problem immediately connected with them—whether combination is something relative to perception—must be set out and discussed.

When the combining constituents have been divided into parts so small, and have been juxtaposed in such a manner, that perception fails to discriminate them one from another, have they then been combined? Or is it rather when any and every part of one constituent is juxtaposed to a part of the other? The term, no doubt, is applied in the latter sense: we speak, e.g., of wheat having been combined with barley when each *grain* of the one is juxtaposed to a *grain* of the other. But every body is divisible and therefore, since body combined with body is uniform, *any and every part* of each constituent ought to be juxtaposed to a part of the other.

No body, however, can be divided into its least parts; and composition is not identical with combination, but other than it. Thus it is clear that so long as the constituents are preserved in small particles, we must not speak of them as combined. (For this will be a composition instead of a blending or combination; nor will the part exhibit the same ratio between its constituents as the whole. But we maintain that, if combination has taken place, the compound *must* be uniform—any part of such a compound being the same as the whole, just as any part of water is water; whereas, if combination is composition of the small particles, nothing of the kind will happen. On the contrary, the constituents will only be combined relatively to perception; and the same thing will be combined to one percipient, if his sight is not sharp—while to the eye of Lynceus nothing will be combined.) Clearly too we must not speak of the constituents as combined in virtue of a division such that *any and every part* of each is juxtaposed to a part of the other; for it is impossible for them to be thus divided. Either, then, there is no combination, or we have still to explain the manner in which it can take place.

Now, as we maintain, some things are such as to act and others such as to suffer action from them. Moreover, some things—viz. those which have the same matter—reciprocate, i.e. are such as to act upon one another and to suffer action from one another; while other things, viz. agents which have not the same matter as their patients, act without themselves suffering action. Such agents cannot combine—that is why neither the art of healing nor health produces health by combining with the bodies of the patients. Amongst those things, however, which are both active and passive, some are easily divisible. Now if a great quantity (or a large bulk) of one of these materials be brought together with a little (or with a small piece) of another, the effect produced is not combination, but increase of the dominant; for the other material is transformed into the dominant. (That is why a drop of wine does not combine with ten thousand gallons of water; for its form is dissolved, and it is changed so as to merge in the total volume of water.) On the other hand, when there is a certain equilibrium between their powers, then each of them changes out of its own nature towards the dominant; yet neither becomes the other, but both become an intermediate with properties common to both.

Thus it is clear that only those agents are combinable which involve a contrariety—for these are such as to suffer action reciprocally. And, further, they combine more freely if small pieces of each of them are juxtaposed. For in that condition they change one another more easily and more quickly; whereas this effect takes a long time when agent and patient are present in bulk.

Hence, amongst the divisible susceptible materials, those whose shape is 328b1
readily adaptable have a tendency to combine; for they are easily divided into small particles, since that is precisely what being readily adaptable in shape implies. For instance, liquids are the most combinable of all bodies—because, of all divisible materials, the liquid is most readily adaptable in shape, unless it be viscous. Viscous liquids, it is true, produce no effect except to increase the bulk. But when one of the constituents is alone susceptible—or superlatively susceptible, the other being susceptible in a very slight degree—the compound resulting from their combination is either no greater in volume or only a little greater. This is what happens when tin is combined with bronze. For some things display a hesitating and ambiguous attitude towards one another—showing a slight tendency to combine and also an inclination to behave as receptive matter and form. The behaviour of these metals is a case in point. For the tin almost vanishes, behaving as if it were an immaterial property of the bronze: having been combined, it disappears, leaving no trace except the colour it has imparted to the bronze. The same phenomenon occurs in other instances too.

It is clear, then, from the foregoing account, that combination occurs, what it is, to what it is due, and what kind of thing is combinable. The phenomenon depends upon the fact that some things are such as to be reciprocally susceptible and readily adaptable in shape, i.e. easily divisible. For such things can be combined without its being necessary *either* that they should have been destroyed *or* that they should survive absolutely unaltered; and their combination need not be a composition, nor merely relative to perception. On the contrary: anything is combinable which, being readily adaptable in shape, is such as to suffer action and to act; and it is combinable with another thing similarly characterized (for the combinable is relative to the combinable); and combination is unification of the combinables, resulting from their alteration.

BOOK II

1 · We have explained under what conditions combination, contact, and action and passion are attributable to the things which undergo natural change. Further, we have discussed unqualified coming-to-be and passing-away, and explained under what conditions they occur, in what subject, and owing to what cause. Similarly, we have also discussed alteration, and explained what altering is and how it differs from coming-to-be and passing-away. But we have still to investigate the so-called elements of bodies.

For coming-to-be and passing-away occur in naturally constituted substances only given the existence of sensible bodies. But as to the matter which underlies these perceptible bodies, some maintain it is single, supposing it to be, e.g., Air or Fire, or an intermediate between these two (but still a body with a separate existence). Others, on the contrary, postulate more than one—ascribing to their association and dissociation, or to their alteration, the coming-to-be and passing-away of things. (Some, for instance, postulate Fire and Earth; some add Air, making three; and some, like Empedocles, reckon Water as well, thus postulating four.)

Now we may agree that the primary materials, whose change (whether it be association and dissociation or a process of another kind) results in coming-to-be and passing-away, are rightly described as principles or elements. But those thinkers are in error who postulate, beside the bodies we have mentioned, a single matter—and that a corporeal and separable matter. For this body cannot possibly exist without a perceptible contrariety—this 'Boundless', which some thinkers identify with the principle, must be either light or heavy, either cold or hot. And what Plato has written in the *Timaeus*[13] is not based on any precisely-articulated conception. For he has not stated clearly whether his 'Omnirecipient' exists in separation from the elements; nor does he make any use of it. He says, indeed, that it is a *substratum* prior to the so-called elements—underlying them, as gold underlies the things that are fashioned of gold. (And yet this comparison, if thus expressed, is itself open to criticism. Things which come-to-be and pass-away cannot be called by the name of the material out of which they have come-to-be: it is only the results of alteration which retain the name. However, he actually says that

[13]See *Timaeus* 49Dff.

far the truest account is to affirm that each of them is gold.) Nevertheless he carries his analysis of the elements—solids though they are—back to planes, and it is impossible for 'the Nurse' (i.e. the primary matter) to be identical with the planes.

Our own doctrine is that although there is a matter of the perceptible bodies (a matter out of which the so-called elements come-to-be), it has no separate existence, but is always bound up with a contrariety. A more precise account of this has been given in another work;[14] we must, however, give a detailed explanation of the primary bodies as well, since they too are similarly derived from the matter. We must reckon as a principle and as primary the matter which underlies, though it is inseparable from, the contrary qualities; for the hot is not matter for the cold nor the cold for the hot, but the *substratum* is matter for them both. Thus as principles we have *firstly* that which is potentially perceptible body, *secondly* the contrarieties (I mean, e.g., heat and cold), and *thirdly* Fire, Water, and the like. For these bodies change into one another (they are not immutable as Empedocles and other thinkers 329b1
assert, since alteration would then have been impossible), whereas the contrarieties do not change.

Nevertheless, even so the question remains: What sorts of contrarieties, and how many of them, are to be accounted principles of body? For all the other thinkers assume and use them without explaining why they are *these* or why they are just *so many*.

2 · Since, then, we are looking for principles of perceptible body; and since perceptible is equivalent to tangible, and tangible is that of which the perception is touch, it is clear that not all the contrarieties constitute forms and principles of body, but only those which correspond to touch. For it is in accordance with a contrariety—a contrariety, moreover, of *tangible* qualities—that the primary bodies are differentiated. That is why neither whiteness and blackness, nor sweetness and bitterness, nor similarly any of the other perceptible contrarieties either, constitutes an element. And yet vision is prior to touch, so that its object also is prior. The object of vision, however, is a quality of tangible body not *qua* tangible, but *qua* something else—even if it *is* naturally prior.

Accordingly, we must segregate the tangible differences and contrarieties, and distinguish which amongst them are primary. Contrarieties correlative to touch are the following: hot-cold, dry-moist, heavy-light, hard-soft, viscous-brittle, rough-smooth, coarse-fine. Of these heavy and light are neither active nor susceptible. Things are not called heavy and light because they act upon, or suffer action from, other things. But the elements must be reciprocally active and susceptible, since they combine and are transformed into one another. On the other hand, hot and cold, and dry and moist, are terms, of which the first pair implies *power to act* and the second pair *susceptibility*. Hot is that which associates things of the same kind (for dissociating, which people attribute to Fire as its function, *is* associating things of the same class, since its effect is to eliminate what is foreign), while cold is that which brings together, i.e. associates, homogeneous and heterogeneous things alike.

[14]See *Physics* I 6–9.

And moist is that which, being readily adaptable in shape, is not determinable by any limit of its own; while dry is that which is readily determinable by its own limit, but not readily adaptable in shape.

From these are derived the fine and coarse, viscous and brittle, hard and soft, and the remaining differences. For since the moist has no determinate shape, but is readily adaptable and follows the outline of that which is in contact with it, it is 330a1 characteristic of it to be such as to fill up. Now the fine is such as to fill up. For the fine consists of subtle particles; but that which consists of small particles is such as to fill up, inasmuch as it is in contact whole with whole—and the fine exhibits this character in a superlative degree. Hence it is evident that the fine derives from the moist, while the coarse derives from the dry. Again the viscous derives from the moist; for the viscous (e.g. oil) is a moist thing modified in a certain way. The brittle, on the other hand, derives from the dry; for brittle is that which is *completely* dry—so completely, that it has actually solidified due to failure of moisture. Further the soft derives from the moist. For soft is that which yields by retiring into itself, though it does change position, as the moist does—which explains why the moist is not soft, although the soft derives from the moist. The hard, on the other hand, derives from the dry; for hard is that which is solidified, and the solidified is dry.

The terms 'dry' and 'moist' have more senses than one. For the damp, as well as the moist, is opposed to the dry: and again the solidified, as well as the dry, is opposed to the moist. But all these derive from the dry and moist we mentioned first. For the dry is opposed to the damp; and the damp is that which has foreign moisture on its surface (sodden being that which is penetrated to its core), while dry is that which has lost foreign moisture. Hence it is evident that the damp will derive from the moist, and the dry which is opposed to it will derive from the primary dry. Again the moist and the solidified derive in the same way from the primary pair. For moist is that which contains moisture *of its own* deep within it (sodden being that which contains *foreign* moisture), whereas solidified is that which has lost this inner moisture. Hence these too derive one from the dry and the other from the moist.

It is clear, then, that all the other differences reduce to the first four, but that these admit of no further reduction. For the hot is not *essentially* moist or dry, nor the moist *essentially* hot or cold; nor are the cold and the dry derivative forms, either of one another or of the hot and the moist. Hence these must be four.

3 · The elements are four, and any four terms can be combined in six couples. Contraries, however, refuse to be coupled; for it is impossible for the same thing to be hot and cold, or moist and dry. Hence it is evident that the couplings of the elements will be four: hot with dry and moist with hot, and again cold with dry 330b1 and cold with moist. And these four couples have attached themselves to the *apparently* simple bodies (Fire, Air, Water, and Earth) in a manner consonant with theory. For Fire is hot and dry, whereas Air is hot and moist (Air being a sort of vapour); and Water is cold and moist, while Earth is cold and dry. Thus the differences are reasonably distributed among the primary bodies, and the number of the latter is consonant with theory. For all who make the simple bodies elements

postulate either one, or two, or three, or four. Now those who assert there is *one* only, and then generate everything else by condensation and rarefaction, are in effect making their principles two, viz. the rare and the dense, or rather the hot and the cold; for it is these which are the moulding forces, while the one underlies them as matter. But those who postulate *two* from the start—as Parmenides postulated Fire and Earth—make the intermediates (e.g. Air and Water) blends of these. The same course is followed by those who advocate *three.* (We may compare what Plato does in the divisions[15]; for he makes 'the middle' a blend.) Indeed, there is practically no difference between those who postulate *two* and those who postulate *three,* except that the former split the middle element into two, while the latter treat it as only one. But some advocate *four* from the start, e.g. Empedocles; yet he too draws them together so as to reduce them to *the two,* for he opposes all the others to Fire.

In fact, however, fire and air, and each of the bodies we have mentioned, are not simple, but combined. The simple bodies are indeed similar in nature to them, but not identical with them. Thus the simple body corresponding to fire is fire-like, not fire; that which corresponds to air is air-like; and so on with the rest of them. But fire is an excess of heat, just as ice is an excess of cold. For freezing and boiling are excesses of cold and heat respectively. Assuming, therefore, that ice is a freezing of moist and cold, fire analogously will be a boiling of dry and hot—a fact which explains why nothing comes-to-be either out of ice or out of fire.

The simple bodies, since they are four, fall into two pairs which belong to the two regions, each to each; for Fire and Air are forms of the body moving towards the limit, while Earth and Water are forms of the body which moves towards the centre. Fire and Earth, moreover, are extremes and purest; Water and Air, on the contrary, are intermediates and more combined. And, further, the members of either pair are contrary to those of the other, Water being contrary to Fire and Earth to Air; for they are constituted from contrary qualities. Nevertheless, since they are four, each of them is characterized simply by a single quality: Earth by dry rather than by cold, Water by cold rather than by moist, Air by moist rather than by hot, and Fire by hot rather than by dry.

4 · It has been established before that the coming-to-be of the simple bodies is reciprocal. At the same time, it is manifest, on the evidence of perception, that they *do* come-to-be; for otherwise there would not have been alteration, since alteration is change in respect to the qualities of the objects of touch. Consequently, we must explain what is the manner of their reciprocal transformation, and whether every one of them can come-to-be out of every one—or whether some can do so, but not others.

Now it is evident that all of them are by nature such as to change into one another; for coming-to-be is a change into contraries and out of contraries, and the elements all involve a contrariety in their mutual relations because their distinctive qualities are contrary. For in some of them *both* qualities are contrary—e.g. in Fire

[15]The ancient commentators take Aristotle to be referring to Plato's 'unwritten doctrines'; Joachim thinks that the reference is to *Timaeus* 35Aff.

and Water, the first of these being dry and hot, and the second moist and cold; while in others *one* of the qualities is contrary—e.g. in Air and Water, the first being moist and hot, and the second moist and cold. It is evident, therefore, if we consider them in general, that every one is by nature such as to come-to-be out of every one; and when we come to consider them severally, it is not difficult to see the manner in which their transformation is effected. For, though all will result from all, both the speed and the facility of their conversion will differ in degree.

Thus the process of conversion will be quick between those which tally with one another, but slow between those which do not. The reason is that it is easier for a single thing to change than for many. Air, e.g., will result from Fire if a single quality changes; for Fire, as we saw, is hot and dry while Air is hot and moist, so that there will be Air if the dry be overcome by the moist. Again, Water will result from Air if the hot be overcome by the cold; for Air, as we saw, is hot and moist while Water is cold and moist, so that, if the hot changes, there will be Water. So too, in the same manner, Earth will result from Water and Fire from Earth, since both tally with both. For Water is moist and cold while Earth is cold and dry—so that, if the moist be overcome, there will be Earth; and again, since Fire is dry and
331b1 hot while Earth is cold and dry, Fire will result from Earth if the cold pass-away.

It is evident, therefore, that the coming-to-be of the simple bodies will be cyclical; and that this method of transformation is the easiest, because the *consecutive* elements tally. On the other hand the transformation of Fire into Water and of Air into Earth, and again of Water and Earth into Fire and Air, though possible, is more difficult because it involves the change of more qualities. For if Fire is to result from Water, both the cold and the moist must pass-away; and again, both the cold and the dry must pass-away if Air is to result from Earth. So, too, if Water and Earth are to result from Fire and Air—both must change.

This second method of coming-to-be, then, takes a longer time. But if one quality in each of two elements pass-away, the transformation, though easier, is not reciprocal. Still, from Fire and Water there will result Earth and Air, and from Air and Earth Fire and Water. For there will be Air, when the cold of the Water and the dry of the Fire have passed-away (since the hot of the latter and the moist of the former are left); whereas, when the hot of the Fire and the moist of the Water have passed-away, there will be Earth, owing to the survival of the dry of the Fire and the cold of the Water. So, too, in the same way, Fire and Water will result from Air and Earth. For there will be Water, when the hot of the Air and the dry of the Earth have passed-away (since the moist of the former and the cold of the latter are left); whereas, when the moist of the Air and the cold of the Earth have passed-away, there will be Fire, owing to the survival of the hot of the Air and the dry of the Earth—qualities constitutive of Fire. Moreover, this mode of Fire's coming-to-be is confirmed by perception. For flame is *par excellence* Fire; but flame is burning smoke, and smoke consists of Air and Earth.

No transformation, however, into any of the bodies can result from the passing-away of one quality in each of two elements when they are taken in their consecutive order, because either *identical* or *contrary* qualities are left—and from them no body can be formed. E.g. if the dry of Fire and the moist of Air were to pass-away, the hot is left in both; and if the hot pass-away out of both, the contraries—dry and moist—are left. A similar result will occur in all the others too; for all the *consecutive* bodies contain one identical and one contrary quality. Hence, too, it clearly follows that, when one is transformed into one, the coming-to-be is effected by the passing-away of a single quality; whereas, when two are transformed into a third, more than one quality must have passed-away.

5 · We have stated that all the bodies come-to-be out of any one of them; and we have explained the manner in which their mutual conversion takes place. Let us nevertheless supplement our theory by the following speculations concerning them.

If Water, Air, and the like are a matter of which the natural bodies consist, as some thinkers in fact believe, they must be either one, or two, or more. Now they cannot all of them be *one*—they cannot, e.g., all be Air or Water or Fire or Earth—because change is into contraries. For if they all were Air, then (assuming Air to persist) there will be alteration instead of coming-to-be. Besides, nobody supposes it to persist in such a way that it is Water as well as Air (or anything else) *at the same time*. So there will be a certain contrariety, i.e. a differentiating quality; and the other member of this contrariety, e.g. heat, will belong to Fire. But Fire will certainly not be 'hot Air'. For a change of that kind is alteration, and is not what is observed. Moreover if Air is again to result out of the Fire, it will do so by the conversion of the hot into its contrary; this contrary, therefore, will belong to Air, and Air will be a cold something; hence it is impossible for Fire to be hot Air, since in that case the same thing will be simultaneously hot and cold. Both Fire and Air, therefore, will be something else which is the same; i.e. there will be some other matter common to both.

The same argument applies to all, proving that there is no single one of them out of which they all originate. But neither is there anything else beside these four—something intermediate, e.g., between Air and Water (coarser than Air, but finer than Water), or between Air and Fire (coarser than Fire, but finer than Air). For the supposed intermediate will be Air and Fire when a pair of contrasted qualities is added to it; but, since one of every two contrary qualities is a privation, the intermediate never can exist—as some thinkers assert the 'Boundless' or the 'Environing' exists—in isolation. It is, therefore, indifferently any one of them, or else it is nothing.

Since, then, there is nothing *perceptible* prior to these, they must be all. That being so, either they must always persist and not be transformable into one another; or they must undergo transformation—either all of them, or some only (as Plato wrote in the *Timaeus*).[16] Now it has been proved before that they must undergo reciprocal transformation, and that the speed with which they come-to-be one out of another is not uniform—since the process of reciprocal transformation is relatively *quick* between those that tally, but relatively *slow* between those which do not.

[16]See *Timaeus* 54BD.

Assuming, then, that the contrariety, in respect to which they are transformed, is *one*, they must be two; for matter is the mean between the two contraries, and is imperceptible and inseparable. Since, however, the elements are seen to be more than two, the contrarieties must at the least be two. But the contrarieties being two, the elements must be four (as they evidently are) and cannot be three; for the couplings are four, since, though six are possible, the two in which the qualities are contrary to one another cannot occur.

These subjects have been discussed before; but the following arguments will make it clear that, since the elements are transformed into one another, it is impossible for any one of them—whether it be at the end or in the middle—to be a principle of the rest. There can be no such principle at the ends; for all of them would then be Fire or Earth, and this theory amounts to the assertion that all things are made of Fire or Earth. Nor can a middle element be such a principle—as some thinkers suppose that Air is transformed both into Fire and into Water, and Water both into Air and into Earth, while the end elements are not further transformed into one another. For the process must come to a stop, and cannot continue *ad infinitum* in a straight line in either direction, since otherwise an infinite number of contrarieties would attach to the single element. Let E stand for Earth, W for Water, A for Air, and F for Fire. Then since A is transformed into F and W, there will be a contrariety belonging to A and F. Let these contraries be whiteness and blackness. Again since A is transformed into W, there will be another contrariety; for W is not the same as F. Let this second contrariety be dryness and moistness, D being dryness and M moistness. Now if the white persists, Water will be moist and white; but if it does not persist, Water will be black, since change is into contraries. Water, therefore, must be either white or black. Let it then be the first. On similar grounds, therefore, D (dryness) will also belong to F. Consequently F (Fire) as well will be able to be transformed into Water; for it has qualities contrary to those of Water, since Fire was *first* taken to be black and *then* to be dry, while Water was moist and *then* showed itself white. Thus it is evident that all will be able to be transformed out of one another; and that, in the instances we have taken, E (Earth) also will contain the remaining two tallies, viz. the black and the moist (for these have not yet been coupled).

We have dealt with this last topic before the thesis we set out to prove. That thesis—viz. that the process cannot continue *ad infinitum*—will be clear from the following considerations. If Fire (which is represented by F) is not to revert, but is to be transformed in turn into some other element (e.g. into Q), a new contrariety, other than those mentioned, will belong to Fire and Q; for it has been assumed that Q is not the same as any of the four, E W A and F. Let K, then, belong to F and Y to Q. Then K will belong to all four, E W A and F; for they are transformed into one another. This last point, however, we may admit, has not yet been proved; but at any rate it is clear that if Q is to be transformed in turn into yet another element, yet another contrariety will belong not only to Q but also to F (Fire). And, similarly, every addition of a new element will carry with it the attachment of a new contrariety to the preceding elements. Consequently, if the elements are infinitely many, there will also belong *to the single element* an infinite number of contrarieties. But if that be so, it will be impossible to define any element; impossible also for any to come-to-be. For if one is to result from another, it will have to pass through so many contrarieties—and then more. Consequently into some elements transformation will never be effected—viz. if the intermediates are infinite in number, as they must be if the elements are infinitely many; further there will not even be a transformation of Air into Fire, if the contrarieties are infinitely many; moreover all the elements become one. For all the contrarieties of the elements above F must belong to those below F, and *vice versa*: hence they will all be one.

6 · As for those who agree with Empedocles that the elements of body are more than one, so that they are not transformed into one another—one may well wonder in what sense it is open to them to maintain that the elements are comparable. Yet Empedocles says 'For these are all equal . . .'[17]

If it is meant that they are comparable in their amount, all the comparables must possess an identical something whereby they are measured. If, e.g., one pint of Water yields ten of Air, both are measured by the same unit; and therefore both were from the first an identical something. On the other hand, suppose they are not comparable in their amount in the sense that so much of the one yields so much of the other, but comparable in power of action (a pint of Water, e.g., having a power of cooling equal to that of ten pints of Air); even so, they *are* comparable in their amount, though not *qua* amount but *qua* having power. Instead of comparing their powers by the measure of their amount, they might be compared as terms in an analogy: e.g., 'as x is hot, so y is white.' But 'as', though it means equality in quantity, means similarity in quality. Thus it is manifestly absurd that the bodies, though they are not transformable, are comparable not by analogy, but by a measure of their powers; i.e. that so much Fire is comparable with many times that amount of Air, as being equally or similarly hot. For the same thing, if it be greater in amount, will, since it belongs to the same kind, have its *ratio* correspondingly increased.

A further objection to the theory of Empedocles is that it makes *growth* impossible, unless it be increase by addition. For his Fire increases by Fire: 'And Earth increases its own frame and Ether increases Ether.'[18] These, however, are cases of addition; but it is not by addition that growing things are believed to increase. And it is far more difficult for him to account for the *coming-to-be* which occurs in nature. For the things which come-to-be by natural process all do so either always or for the most part in a given way; while any exceptions—any results which occur neither always nor for the most part—are products of chance and spontaneity. Then what is the cause determining that man comes-to-be from man, that wheat (instead of an olive) comes-to-be from wheat, either always or for the most part? Are we to say that bone comes-to-be if the elements be put together in

[17]Frag. 17, line 17, Diels-Kranz.
[18]Empedocles, frag. 37 Diels-Kranz.

such-and-such a manner? For, according to his own statements, nothing comes-to-be from their coming together as chance has it, but only from their coming together in a certain proportion. What, then, is the cause of this? Presumably not Fire or Earth. But neither is it Love and Strife; for the former is a cause of association only, and the latter only of dissociation. No: the cause in question is the substance of each thing—not merely (to quote his words) 'a combining and a divorce of what has been combined'. And *chance,* not *proportion,* 'is the name given to these occurrences;'[19] for things can be combined as chance has it.

The cause, therefore, of the things which exist by nature is that they are in such and such a condition; and it is *this* which constitutes the nature of each thing—a nature about which he says nothing. What he says, therefore, tells us nothing About Nature.[20] Moreover, it is *this* which is both the excellence of each thing and its good; whereas he assigns the whole credit to the combining. (And yet *the elements* at all events are dissociated not by Strife, but by Love; since the elements are by nature prior to god, and they too are gods.)

Again, his account of motion is too simple. For it is not an adequate explanation to say that Love and Strife set things moving, unless the essence of Love is a movement of *this* kind and the essence of Strife a movement of *that* kind. He ought, then, either to have defined or to have postulated these characteristic movements, or to have demonstrated them—whether strictly or laxly or in some other fashion. Moreover, since the bodies are seen to move naturally as well as by compulsion, i.e. in a manner contrary to nature (fire, e.g., moves upwards without compulsion, though by compulsion downwards); and since what is natural is contrary to that which is due to compulsion, and movement by compulsion actually occurs; it follows that natural movement also occurs. Is *this*, then, the movement that Love sets going? No: for, on the contrary, the natural movement moves Earth downwards and resembles dissociation, and Strife rather than Love is its cause—so that in general, too, Love rather than Strife would seem to be contrary to nature. And unless Love or Strife is actually setting them in motion, the bodies themselves have absolutely no movement or rest. But this is absurd; and what is more, they do
334a1 in fact obviously move. For though Strife dissociated, it was not by Strife that the Ether was borne upwards. On the contrary, sometimes he attributes its movement to something like *chance* ('For *thus*, as it ran, it *happened* to meet them then, though often otherwise'),[21] while at other times he says it is the *nature* of Fire to be borne upwards, but 'the Ether' (to quote his words) 'sank down upon the Earth with long roots'.[22] With such statements, too, he combines the assertion that the Order of the World is the same *now*, in the reign of Strife, as it was *formerly* in the reign of Love. What, then, is the first mover and the cause of motion? Presumably not Love and Strife: on the contrary, these are causes of a *particular* motion, if at least we assume that first mover to be a principle.

An additional absurdity is that the soul should consist of the elements, or that

[19]See Empedocles, frag. 8 Diels-Kranz.
[20]*About Nature* (περὶ Φύσεως) was the title of Empedocles' scientific poem.
[21]Empedocles, frag. 53 Diels-Kranz.
[22]*ib.*, frag. 54.

it should be one of them. How are the soul's alterations to take place? How, e.g., is the change from being musical to being unmusical, or how is memory or forgetting, to occur? For clearly, if the soul be Fire, only such properties will belong to it as characterize Fire *qua* Fire; while if it be compounded, only the corporeal modifications will occur in it. But the changes we have mentioned are none of them corporeal.

7 · The discussion of these difficulties, however, is a task appropriate to a different investigation:[23] let us return to the elements of which bodies are composed. The theories that there is something common to all the elements, and that they are reciprocally transformed, are so related that those who accept *either* are bound to accept *the other* as well. Those, on the other hand, who do not make their coming-to-be reciprocal—who refuse to suppose that any one of the 'elements' comes-to-be out of any other *taken singly*, except in the sense in which bricks come-to-be out of a wall—are faced with an absurdity. How, on their theory, are flesh and bones or any of the other compounds to result from the elements?

Indeed, the point we have raised constitutes a problem even for those who generate the elements out of one another. In what manner does anything other than, and beside, the elements come-to-be out of them? Let me illustrate my meaning. Water can come-to-be out of Fire and Fire out of Water; for their *substratum* is something common to them both. But flesh too, presumably, and marrow come-to-be out of them. How, then, do such things come-to-be? For how is the manner of their coming-to-be to be conceived by those who maintain a theory like that of Empedocles? They must conceive it as *composition*—just as a wall comes-to-be out of bricks and stones; and this mixture will be composed of the elements, these being preserved in it unaltered but with their small particles juxtaposed each to each. That will be the manner, presumably, in which flesh and every other compound results from the elements. Consequently, it follows that Fire and Water do not come-to-be out of any and every part of flesh. For instance, although a sphere might come-to-be out of *this* part of a lump of wax and a pyramid out of *some other* part, it was nevertheless possible for either figure to have come-to-be out of either part indifferently: *that* is the manner of coming-to-be when both come-to-be out of any and every part of flesh. Those, however, who maintain the theory in question, are not at liberty to conceive things in that manner, but only as a stone and a brick both come-to-be out of a wall—viz. each out of a different place or part. Similarly even for those who postulate a single matter of their elements there is a certain difficulty in explaining how anything is to result from two of them taken together—e.g. from cold and hot, or from Fire and Earth. For if flesh consists of both and is neither of them, nor again is a composition of them in which they are preserved unaltered, what alternative is left except to identify the resultant of the two elements with their matter? For the passing-away of either element produces *either* the other *or* the matter.

Now since there are differences of degree in hot and cold, then although when

[23]See *On the Soul* I 4–5.

either is actual without qualification, the other will exist potentially; yet, when neither exists in the full completeness of its being, but both by combining destroy one another's excesses so that there exist instead a hot which (for a hot) is cold and a cold which (for a cold) is hot; then there will exist neither their matter, nor either of the contraries in actuality without qualification, but rather an intermediate; and this intermediate, according as it is potentially more hot than cold or *vice versa,* will in accordance with that proportion be potentially twice as hot or as cold—or three times or whatever. Thus all the other bodies will result from the contraries, or from the elements, in so far as these have been combined; while the elements will result from the contraries, in so far as these exist potentially in a special sense—not as matter exists potentially, but in the sense explained above. And when a thing comes-to-be in *this* manner, the process is combination; whereas what comes-to-be in the other manner is matter. Moreover contraries also suffer action, in accordance with the definition established in the early part of this work.[24] For the actually hot is potentially cold and the actually cold potentially hot; so that hot and cold, unless they are equally balanced, are transformed into one another (and all the other contraries behave in a similar way). It is thus, then, that *in the first place* the elements are transformed; and that out of the elements there come-to-be flesh and bones and the like—the hot becoming cold and the cold becoming hot when they have been brought to the mean. For at the mean is neither hot nor cold. The mean, however, is of considerable extent and not indivisible. Similarly, it is in virtue of a mean condition that the dry and the moist and the rest produce flesh and bone and the remaining compounds.

8 · All the compound bodies—all of which exist in the region belonging to the central body—are composed of all the simple bodies. For they all contain Earth because every simple body is to be found specially and most abundantly in its own place. And they all contain Water because the compound must possess a definite outline and Water, alone of the simple bodies, is readily adaptable in shape; moreover Earth has no power of cohesion without the moist. On the contrary, the moist is what holds it together; for it would fall to pieces if the moist were eliminated from it completely.

They contain Earth and Water, then, for the reasons we have given; and they contain Air and Fire, because these are contrary to Earth and Water (Earth being contrary to Air and Water to Fire, in so far as one Substance can be contrary to another). Now comings-to-be result from contraries, and one pair of the contrary extremes is present; hence the other pair must also be present, so that every compound will include all the simple bodies.

Additional evidence seems to be furnished by the food each compound takes. For all of them are fed by what they are constituted from, and all of them are fed by more things than one. Indeed, even plants, though it might be thought they are fed by one thing only, viz. by Water, are fed by more than one; for Earth has been mixed with the Water. That is why farmers too endeavour to mix before watering.

[24]See I 7.

Although food is akin to the matter, that which is fed is the figure—i.e. the form—taken along with the matter. Hence it is reasonable that, whereas all the simple bodies come-to-be out of one another, Fire is the only one of them which (as our predecessors also assert) is fed. For Fire alone—or more than all the rest—is akin to the form because it tends by nature to be borne towards the limit. Now each of them naturally tends to be borne towards its own place; but the figure—i.e. the form—of them all is at the limits.

Thus we have explained that all bodies are composed of all the simple bodies.

9 · Since some things are such as to come-to-be and pass-away, and since coming-to-be in fact occurs in the region about the centre, we must explain the *number* and the *nature* of the principles of all coming-to-be alike; for a grasp of any universal facilitates the understanding of its specific forms.

The principles, then, are equal in number to, and identical in kind with, those in the sphere of the eternal and primary things. For there is *one* in the sense of matter, and a *second* in the sense of form; and, in addition, the *third* must be present as well. For the two are not sufficient to bring things into being, any more than they are adequate to account for the primary things.

Now cause, in the sense of matter, for the things which are such as to come-to-be is that which can be and not be; and this is identical with that which can come to be and pass away, since the latter, while it *is* at one time, at another time *is not*. (For whereas some things *are* of necessity, viz. the eternal things, others of necessity *are not*. And of these two sets of things, since they cannot diverge from the
335b1
necessity of their nature, it is impossible for the first *not to be* and impossible for the second *to be*. Other things, however, can both *be* and *not be*.) Hence coming-to-be and passing-away must occur within the field of that which can be and not be. This, therefore, is cause in the sense of matter for the things which are such as to come-to-be; while cause, in the sense of their end, is their figure or form—and that is the formula expressing the substance of each of them.

But the third principle must be present as well—the cause vaguely dreamed of by all our predecessors, definitely stated by none of them. On the contrary some amongst them thought the nature of the Forms was adequate to account for coming-to-be. Thus Socrates in the *Phaedo* first blames everybody else for having given no explanation;[25] and then lays it down that some things are Forms, others participants in the Forms, and that while a thing is said to be in virtue of the Form, it is said to come-to-be *qua* sharing in, to pass-away *qua* losing, the Form. Hence he thinks that assuming the truth of these theses, the Forms *must* be causes both of coming-to-be and of passing-away. On the other hand there were others who thought the matter was adequate by itself to account for coming-to-be, since the movement originates from the matter.

Neither of these theories, however, is sound. For if the Forms are causes, why is their generating activity intermittent instead of perpetual and continuous—since there always *are* participants as well as Forms? Besides, in some instances we *see*

[25]See *Phaedo* 96Aff.

that the cause is other than the Form. For it is the doctor who implants health and the man of science who implants science, although Health itself and Science itself *are* as well as the participants; and the same principle applies to everything else that is produced in accordance with a capacity. On the other hand to say that matter generates owing to its movement would be, no doubt, more scientific than to make such statements as are made by the thinkers we have been criticizing. For what alters and transfigures plays a greater part in bringing things into being; and we are everywhere accustomed, in the products of nature and of art alike, to look upon that which can initiate movement as the producing cause. Nevertheless this second theory is not right either.

For, to begin, with, it is characteristic of matter to suffer action, i.e. to be moved; but to move, i.e. to act, belongs to a different power. This is obvious both in the things that come-to-be by art and in those that come-to-be by nature. Water does not of itself produce out of itself an animal; and it is the art, not the wood, that makes a bed. Nor is this their only error. They make a second mistake in omitting the more controlling cause; for they eliminate the essential nature, i.e. the form. And what is more, since they remove the formal cause, they invest the forces they assign to the simple bodies—the forces which enable these bodies to bring things into being—with too instrumental a character. For since (as they say) it is the nature of the hot to dissociate, of the cold to bring together, and of each remaining contrary either to act or to suffer action, it is out of such materials and by their agency (so they maintain) that everything else comes-to-be and passes-away. Yet it is evident that even Fire is itself moved, i.e. suffers action. Moreover their procedure is virtually the same as if one were to treat the saw (and the various instruments of carpentry) as the cause of the things that come-to-be; for the wood *must* be divided if a man saws, *must* become smooth if he planes, and so on with the remaining tools. Hence, however true it may be that Fire is active, i.e. sets things moving, there is a further point they fail to observe—viz. that Fire is inferior to the tools or instruments in the manner in which it sets things moving.

10 · As to our own theory—we have given a general account of the causes in an earlier work,[26] and we have now explained and distinguished the matter and the form. Further, since the change which is motion has been proved to be eternal, the continuity of coming-to-be follows necessarily from what we have established; for the eternal motion, by causing the generator to approach and retire, will produce coming-to-be uninterruptedly. At the same time it is clear that we were also right when, in an earlier work,[27] we called motion (not coming-to-be) the primary form of change. For it is far more reasonable that *what is* should cause the coming-to-be of *what is not*, than that *what is not* should cause the being of *what is*. Now that which is being moved *is*, but that which is coming-to-be *is not*: hence motion is prior to coming-to-be.

We have assumed, and have proved, that coming-to-be and passing-away

[26]See *Physics* II 3–4.
[27]See *Physics* 260^{a}26ff.

happen to things continuously; and we assert that motion causes coming-to-be. That being so, it is evident that, if the motion be single, *both* processes cannot occur since they are contrary to one another; for nature by the same cause, provided it remain in the same condition, always produces the same effect, so that either coming-to-be or passing-away will always result. The movements must be more than one, and they must be one another either by the sense of their motion or by its irregularity; for contrary effects demand contraries as their causes.

This explains why it is not the primary motion that causes coming-to-be and passing-away, but the motion along the inclined circle; for this motion not only possesses the necessary continuity, but includes a duality of movements as well. For if coming-to-be and passing-away are always to be continuous, there must be some body always being moved (in order that these changes may not fail) and moved with a duality of movements (in order that both changes, not one only, may result). Now the continuity of this movement is caused by the motion of the whole; but the approaching and retreating of the moving body are caused by the inclination. For the consequence of the inclination is that the body becomes alternately remote and near; and since its distance is thus unequal, its movement will be irregular. Therefore, if it generates by approaching and by its proximity, it—this very same body—destroys by retreating and becoming remote; and if it generates by many successive approaches, it also destroys by many successive retirements. For contrary effects demand contraries as their causes; and the natural processes of passing-away and coming-to-be occupy equal periods of time. Hence, too, the times—i.e. the lives—of the several kinds of things have a number by which they are distinguished; for there is an order for all things, and every time (i.e. every life) is measured by a period. Not all of them, however, are measured by the same period, but some by a smaller and others by a greater one; for to some of them the period, which is their measure, is a year, while to some it is longer and to others shorter.

And there are facts of observation in manifest agreement with our theories. Thus we see that coming-to-be occurs as the sun approaches and decay as it retreats; and we see that the two processes occupy equal times. For the durations of the natural processes of passing-away and coming-to-be are equal. Nevertheless it often happens that things pass-away in too short a time, because of their mutual commingling. For their matter is irregular, i.e. is not everywhere the same; hence the processes by which they come-to-be must be irregular too, i.e. some too quick and others too slow. Consequently the phenomenon in question occurs, because the coming-to-be of these things is the passing-away of other things.

Coming-to-be and passing-away will, as we have said, always be continuous, and will never fail owing to the cause we stated. And this continuity has a sufficient reason. For in all things, as we affirm, nature always strikes after the better. Now being (we have explained elsewhere the variety of meanings we recognize in this term) is better than not-being; but not all things can possess being, since they are too far removed from the principle. God therefore adopted the remaining alternative, and fulfilled the perfection of the universe by making coming-to-be uninterrupted; for the greatest possible coherence would thus be secured to existence, because that coming-to-be should itself come-to-be perpetually is the closest approximation to eternal being.

337a1 The cause of this as we have often said, is circular motion; for that is the only motion which is continuous. That, too, is why all the other things—the things, I mean, which are reciprocally transformed in virtue of their qualities and their powers, e.g. the simple bodies—imitate circular motion. For when Water is transformed into Air, Air into Fire, and the Fire back into Water, we say the coming-to-be has completed the circle, because it reverts again to the beginning. Hence it is by imitating circular motion that rectilinear motion too is continuous.

These considerations serve at the same time to explain what is to some people a puzzle—viz. why the bodies, since each of them is travelling towards its own place, have not become dissevered from one another in the infinite lapse of time. The reason is their reciprocal transformation. For, had each of them persisted in its own place instead of being transformed by its neighbour, they would have got dissevered long ago. They are transformed, however, owing to the motion with its dual character; and because they are transformed, none of them is able to persist in any fixed place.

It is clear from what been said that coming-to-be and passing-away actually occur, what causes them, and what subject undergoes them. But if there is to be movement (as we have explained elsewhere, in an earlier work)[28] there must be something which initiates it; if there is to be movement always, there must always be something which initiates it; if the movement is to be continuous, what initiates it must be single, unmoved, ungenerated, and incapable of alteration; and if the circular movements are more than one, they must all of them, in spite of their plurality, be in some way subordinated to a single principle. Further since time is continuous, movement must be continuous, inasmuch as there can be no time without movement. Time, therefore, is a number of some continuous movement—a number, therefore, of the circular movement, as was established in the discussions at the beginning.[29] But is movement continuous because of the continuity of that which is moved, or because that in which the movement occurs (I mean, e.g., the place or the quality) is continuous? The answer must clearly be because that which is moved is continuous. (For how can the quality be continuous except in virtue of the continuity of the thing to which it belongs? But if the continuity of 'that in which' makes the movement continuous, this is true only of the place in which; for that has magnitude.) But amongst bodies which are moved, only that which is moved in a circle is continuous in such a way that it always preserves its continuity with itself. The conclusion therefore is that *this* is what produces continuous movement, viz. the body which is being moved in a circle; and its movement makes time continuous.

11 · Wherever there is continuity in any process (coming-to-be or alteration
337b1 or any kind of change whatever) we observe consecutiveness, i.e. *this* coming-to-be after *that* in such a way that there is no cessation. Hence we must investigate

[28] See *Physics* 255^b31ff.
[29] See *Physics* 217^b29ff.

whether there is anything which will necessarily exist, or whether everything may fail to come-to-be. For that some of them may fail to occur, is clear—and that is why 'it will be' and 'it is going to be' are different. For if it be true to say of something that it will be, it must at some time be true to say of it that it is; whereas, though it be true to say of something *now* that it is going to be, it is quite possible for it not to come-to-be—thus a man might not go for a walk, though he is now going to go for a walk. And since in general amongst the things which are some are capable also of not being, it is clear that the same character will attach to them when they are coming-to-be: in other words, their coming-to-be will not be necessary.

Then are all the things that come-to-be of this character? Or, on the contrary, is it absolutely necessary for some of them to come-to-be? Is there, in fact, a distinction in the field of coming-to-be corresponding to the distinction, within the field of being, between things that cannot possibly not be and things that can not be? For instance, is it necessary that solstices shall come-to-be, i.e. impossible that they should fail to be able to occur?

Assuming that what is prior must have come-to-be if what is posterior is to be (e.g. that foundations must have come-to-be if there is to be a house; clay, if there are to be foundations), is the converse also true? If foundations have come-to-be, must a house come-to-be? It seems that this is not so, unless it is necessary absolutely for the latter to come-to-be. If that be the case, however, a house must come-to-be if foundations have come-to-be. For the prior was assumed to be so related to the posterior that, if the latter is to be, the prior must have come-to-be before it. If, therefore, it is necessary that the posterior should come-to-be, the prior also must have come-to-be; and if the prior has come-to-be, then the posterior also must come-to-be—not, however, because of the prior, but because its future being was assumed as necessary. Hence, whenever the being of the posterior is necessary, the *nexus* is reciprocal—in other words, when the prior has come-to-be the posterior must always come-to-be too.

Now if the sequence of occurrences is to proceed *ad infinitum* downwards, the coming-to-be of any determinate later member will not be *absolutely*, but only *conditionally*, necessary. For it will always be necessary that some other member shall have come-to-be beforehand, on account of which it is necessary that this should come-to-be: consequently, since what is infinite has no beginning, neither will there be any primary member which will make it necessary for the remaining members to come-to-be.

Nor again will it be possible to say with truth, even in regard to the members of a limited sequence, that it is absolutely necessary for any one of them to come-to-be e.g. a house, when foundations have been laid; for (unless it is *always* necessary for a house to come-to-be) we should be faced with the consequence that, when foundations have been laid, a thing, which need not always be, must always be. No: if its coming-to-be is to be necessary, it must be always in its coming-to-be. For what is of necessity coincides with what is always, since that which must be cannot not be. Hence a thing is eternal if it is of necessity; and if it is eternal, it is of 338a1 necessity. And if, therefore, the coming-to-be of a thing is necessary, its coming-to-be is eternal; and if eternal, necessary.

It follows that the coming-to-be of anything, if it is absolutely necessary, must be cyclical—i.e. must return upon itself. For coming-to-be must either be limited or not limited; and if not limited, it must be either rectilinear or cyclical. But the first of these last two alternatives is impossible if coming-to-be is to be eternal, because there could not be any beginning, whether the members be taken downwards (as future events) or upwards (as past events). Yet coming-to-be must have a beginning ⟨if it is to be necessary and therefore eternal⟩, nor can it be eternal if it is limited.[30] Consequently it must be cyclical. Hence the *nexus* must be reciprocal. By this I mean that the necessary occurrence of this involves the necessary occurrence of something prior; and conversely that, given the prior, it is also necessary for the posterior to come-to-be. And this will hold continuously throughout the sequence; for it makes no difference whether we take two, or by many, members.

It is in circular movement, therefore, and in cyclical coming-to-be that the absolutely necessary is to be found. In other words, if the coming-to-be of any things is cyclical, it is necessary that each of them is coming-to-be and has come-to-be; and if it is necessary, their coming-to-be is cyclical.

And this is reasonable; for circular motion, i.e. the revolution of the heavens, was seen on other grounds to be eternal since precisely those movements which
338b1 belong to, and depend upon this eternal revolution come-to-be of necessity, and of necessity will be. For since the revolving body is always setting something in motion, the movement of the things it moves must also be circular. Thus, since the upper movement is cyclical, the sun[31] moves in this determinate manner; and since the sun moves *thus*, the seasons in consequence come-to-be in a cycle, i.e. return upon themselves; and since they come-to-be cyclically, so in their turn do the things whose coming-to-be the seasons initiate.

Then why do some things manifestly come-to-be in this fashion (as, e.g., showers and air come-to-be cyclically, so that it must rain if there is to be a cloud and, conversely, there must be a cloud if it is to rain), while men and animals do not return upon themselves so that the same individual comes-to-be a second time (for though your coming-to-be presupposes your father's, his coming-to-be does not presuppose yours)? Why, on the contrary, does this coming-to-be seem to constitute a rectilinear sequence?

In discussing this, we must begin by inquiring whether all things return upon themselves in a uniform manner; or whether, on the contrary, though in some sequences what recurs is *numerically* the same, in other sequences it is the same *only in species*. Now it is evident that those things, whose substance—that which is undergoing the process—is imperishable, will be numerically the same; for the character of the process is determined by the character of that which undergoes it. Those things, on the other hand, whose substance is perishable (not imperishable) must return upon themselves specifically, not numerically. That is why, when Water comes-to-be from Air and Air from Water, the Air is the same specifically, not numerically; and if these too recur numerically the same, at any rate this does not happen with things whose substance comes-to-be—whose substance is such that it is capable of not-being.

[30]The text is corrupt at this point.
[31]Reading κύκλῳ ὁ ἥλιος.

METEOROLOGY

E. W. Webster

BOOK I

1 · We have already discussed the first causes of nature, and all natural motion, also the stars ordered in the motion of the heavens, and the corporeal elements—enumerating and specifying them and showing how they change into one another—and becoming and perishing in general. There remains for consideration a part of this inquiry which all our predecessors called meteorology. It is concerned with events that are natural, though their order is less perfect than that of the first of the elements of bodies. They take place in the region nearest to the motion of the stars. Such are the milky way, and comets, and the movements of meteors. It studies also all the affections we may call common to air and water, and the kinds and parts of the earth and the affections of its parts. These throw light on the causes of winds and earthquakes and all the consequences of their motions. Of these things some puzzle us, while others admit of explanation in some degree. Further, the inquiry is concerned with the falling of thunderbolts and with whirlwinds and fire-winds, and further, the recurrent affections produced in these same bodies by concretion. When the inquiry into these matters is concluded let us consider what account we can give, in accordance with the method we have followed, of animals and plants, both generally and in detail. When that has been done we may say that the whole of our original undertaking will have been carried out.

After this introduction let us begin by discussing our immediate subject.

2 · We have already laid down that there is one principle which makes up the nature of the bodies that move in a circle, and besides this four bodies owing their existence to the four principles, the motion of these latter bodies being of two kinds: either from the centre or to the centre. These four bodies are fire, air, water, earth. Fire occupies the highest place among them all, earth the lowest, and two elements correspond to these in their relation to one another, air being nearest to fire, water to earth. The whole world surrounding the earth, then, the affections of which are our subject, is made up of these bodies. This world necessarily has a certain continuity with the upper motions; consequently all its power is derived from them. (For the originating principle of all motion must be deemed the first cause. Besides, that element is eternal and its motion has no limit in space, but is always complete;

TEXT: F. H. Fobes, Cambridge, Mass., 1918

whereas all these other bodies have separate regions which limit one another.) So we must treat fire and earth and the elements like them as the material causes of the events in this world (meaning by material what is subject and is affected), but must assign causality in the sense of the originating principle of motion to the power of the eternally moving bodies.

3 · Let us first recall our original postulates and the definitions already given and then explain the milky way and comets and the other phenomena akin to these.

Fire, air, water, earth, we assert, come-to-be from one another, and each of
339b1 them exists potentially in each, as all things do that can be resolved into a common and ultimate substrate.

The first difficulty is raised by what is called the air. What are we to take its nature to be in the world surrounding the earth? And what is its position relatively to the other so-called elements of bodies? (For there is no question as to the relation of the bulk of the earth to the size of the bodies which exist around it, since astronomical researches have by this time shown us that it is actually far smaller than some individual stars. As for the water, it is not observed to exist collectively and separately, nor can it do so apart from that volume of it which has its seat about the earth: the sea, that is, and rivers, which we can see, and any subterranean water that may be hidden from our observation.) The question is really about that which lies between the earth and the extreme stars. Are we to consider it to be one kind of body or more than one? And if more than one, how many are there and what are the bounds of their regions?

We have already described the first element and its powers, and explained that the whole world of the upper motions is full of that body.

This is an opinion we are not alone in holding: it appears to be an old belief and one which men have held in the past, for the word 'ether' has long been used to denote that element. Anaxagoras, it is true, seems to me to think that the word means the same as fire. For he thought that the upper regions were full of fire, and that men[1] referred to those regions when they spoke of ether. In the latter point he was right; for men seem to have assumed that a body that was eternally in motion was also divine in nature; and, as such a body was different from any of the terrestrial elements, they determined to call it 'ether'.[2]

For the same opinions appear in cycles among men not once nor twice nor occasionally, but infinitely often.

Now there are some who maintain that not only the bodies in motion but that which contains them is pure fire, and the interval between the earth and the stars air; but if they had considered what is now satisfactorily established by mathematics, they might have given up this puerile opinion. For it is altogether childish to suppose that the moving bodies are all of them of a small size, because they seem so to us, looking at them from the earth.

[1]Reading κἀκείνους (Thurot) for κἀκεῖνος.
[2]Αἰθήρ being derived from ἀεί (always) and θεῖν (to run), with an allusion to θεῖος (divine).

This is a matter which we have already discussed in our treatment of the upper region,[3] but we may return to the point now.

If the intervals were full of fire and the bodies consisted of fire every one of the other elements would long ago have vanished.

However, they cannot simply be said to be full of air either; for even if there were two elements to fill the space between the earth and the heavens, the air would far exceed the quantity required to maintain its proper proportion to the other elements. For the bulk of the earth (which includes the whole volume of water) is infinitesimal in comparison with the whole world that surrounds it. Now we find that the excess in volume is not proportionately great where water dissolves into air or air into fire. Whereas the *proportion* between any given quantity however small of water and the air that is generated from it ought to hold good between the total amount of air and the total amount of water. Nor does it make any difference if any one denies that the elements come-to-be from one another, but asserts that they are equal in power. For on this view it is certain amounts of each that are equal in power, just as would be the case if they actually came-to-be from one another.

So it is clear that neither air nor fire alone fills the intermediate space.

It remains to explain, after a discussion of difficulties, the relation of the two elements air and fire to the position of the first element, and the reason why the stars in the upper region impart heat to the earth and its neighbourhood. Let us first treat of the air, as we proposed, and then go on to these questions.

Since water is generated from air, and air from water, why are clouds not formed in the upper region? They ought to form there the more, the further from the earth and the colder that region is. For it is neither appreciably near to the heat of the stars, nor to the rays reflected from the earth. It is these that dissolve any formation by their heat and so prevent clouds from forming near the earth. For clouds gather at the point where the reflected rays disperse in the infinity of space and are lost. Thus either it is not all air from which water is generated, or, if it is produced from all air alike, what immediately surrounds the earth is not mere air, but a sort of vapour, for that reason it condenses back to water again. But if the whole of that vast region is vapour, the amount of air and of water will be disproportionately great. For the spaces between the heavenly bodies must be filled by some element. This cannot be fire, for then all the rest would have been dried up. Consequently, what fills it must be air and the water that surrounds the whole earth—vapour being water dissolved.

After this exposition of the difficulties involved, let us go on to state our own opinion, with a view at once to what follows and to what has already been said. The upper region as far as the moon we affirm to consist of a body distinct both from fire and from air, but varying in degree of purity and in kind, especially towards its limit on the side of the air, and of the world surrounding the earth. Now the circular motion of the first element and of the bodies it contains dissolves, and inflames by its motion, whatever part of the lower world is nearest to it, and so generates heat.

[3] See *On the Heavens* 297b30ff.

From another point of view we may look at the motion as follows. The body that lies below the circular motion of the heavens is, in a way, matter, and is potentially hot, cold, dry, moist, and possessed of whatever other qualities are derived from these. But it actually acquires or retains one of these in virtue of motion or rest, the cause and principle of which has already been explained. So at the centre and round it we get earth and water, the heaviest and coldest elements, by themselves; round them and contiguous with them, air and what we commonly call fire. It is not really fire, for fire is an excess of heat and a sort of ebullition; but in reality, of what we call air, the part surrounding the earth is moist and warm, because it contains both vapour and a dry exhalation from the earth. But the next part, above that, is warm and dry. For vapour is naturally moist and cold, exhalation warm and dry; and vapour is potentially like water, exhalation potentially like fire. So we must take the reason why clouds are not formed in the upper region to be this: that it is filled not with mere air but rather with a sort of fire.

However, it may well be that the formation of clouds in that upper region is also prevented by the circular motion. For the air round the earth is necessarily all of it in motion, except that which is cut off inside the circumference which makes the earth a complete sphere. In the case of winds it is actually observable that they originate in marshy districts of the earth; and they do not seem to blow above the level of the highest mountains. It is the revolution of the heaven which carries the air with it and causes its circular motion, fire being continuous with the upper element and air with fire. Thus its motion is a second reason why that air is not condensed into water.

But whenever a particle of air grows heavy, the warmth in it is squeezed out into the upper region and it sinks, and other particles in turn are carried up together with the fiery exhalation. Thus the one region is always full of air and the other of fire, and each of them is perpetually in a state of change.

So much to explain why clouds are not formed and why the air is not condensed into water, and what account must be given of the space between the stars and the earth, and what is the body that fills it.

As for the heat derived from the sun, the right place for a special and accurate account of it is in the treatise about perception,[4] since heat is an affection of perception; but we may now explain how it can be produced by the heavenly bodies which are not themselves naturally hot.

We see that motion is able to dissolve and inflame the air; indeed, moving bodies are often actually found to melt. Now the sun's motion alone is sufficient to account for the origin of warmth and heat. For a motion that is to have this effect must be rapid and near, and that of the stars is rapid but distant, while that of the moon is near but slow, whereas the sun's motion combines both conditions in a sufficient degree. That most heat should be generated where the sun is present is easy to understand if we consider the analogy of terrestrial phenomena; for here, too, it is the air that is nearest to a thing in rapid motion which is heated most. This

[4]No such account is to be found in *On the Soul* or *Sense and Sensibilia*.

is just what we should expect, as it is the nearest air that is most dissolved by the motion of a solid body.

This then is one reason why heat reaches our world. Another is that the fire surrounding the air is often scattered by the motion of the heavens and driven downwards in spite of itself.

Shooting-stars further suffice to prove that the upper region is not hot or fiery; for they do not occur there but below; yet the more and the faster a thing moves, the more apt it is to take fire. Besides, the sun, which most of all the stars is considered to be hot, is really white and not fiery.

4 · Having determined these principles let us explain the cause of the appearance in the sky of burning flames and of shooting-stars, and of 'torches', and 'goats', as some people call them. All these phenomena are one and the same thing, and are due to the same cause, the difference between them being one of degree.

The origin of these and many other phenomena is this. When the sun warms the earth the exhalation which takes place is necessarily of two kinds, not of one only as some think. One kind is rather of the nature of vapour, the other of the nature of a windy exhalation. That which rises from the moisture contained in the earth and on its surface is vapour, while that rising from the earth itself, which is dry, is like smoke. Of these the windy exhalation, being warm, rises above the moister vapour, which is heavy and sinks below the other. Hence the world surrounding the earth is ordered as follows. First below the circular motion comes the warm and dry element, which we call fire, for there is no word fully adequate to every state of the smoky evaporation; but we must use this terminology since this element is the most inflammable of all bodies. Below this comes air. We must think of what we just called fire as being spread round the terrestrial sphere on the outside like a kind of fuel, so that a little motion often makes it burst into flame just as smoke does; for flame is the ebullition of a dry exhalation. So whenever the circular motion stirs this stuff up in any way, it catches fire at the point at which it is most inflammable. The result differs according to the disposition and quantity of the fuel. If this is broad and long, we often see a flame burning as in a field of stubble; if it burns lengthwise only, we see what are called 'torches' and 'goats' and shooting-stars. Now when the inflammable material is longer than it is broad sometimes it seems to throw off sparks as it burns. (This happens because matter catches fire at the sides in small portions but continuously with the main body.) Then it is called a 'goat'. When this does not happen it is a 'torch'. But if the whole length of the exhalation is scattered in small parts and in many directions and in breadth and depth alike, we get what are called shooting-stars.

The cause of these shooting-stars is sometimes the motion which ignites the exhalation. At other times the air is condensed by cold and squeezes out and ejects the hot element; making their motion look more like that of a thing thrown than like a running fire. For the question might be raised whether the shooting of a star is the same thing as when you put an exhalation below a lamp and it lights the lower lamp from the flame above. For here too the flame passes wonderfully quickly and looks like a thing thrown, and not as if one thing after another caught fire. Or is a star when it shoots a single body that is thrown? Apparently both cases occur: sometimes it is like the flame from the lamp and sometimes bodies are projected by being squeezed out (like fruit stones from one's fingers) and so are seen to fall into the sea and on the dry land, both by night and by day when the sky is clear. They are thrown downwards because the condensation which propels them inclines downwards. Thunderbolts fall downwards for the same reason:[5] their origin is never combustion but ejection under pressure, since naturally all heat tends upwards.

When the phenomenon is formed in the upper region[6] it is due to the combustion of the exhalation. When it takes place at a lower level it is due to the ejection of the exhalation by the condensing and cooling of the moister exhalation; for this latter as it condenses and inclines downward contracts, and thrusts out the hot element and causes it to be thrown downwards. The motion is upwards or downwards or sideways according to the way in which the exhalation lies, and its disposition in respect of breadth and depth. In most cases the direction is sideways because two motions are involved, a compulsory motion downwards and a natural motion upwards, and under these circumstances an object always moves obliquely. Hence the motion of shooting-stars is generally oblique.

So the material cause of all these phenomena is the exhalation, the efficient cause sometimes the upper motion, sometimes the contraction and condensation of the air. Further, all these things happen below the moon. This is shown by their apparent speed, which is equal to that of things thrown by us; for it is because they are close to us, that these latter seem far to exceed in speed the stars, the sun, and the moon.

5 · Sometimes on a fine night we see a variety of appearances that form in the sky: 'chasms' for instance and 'trenches' and blood-red colours. These, too, have the same cause. For we have seen that the upper air condenses into an inflammable condition and that the combustion sometimes takes on the appearance of a burning flame, sometimes that of moving torches and stars. So it is not surprising that this same air when condensing should assume a variety of colours. For a weak light shining through a dense medium, and the air when it acts as a mirror, will cause all kinds of colours to appear, but especially crimson and purple. For these colours generally appear when fire-colour and white are combined by superposition. Thus on a hot day, the stars when they rise and set look crimson when seen through a smoky medium. The air will also create colours by reflection when the mirror is such as to reflect colour only and not shape.

These appearances do not persist long, because the condensation of the air is transient.

'Chasms' get their appearance of depth from light breaking out of a dark blue or black background. When the process of condensation goes further in such a case

[5]Omitting τοῦ πυρὸς ἄνω φερομένου κατὰ φύσιν.
[6]Omitting μᾶλλον, and reading ἄνω for ἀνωτάτῳ.

we often find 'torches' ejected; but while the contraction is taking place a 'chasm' appears.

In general, white in contrast with black creates a variety of colours; like flame, for instance, through a medium of smoke. But by day the sun obscures them, and, with the exception of crimson, the colours are not seen at night because they are dark.

These then must be taken to be the causes of shooting-stars and the phenomena of combustion and also of the other transient appearances of this kind.

6 · Let us go on to explain the nature of comets and the 'milky way', after a preliminary discussion of the views of others.

Anaxagoras and Democritus declare that comets are a conjunction of the planets approaching one another and so appearing to touch one another.

Some of the Italians called Pythagoreans say that the comet is one of the planets, but that it appears at great intervals of time and only rises a little above the horizon. This is the case with Mercury too; because it only rises a little above the horizon it often fails to be seen and consequently appears at great intervals of time.

A view like theirs was also expressed by Hippocrates of Chios and his pupil Aeschylus. Only they say that the tail does not belong to the comet itself, but is 343a1
occasionally assumed by it on its course in certain situations, when our sight is reflected to the sun from the moisture attracted by the comet. It appears at greater intervals than the other stars because it is slowest to fall behind the sun and has fallen behind to the extent of the whole of its circle before it reappears at the same point. It falls behind both towards the north and towards the south. In the space between the tropics it does not draw water to itself because that region is dried up by the sun on its course. When it moves towards the south it has no lack of the necessary moisture, but because the segment of its circle which is above the horizon is small, and that below it many times as large, it is impossible for human sight to be reflected to the sun, either when it approaches the region of the tropic, or at the summer solstice. Hence in these regions it does not become a comet. But when it falls behind towards the north it assumes a tail because the arc above the horizon is large and that below it small. For under these circumstances human sight is easily reflected to the sun.

These views involve impossibilities, some of which are common to all of them, while others are peculiar to some only.

This is the case, first, with those who say that the comet is one of the planets. For all the planets fall behind in the circle of the zodiac, whereas many comets have been seen outside that circle. Again more comets than one have often appeared simultaneously. Besides, if their tail is due to reflection, as Aeschylus and Hippocrates say, this planet ought sometimes to be visible without a tail since, as they say, it does not possess a tail in every place in which it falls behind. But, as a matter of fact, no planet has been observed besides the five. And all of them are often visible above the horizon together at the same time. Further, comets are often found to appear, as well when all the planets are visible as when some are not, but are obscured by the neighbourhood of the sun. Moreover the statement that a comet only appears in the north, with the sun at the summer solstice, is not true either. The great comet which appeared at the time of the earthquake in Achaea and the tidal wave[7] rose due west; and many have been known to appear in the south. Again in the archonship of Euclees, son of Molon, at Athens[8] there appeared a comet in the north in the month Gamelion, the sun being about the winter solstice. Yet they themselves admit that reflection over so great a space is an impossibility.

An objection that tells equally against those who hold this theory and those who say that comets are a conjunction of the planets is, first, the fact that some of the fixed stars too get a tail. For this we must not only accept the authority of the Egyptians who assert it, but we have ourselves observed the fact. For a star in the thigh of the Dog had a tail, though a faint one. If you fixed your sight on it its light was dim, but if you just glanced at it, it appeared brighter. Besides, all the comets that have been seen in our day have vanished without setting, gradually fading away above the horizon; and they have not left behind them either one or more stars. For instance the great comet we mentioned before appeared to the west in winter in frosty weather when the sky was clear, in the archonship of Asteius. On the first day it set before the sun and was then not seen. On the next day it was seen, being ever so little behind the sun and immediately setting. But its light extended over a third part of the sky like a band[9] so that people called it a 'path'. This comet receded as far as Orion's belt and there dissolved. Democritus, however, insists upon the truth of his view and affirms that certain stars have been seen when comets dissolve. But on his theory this ought to occur not occasionally but always. Besides, the Egyptians affirm that conjunctions of the planets with one another, and with the fixed stars, take place, and we have ourselves observed Jupiter coinciding with one of the stars in the Twins and hiding it, and yet no comet was formed. Further, we can also give a rational proof of our point. It is true that some stars seem to be bigger than others, yet each one by itself looks indivisible. Consequently, just as, if they really had been indivisible, their conjunction could not have created any greater magnitude, so now that they are not in fact indivisible but look as if they were, their conjunction will not make them look any bigger.

Enough has been said, without further argument, to show that the causes brought forward to explain comets are false.

7 · We consider a satisfactory explanation of phenomena inaccessible to observation to have been given when our account of them is free from impossibilities. The phenomenon available suggest the following account of the matters in question. We suppose that the dry and warm exhalation is the outermost part of the terrestrial world which falls below the circular motion. It, and a great part of the air that is continuous with it below, is carried round the earth by the motion of the

[7]In 373/2 B.C.
[8]427/6 B.C.
[9]Reading ἄμμα for ἄλμα.

circular revolution. In the course of this motion it often ignites wherever it may happen to be of the right consistency, and this we maintain to be the cause of the shooting of scattered stars. We may say, then, that a comet is formed when the upper motion introduces into a condensation of this kind a fiery principle not of such excessive strength as to burn up much of the material quickly, nor so weak as soon to be extinguished, but stronger and capable of burning up much material, and when exhalation of the right consistency rises from below and meets it. The kind of comet varies according to the shape which the exhalation happens to take. If it is diffused equally on every side the star is a comet, if it stretches out in one direction it is called bearded. And just as when a phenomenon of this kind moves we seem to have a shooting-star, so when it stands still we seem to have a star standing still. We may compare these phenomena to a heap or mass of chaff into which a torch is thrust, or a spark thrown. That is what a shooting-star is like. The fuel is so inflammable that the fire runs through it quickly in a line. Now if this fire were to persist instead of running through the fuel and perishing away, its course through the fuel would stop at the point where the latter was densest, and then the whole might begin to move. Such is a comet—like a shooting-star that contains its beginning and end in itself.

When the matter begins to gather in the lower region independently the comet appears by itself. But when the exhalation is constituted by one of the fixed stars or the planets, owing to their motion, one of them becomes a comet. The fringe is not close to the stars themselves. Just as haloes appear to follow the sun and the moon as they move, when the air is dense enough for them to form along under the sun's course, so too the tail stands in the relation of a halo to the stars, except that the colour of the halo is due to reflection, whereas in the case of comets the colour is something that appears actually on them.

Now when this matter gathers in relation to a star the comet necessarily appears to follow the same course as the star. But when the comet is formed independently it falls behind; for such is the motion of the terrestrial sphere. It is this fact, that a comet often forms independently, indeed oftener than round one of the regular stars, that makes it impossible to maintain that a comet is a sort of reflection, not indeed, as Hippocrates and his school say, to the sun, but to the very star it is alleged to accompany—in fact, a kind of halo in the pure fuel.

As for the halo we shall explain its cause later.

The fact that comets when frequent foreshadow wind and drought must be taken as an indication of their fiery constitution. For their origin is plainly due to the plentiful supply of that secretion. Hence the air is necessarily drier and the moist evaporation is so dissolved and dissipated by the quantity of the hot exhalation as not readily to condense into water.—But this phenomenon too will be explained more clearly later when the time comes to speak of the winds.—So when there are many comets and they are frequent, it is as we say, and the years are clearly dry and windy. When they are fewer and fainter this effect does not appear in the same degree, though as a rule the wind is found to be excessive either in duration or strength. For instance when the stone at Aegospotami fell out of the air—it had been carried up by a wind and fell down in the daytime—then too a comet happened to have appeared in the west. And at the time of the great comet the winter was dry and north winds prevailed, and the wave was due to an opposition of winds. For in the gulf a north wind blew and outside it a violent south wind. Again in the archonship of Nicomachus[10] a comet appeared for a few days about the equinoctial circle (this one had not risen in the west), and simultaneously with it there happened the storm at Corinth.

That there are few comets and that they appear rarely and outside the tropic circles more than within them is due to the motion of the sun and the stars. For this motion does not only cause the hot principle to be secreted but also dissolves it when it is gathering. But the chief reason is that most of this stuff collects in the region of the milky way.

8 · Let us now explain the origin, cause, and nature of the milky way. And here too let us begin by discussing the statements of others on the subject.

Of the so-called Pythagoreans some say that this is the path of one of the stars that fell from heaven during the alleged destruction at the time of Phaethon. Others say that the sun used once to move in this circle. Thus this region was scorched or met with some other affection of this kind, because of the motion of these bodies.

But it is absurd not to see that if this were the reason the circle of the Zodiac ought to be affected in the same way, and indeed more so than that of the milky way, since not the sun only but all the planets move in it. We can see the whole of this circle (half of it being visible at any time of the night), but it shows no signs of any such affection except where a part of it touches the circle of the milky way.

Anaxagoras, Democritus, and their schools say that the milky way is the light of certain stars. For, they say, when the sun passes below the earth some of the stars are hidden from it. Now the light of those on which the sun shines is invisible, being obscured by the rays of the sun. But the milky way is the peculiar light of those stars which are shaded by the earth from the sun's rays.

This, too, is obviously impossible. The milky way is always unchanged and among the same constellations (for it is clearly a greatest circle), whereas, since the sun does not remain in the same place, what is hidden from it differs at different times. Consequently with the change of the sun's position the milky way ought to change its position too; but we find that this does not happen. Besides, if current astronomical demonstrations are correct and the size of the sun is greater than that of the earth and the distance of the stars from the earth many times greater than that of the sun (just as the sun is further from the earth than the moon), then the cone made by the rays of the sun would terminate at no great distance from the earth, and the shadow of the earth (what we call night) would not reach the stars. On the contrary, the sun shines on all the stars and the earth screens none of them.

There is a third theory about the milky way. Some say that it is a reflection of our sight to the sun, just as they say that the comet is.

But this too is impossible. For if the eye and the mirror and the whole of the object were severally at rest, then the same part of the image would appear at the

[10] 341/0 B.C.

same point in the mirror. But if the mirror and the object move, keeping the same distance from the eye which is at rest, but at different rates of speed and so not always at the same interval from one another, then it is impossible for the same image always to appear in the same part of the mirror. Now the constellations included in the circle of the milky way move; and so does the sun, the object to which our sight is reflected; but we stand still. And the distance of those two from us is constant and uniform, but their distance from one another varies. For the Dolphin sometimes rises at midnight, sometimes in the morning. But in each case the same parts of the milky are found near it. But if it were a reflection and not a genuine affection of these regions, this ought not to be the case.

Again, we can see the milky way reflected at night in water and similar mirrors. But under these circumstances it is impossible for our sight to be reflected to the sun.

These considerations show that the milky way is not the path of one of the planets, nor the light of stars unseen by the sun, nor a reflection. And those are pretty well the only views handed down by others hitherto.

Let us recall our fundamental principle and then explain our views. We have already laid down that the outermost part of what is called the air has the powers of fire and that therefore when the air is dissolved by motion, there is separated off a kind of matter—and of this matter we assert that comets consist. We must suppose that what happens is the same as in the case of the comets when the matter does not form independently but is formed by one of the fixed stars or the planets. Then these stars appear as comets, because matter of this kind follows their course. In the same way, a certain kind of matter follows the sun, and we explain the halo as a reflection from it when the air is of the right constitution. Now we must assume that what happens in the case of the stars severally happens in the case of the whole of the heavens and all the upper motion. For it is natural to suppose that, if the motion of a single star excites a flame, that of all the stars should have a similar result,[11] and especially in that region in which the stars are biggest and most numerous and nearest to one another. Now the circle of the zodiac dissolves this kind of matter because of the motion of the sun and the planets, and for this reason most comets are found outside the tropic circles. Again, no tail appears round the sun or moon; for they dissolve such matter too quickly to admit of its formation. But this circle in which the milky way appears to our sight is the greatest circle, and its position is such that it extends far outside the tropic circles. Besides the region is full of the biggest and brightest constellations and also of what are called 'scattered' stars (you have only to look to see this clearly). So for these reasons all this matter is continually and ceaselessly collecting there. A proof of the theory is this: in the circle itself the light is stronger in the half where the milky way is double, and in it the constellations are more numerous and closer to one another than in the other half; which shows that the cause of the light is the motion of the constellations and nothing else. For if it is found in the circle in which there are most constellations and at that point in the circle in which they are densest and contain the biggest and the

[11]Omitting ἀέρα τε . . . ποιήσῃ.

most stars, it is natural to suppose that they are the most appropriate cause of the affection in question. The circle and the constellations in it may be seen in the diagram. The so-called 'scattered' stars it is not possible to set down in the same way on the sphere because none of them has an evident permanent position; but if you look up to the sky the point is clear. For in this circle alone are the intervals full of these stars: in the other circles there are obvious gaps. Hence if we accept the cause assigned for the appearance of comets as plausible we must assume that the same kind of thing holds good of the milky way. For the tail which in the former case is an affection of a single star here forms in the same way in relation to a whole circle. So if we are to define the milky way we may call it the tail attaching to the greatest circle, and due to the matter secreted. This, as we said before, explains why there are few comets and why they appear rarely; it is because at each revolution of the heavens this matter has always been and is always being separated off and gathered into this region.

We have now explained the phenomena that occur in that part of the terrestrial world which is continuous with the motions of the heavens, namely, shooting-stars and the burning flame, comets and the milky way, these being the chief affections that appear in that region.

9 · Let us go on to treat of the region which follows next in order after this and which immediately surrounds the earth. It is the region common to water and air, and the processes attending the formation of water above take place in it. We must consider their principles and causes too.

The efficient and chief and first of the principles is the circle in which the sun moves. For the sun as it approaches or recedes, obviously causes dissipation and condensation and so gives rise to generation and destruction. Now the earth remains but the moisture surrounding it is made to evaporate by the sun's rays and the other heat from above, and rises. But when the heat which was raising it leaves it, in part dispersing to the higher region, in part quenched through rising so far into the upper air, then the vapour cools because its heat is gone and because of the place, and condenses again and turns from air into water. And after the water has formed it falls down again to the earth.

The exhalation of water is vapour: air condensing into water is cloud. Mist is what is left over when a cloud condenses into water, and is therefore rather a sign of fine weather than of rain; for mist might be called a barren cloud.

So we get a circular process that follows the course of the sun. For according as the sun moves to this side or that, the moisture in this process rises or falls. We must think of it as a river flowing up and down in a circle and made up partly of air, partly of water. When the sun is near, the stream of vapour flows upwards; when it recedes, the stream of water flows down; and the order of sequence, at all events, in this process always remains the same. So if 'Oceanus' had some secret meaning in early writers, perhaps they may have meant this river that flows in a circle about the earth.

So the moisture is always raised by the heat and descends to the earth again when it gets cold. These processes and, in some cases, their varieties are distinguished by special names. When the water falls in small drops it is called a drizzle; when the drops are larger it is rain.

10 · Some of the vapour that is formed by day does not rise high because the ratio of the fire that is raising it to the water that is being raised is small. When this cools and descends at night it is called dew and hoar-frost. When the vapour is frozen before it has condensed to water again it is hoar-frost; and this appears in winter and is commoner in cold places. It is dew when the vapour has condensed into water and the heat is not so great as to dry up the moisture that has been raised, nor the cold sufficient (owing to the warmth of the climate or season) for the vapour itself to freeze. For dew is more commonly found when the season or the place is warm, whereas the opposite, as has been said, is the case with hoar-frost. For obviously vapour is warmer than water, having still the fire that raised it: consequently more cold is needed to freeze it.

Both dew and hoar-frost are found when the sky is clear and there is no wind. For the vapour could not be raised unless the sky were clear, and if a wind were blowing it could not condense.

The fact that hoar-frost is not found on mountains contributes to prove that these phenomena occur because the vapour does not rise high. One reason for this is that it rises from hollow and water places, so that the heat that is raising it, bearing as it were too heavy a burden, cannot lift it to a great height but soon lets it fall again. A second reason is that the motion of the air is more pronounced at a height, and this dissolves a gathering of this kind.

Everywhere, except in Pontus, dew is found with south winds and not with north winds. There the opposite is the case and it is found with north winds and not with south. The reason is the same as that which explains why dew is found in warm weather and not in cold. For the south wind brings warm, and the north, wintry weather. For the north wind is cold and so, bringing wintry weather, quenches the heat of the evaporation. But in Pontus the south wind does not bring warmth enough to cause evaporation, whereas the coldness of the north wind surrounds and concentrates the heat, so that there is more evaporation and not less. This is a thing which we can often observe in other places too. Wells, for instance, give off more vapour in a north than in a south wind. But the north winds quench the heat before any considerable quantity of vapour has gathered, while in a south wind the evaporation is allowed to accumulate. The water itself does not freeze in the way that it does in the region of the clouds.

11 · From that region there fall three bodies condensed by cold, namely water, snow, hail. Two of these correspond to the phenomena on the lower level and are due to the same causes, differing from them only in degree and quantity.

Snow and hoar-frost are one and the same thing, and so are rain and dew: only there is a great deal of the former and little of the latter. For rain is due to the cooling of a great amount of vapour; for the region from which and the time during which the vapour is collected are considerable. But of dew there is little; for the vapour collects for it in a single day and from a small area, as its quick formation and scanty quantity show.

The relation of hoar-frost and snow is the same: when cloud freezes there is snow, when vapour freezes there is hoar-frost. Hence snow is a sign of a cold season or country. For a great deal of heat is still present and unless the cold were overpowering it the cloud would not freeze. For there still survives in it a great deal of the heat which[12] caused the moisture to rise as vapour from the earth.

Hail on the other hand is found in the upper region, but the corresponding phenomenon in the vaporous region near the earth is lacking. For, as we said, to snow in the upper region corresponds hoar-frost in the lower, and to rain in the upper region, dew in the lower. But there is nothing here to correspond to hail in the upper region. Why this is so will be clear when we have explained the nature of hail.

12 · But we must go on to collect the facts bearing on the origin of it, both those which raise no difficulties and those which seem paradoxical.

Hail is ice, and water freezes in winter; yet hailstorms occur chiefly in spring and autumn and less often in the late summer, but rarely in winter and then only when the cold is less intense. And in general hailstorms occur in warmer, and snow in colder places. Again, there is a difficulty about water freezing in the upper region. It cannot have frozen before becoming water; and water cannot remain suspended in the air for any space of time. Nor can we say that the case is like that of particles of moisture which are carried up owing to their small size and rest on the air (the water swimming on the air just as small particles of earth and gold often swim on water). In that case large drops are formed by the union of many small, and so fall down. This cannot take place in the case of hail, since frozen bodies cannot coalesce like liquid ones. Clearly then drops of that size were suspended in the air or else they could not have been so large when frozen.

Some think that the cause and origin of hail is this. The cloud is thrust up into the upper region, which is colder because the reflection of the sun's rays from the earth ceases there, and upon its arrival there the water freezes. They think that this explains why hailstorms are commoner in summer and in warm countries; the heat is greater and it thrusts the clouds further up from the earth. But the fact is that hail does not occur at all at a great height: yet it ought to do so, on their theory, just as we see that snow falls most on high mountains. Again, clouds have often been observed moving with a great noise close to the earth, terrifying those who heard and saw them as portents of some catastrophe. Sometimes, too, when such clouds have been seen, without any noise, there follows a violent hailstorm, and the stones are of incredible size, and angular in shape. This shows that they have not been falling for long and that they were frozen near to the earth, and not as that theory would have it. Moreover, where the hailstones are large, the cause of their freezing

[12]Omitting πυρός.

must be present in the highest degree; for hail is ice, as every one can see. Now those hailstones are large which are angular in shape. And this shows that they froze close to the earth; for those that fall far are worn away by the length of their fall and become round and smaller in size.

It clearly follows that the freezing does not take place because the cloud is thrust up into the cold upper region. 348b1

Now we see that warm and cold react upon one another. Hence in warm weather the lower parts of the earth are cold and in a frost they are warm. The same thing, we must suppose, happens in the upper region, so that in the warmer seasons the cold is concentrated by the surrounding heat and causes the cloud to go over into water suddenly. (For this reason rain-drops are much larger on warm days than in winter, and showers more violent. A shower is said to be more violent in proportion as the water comes down in a body, and this happens when the condensation takes place quickly—though this is just the opposite of what Anaxagoras says. He says that this happens when the cloud has risen into the cold air; whereas we say that it happens when the cloud has descended into the warm air, and that the more the further the cloud has descended). But when the cold has been concentrated within still more by the outer heat, it freezes the water it has formed and there is hail. We get hail when the process of freezing is quicker than the descent of the water. For if the water falls in a certain time and the cold is sufficient to freeze it in less, there is no difficulty about its having frozen in the air, provided that the freezing takes place in a shorter time than its fall. The nearer to the earth, and the more intensely, this process takes place, the more violent is the rain that results and the larger the raindrops and the hailstones because of the shortness of their fall. For the same reason large raindrops do not fall thickly. Hail is rarer in summer than in spring and autumn, though commoner than in winter, because the air is drier in summer, whereas in spring it is still moist, and in autumn it is beginning to grow moist. It is for the same reason that hailstorms sometimes occur in the late summer too, as we have said.

The fact that the water has previously been warmed contributes to its freezing quickly; for so it cools sooner. (Hence many people, when they want to cool water quickly, begin by putting it in the sun. So the inhabitants of Pontus when they encamp on the ice to fish (they cut a hole in the ice and then fish) pour warm water round their rods that it may freeze the quicker; for they use the ice like lead to fix 349a1
the rods.) Now it is in hot countries and seasons that the water which forms soon grows warm.

It is for the same reason that rain falls in summer and not in winter in Arabia and Ethiopia too, and that in torrents and repeatedly on the same day. For the concentration due to the extreme heat of the country cools the clouds quickly.

So much for an account of the nature and causes of rain, dew, snow, hoar-frost, and hail.

13 · Let us explain the nature of winds, and all windy vapours, also of rivers and of the sea. But here, too, we must first discuss for ourselves the difficulties

involved; for, as in other matters, so in this nothing has been handed down to us that anyone could not have thought of.

Some say that what is called air, when it is motion and flows, is wind, and that this same air when it condenses again becomes cloud and water, implying that the nature of wind and water is the same. So they define wind as a motion of the air. Hence some, wishing to say a clever thing, assert that all the winds are one wind, because the air that moves is in fact all of it one and the same; they maintain that the winds appear to differ owing to the region from which the air may happen to flow on each occasion, but really do not differ at all. This is just like thinking that all rivers are one and the same river, and the ordinary unscientific view is better than a scientific theory like this. If all rivers flow from one source, and the same is true in the case of the winds, there might be some truth in this theory; but if it is no more true in the one case than in the other, this ingenious idea is plainly false. What requires investigation is this: the nature of wind and how it originates, its efficient cause and whence they derive their source; whether one ought to think of the wind as issuing from a sort of vessel and flowing until the vessel is empty, as if let out of a wineskin, or, as painters represent the winds, as drawing their source from themselves.

We find analogous views about the origin of rivers. It is thought that the water is raised by the sun and descends in rain and gathers below the earth and so flows from a great hollow, all the rivers from one, or each from a different one. No water at all is generated, but the volume of the rivers consists of the water that is gathered into such reservoirs in winter. Hence rivers are always fuller in winter than in summer, and some are perennial, others not. Rivers are perennial where the hollow is large and so enough water has collected in it to last out and not be used up before the winter rain returns. Where the reservoirs are smaller there is less water in the rivers, and they are dried up and their vessel empty before the fresh rain comes on.

But if any one will picture to himself a reservoir adequate to the water that is continuously flowing day by day, and consider the amount of the water, it is obvious that a receptacle that is to contain all the water that flows in the year would be larger than the earth, or, at any rate, not much smaller.

Though it is evident that many reservoirs of this kind do exist in many parts of the earth, yet it is unreasonable for any one to refuse to admit that air becomes water in the earth for the same reason as it does above it. If the cold causes the vaporous air to condense into water above the earth we must suppose the cold in the earth to produce this same effect, and recognize that there not only exists in it and flows out of it actually formed water, but that water is continually forming in it too.

Again, even in the case of the water that is not being formed from day to day but exists as such, we must not suppose as some do that rivers have their source in definite subterranean lakes. On the contrary, just as above the earth small drops form and these join others, till finally the water descends in a body as rain, so too we must suppose that in the earth the water at first trickles together little by little, and that the sources of the rivers are formed where the earth gushes out, as it were, at a single point. This is proved by facts. When men construct irrigation works they collect the water in pipes and trenches, as if the earth in the higher ground were sweating the water out. Hence, too, the head-waters of rivers are found to flow from mountains, and from the greatest mountains there flow the most numerous and greatest rivers. Again, most springs are in the neighbourhood of mountains and of high ground, whereas if we except rivers, water rarely appears in the plains. For mountains and high ground, suspended over the country like a saturated sponge, make the water ooze out and trickle together in minute quantities but in many places. They receive a great deal of water falling as rain (for it makes no difference whether a spongy receptacle is concave and turned up or convex and turned down: in either case it will contain the same volume of matter) and they also cool the vapour that rises and condense it back into water.

Hence, as we said, we find that the greatest rivers flow from the greatest mountains. This can be seen by looking at maps: what is recorded in them consists either of things which the writer has seen himself or of such as he has compiled after inquiry from those who have seen them.

In Asia we find that the most numerous and greatest rivers flow from the mountain called Parnassus, admittedly the greatest of all mountains towards the south-east. When you have crossed it you see the outer ocean, the further limit of which is unknown to the dwellers in our world. Besides other rivers there flow from it the Bactrus, the Choaspes, the Araxes: from the last a branch separates off and flows into lake Maeotis as the Tanais. From it, too, flows the Indus, the volume of whose stream is greatest of all rivers. From the Caucasus flows the Phasis, and very many other great rivers besides. Now the Caucasus is the greatest of the mountains that lie to the north-east, both as regards its extent and its height. A proof of its height is the fact that it can be seen from the so-called 'deeps' and from the entrance to the lake. Again, the sun shines on its peaks for a third part of the night before sunrise and again after sunset. Its extent is proved by the fact that though it contains many inhabitable regions which are occupied by many nations and in which there are said to be great lakes, yet they say that all these regions are visible up to the last peak. From Pyrene (this is a mountain towards the west in Celtice) there flow the Istrus and the Tartessus. The latter flows outside the pillars, while the Istrus flows through all Europe into the Euxine. Most of the remaining rivers flow northwards from the Hercynian mountains, which are the greatest in height and extent about that region. In the extreme north, beyond furthest Scythia, are the mountains called Rhipae. The stories about their size are altogether too fabulous: however, they say that the most and (after the Istrus) the greatest rivers flow from them. So, too, in Libya there flow from the Aethiopian mountains the Aegon and the Nyses; and from the so-called Silver Mountain the two greatest of named rivers, the river called Chremetes that flows into the outer ocean, and the main source of the Nile. Of the rivers in the Greek world, the Achelous flows from Pindus, the Inachus from the same mountain; the Strymon, the Nessus, and the Hebrus all three from Scombrus; many rivers, too, flow from Rhodope.

All other rivers would be found to flow in the same way, but we have mentioned these as examples. Even where rivers flow from marshes, the marshes in almost every case are found to lie below mountains or gradually rising ground.

It is clear then that we must not suppose rivers to originate from definite reservoirs; for the whole earth, we might almost say, would not be sufficient (any more than the region of the clouds would be) if we were to suppose that they were fed by actually existing water only and it were not the case that as some water passed out of existence some more came into existence, but rivers always drew their stream from an existing store. Secondly, the fact that rivers rise at the foot of mountains proves that a place transmits the water it contains by gradual percolation of many drops, little by little, and that this is how the sources of rivers originate. However, there is nothing impossible about the existence of such places containing a quantity of water like lakes: only they cannot be big enough to produce the supposed effect, any more than one could suppose that rivers drew all their water from the sources we see (for most rivers do flow from springs). So it is no more reasonable to suppose those lakes to contain the whole volume of water than these springs.

That there exist such chasms and cavities in the earth we are taught by the rivers that are swallowed up. They are found in many parts of the earth: in the Peloponnesus, for instance, there are many such rivers in Arcadia. The reason is that Arcadia is mountainous and there are no channels from its valleys to the sea. So these places get full of water, and this, having no outlet, under the pressure of the water that is added above, finds a way out for itself underground. In Greece this kind of thing happens on quite a small scale; but there is the lake at the foot of the Caucasus, which the inhabitants of these parts call a sea. Many great rivers fall into it and it has no visible outlet but issues below the earth off the land of the Coraxi about the so-called deeps of Pontus. This is a place of unfathomable depth in the sea: at any rate no one has yet been able to find bottom there by sounding. At this spot, about three hundred stadia from land, there comes up sweet water over a large area, not all of it together but in three places. And in Liguria a river equal in size to the Rhodanus is swallowed up and appears again elsewhere: the Rhodanus being a navigable river.

14 · The same parts of the earth are not always moist or dry, but they change according as rivers come into existence and dry up. And so the relation of land to sea changes too and a place does not always remain land or sea throughout all time, but where there was dry land there comes to be sea, and where there is now sea, there one day comes to be dry land. But we must suppose these changes to follow some order and cycle. The principle and cause of these changes is that the interior of the earth has its periods of maturity, like the bodies of plants and animals. Only in the case of these latter the process does not go on by parts, but each of them necessarily grows or decays as a whole, whereas it does go on by parts in the case of the earth. Here the causes are cold and heat, which increase and diminish on account of the sun and its course. It is owing to them that the parts of the earth come to have a different character, so that some parts remain moist for a certain time, and then dry up and grow old, while other parts in their turn are filled with life and moisture. Now when places become drier the springs necessarily give out, and when this happens the rivers first decrease in size and then finally become dry; and when rivers change and disappear in one part and come into existence correspondingly in another, the sea must needs be affected.

For where the sea is pushed out by rivers and encroaches upon the land, it necessarily leaves that place dry when it recedes; and where it becomes dry, being silted up by the rivers when at their full, the time must come when this place will be flooded again.[13]

But the whole vital process of the earth takes place so gradually and in periods of time which are so immense compared with the length of our life, that these changes are not observed, and before their course can be recorded from beginning to end whole nations perish and are destroyed. Of such destructions the most utter and sudden are due to wars; but pestilence or famine cause them too. Famines, again, are either severe or else gradual. In the latter case the disappearance of a nation is not noticed because some leave the country while others remain; and this goes on until the land is unable to maintain any inhabitants at all. So a long period of time is likely to elapse from the first departure to the last, so that no one remembers and the lapse of time destroys all record even before the last inhabitants have disappeared. In the same way a nation must be supposed to lose account of the time when it first settled in a land that was changing from a marshy and watery state and becoming dry. Here, too, the change is gradual and lasts a long time and men do not remember who came first, or when, or what the land was like when they came. This has been the case with Egypt. Here it is obvious that the land is continually getting drier and that the whole country is a deposit of the river Nile. But because the neighbouring peoples settled in the land gradually as the marshes dried, the lapse of time has hidden the beginning of the process. Thus, all the mouths of the Nile, with the single exception of that at Canopus, are obviously artificial and not natural. And Egypt was originally what is called Thebes, as Homer, too, shows, modern though he is in relation to such changes. For Thebes is the place that he mentions; which implies that Memphis did not yet exist, or at any rate was not as important as it is now. That this should be so is natural, since the lower land came to be inhabited later than that which lay higher. For the parts that lie nearer to the place where the river is depositing the silt are necessarily marshy for a longer time since the water always lies most in the newly formed land. But in time this land changes its character, and in its turn enjoys a period of prosperity. For these places dry up and come to be in good condition while the places that were formerly well-tempered some day grow excessively dry and deteriorate. This happened to the land of Argos and Mycenae in Greece. In the time of the Trojan wars the Argive land was marshy and could only support a small population, whereas the land of Mycenae was in good condition (and for this reason Mycenae was the superior). But now the

[13] Reading πληθύουσι for πληθύουσα.

opposite is the case, for the reason we have mentioned: the land of Mycenae has become completely dry and barren, while the Argive land that was formerly barren owing to the water has now become fruitful. Now the same process that has taken place in this small district must be supposed to be going on over whole countries and on a large scale.

Men whose outlook is narrow suppose the cause of such events to be change in the universe, in the sense of a coming to be of the world as a whole. Hence they say that the sea is being dried up and is growing less, because this is observed to have happened in more places now than formerly. But this is only partially true. It is true that many places are now dry, that formerly were covered with water. But the opposite is true too; for if they look they will find that there are many places where the sea has invaded the land. But we must not suppose that the cause of this is that the world is in process of becoming. For it is absurd to make the universe to be in process because of small and trifling changes, when the bulk and size of the earth are surely as nothing in comparison with the whole world. Rather we must take the cause of all these changes to be that, just as winter occurs in the seasons of the year, so in determined intervals in some great period of time there comes a great winter and with it excess of rain. But this excess does not always occur in the same place. The so-called flood in the time of Deucalion, for instance, took place chiefly in the Greek world and in it especially about ancient Hellas, the country about Dodona and the Achelous, a river which has often changed its course. Here the Selli dwelt and those who were formerly called Graeci and now Hellenes. When, therefore, such an excess of rain occurs we must suppose that it suffices for a long time. Just as some say that the size of the subterranean cavities is what makes some rivers perennial and others not, whereas we maintain that the size of the mountains is the cause, and their density and coldness (for they catch and keep and create most water: whereas if the mountains that overhang the sources of rivers are small or porous and stony and clayey, these rivers run dry earlier); so too we must realize that where such abundance of rain falls it tends to make the moisture of those places almost everlasting. But as time goes on places of the latter type dry up more,[14] while those of the former, moist type, do so less:[15] until at last the beginning of the same cycle returns.

Since there is necessarily some change in the whole world, but not in the way of coming into existence or perishing (for the universe is permanent), it must be, as we say, that the same places are not for ever moist through the presence of sea and rivers, nor for ever dry. And the facts prove this. The whole land of the Egyptians, whom we take to be the most ancient of men, has evidently come into existence and been produced by the river. This is clear from an observation of the country itself, and the facts about the Red Sea suffice to prove it too. One of their kings tried to make a canal to it (for it would have been of no little advantage to them for the whole region to have become navigable; Sesostris is said to have been the first of the

[14] Omitting γιγνόμενα.
[15] Reading ἔλαττον for ἐλάττω.

ancient kings to try), but he found that the sea was higher than the land. So he first, and Darius afterwards, stopped making the canal, lest the sea should mix with the river water and spoil it. So it is clear that all this part was once one unbroken sea. For the same reason Libya—the country of Ammon—is, strangely enough, lower and hollower than the land to the seaward of it. For it is clear that a barrier of silt was formed and after it lakes and dry land, but in the course of time the water that was left behind in the lakes dried up and is now all gone. Again the silting up of the lake Maeotis by the rivers has advanced so much that the limit to the size of the ships which can now sail into it to trade is much lower than it was sixty years ago. Hence it is easy to infer that it, too, like most lakes, was originally produced by the rivers and that it must end by drying up entirely.

Again, this process of silting up causes a continuous current through the Bosporus; and in this case we can directly observe the nature of the process. Whenever the current from the Asiatic shore threw up a sandbank, there first formed a small lake behind it. Later it dried up and a second sandbank formed in front of the first and a second lake. This process went on uniformly and without interruption. Now when this has been repeated often enough, in the course of time the strait must become like a river, and in the end the river itself must dry up.

So it is clear, since there will be no end to time and the world is eternal, that neither the Tanais nor the Nile has always been flowing, but that the region whence they flow was once dry; for their action has an end, but time does not. And this will be equally true of all other rivers. But if rivers come into existence and perish and the same parts of the earth were not always moist, the sea must needs change correspondingly. And if the sea is always advancing in one place and receding in another it is clear that the same parts of the whole earth are not always either sea or land, but that all this changes in the course of time.

So we have explained that the same parts of the earth are not always land or sea and why that is so; and also why some rivers are perennial and others not.

BOOK II

1 · Let us explain the nature of the sea and the reason why such a large mass of water is salt and the way in which it originally came to be.

The old writers who concerned themselves with theogonies say that the sea has springs, for they want earth and sea to have origins and roots. Presumably they thought that this view was grander and more impressive as implying that our earth was an important part of the universe. For they believed that the whole world had been built up round our earth and for its sake, and that the earth was the most important and primary part of it. Others, wiser in human knowledge, give an account of its origin. At first, they say, the earth was surrounded by moisture. Then the sun began to dry it up, part of it evaporated and is the cause of winds and the turnings back of the sun and the moon, while the remainder forms the sea. So the sea is being dried up and is growing less, and will end by being some day entirely dried up. Some of them say that the sea is a kind of sweat exuded by the earth when the sun heats it, and that this explains its saltness; for all sweat is salt. Others say that the saltness is due to the earth. Just as water strained through ashes becomes salt, so the sea owes its saltness to the admixture of earth with similar properties.

We must now consider the facts which prove that the sea cannot have springs. The waters we find on the earth either flow or are stationary. All flowing water has springs. (By a spring, as we have explained above, we must not understand a source from which waters are ladled[16] as it were from a vessel, but a first point at which[17] the water which is continually forming and percolating gathers.)[18] Stationary water is either that which has collected and has been left standing, marshy pools, for instance, and lakes, which differ merely in size, or else it comes from springs. In this case it is always artificial, I mean as in the case of wells. For the spring must always be higher than the stream. Hence the water from fountains and rivers flows of itself, whereas wells need to be worked artificially. All the waters that exist belong to one or other of these classes.

On the basis of this division we can see that the sea cannot have springs. For it falls under neither of the two classes; it does not flow and it is not artificial; whereas all water from springs belongs to one or other of them. Natural standing water from springs is never found on such a large scale.

354a1 Again, there are several seas that have no communication with one another at all. The Red Sea, for instance, communicates but slightly with the ocean outside the straits, and the Hyrcanian and Caspian seas are distinct from this ocean and people dwell all round them. Hence, if these seas had had any springs anywhere they must have been discovered.

It is true that in straits, where the land on either side contracts an open sea into a small space, the sea evidently flows. But this is because it is swinging to and fro. In the open sea this motion is not observed, but where the land narrows and contracts the sea the motion that was slight in the open necessarily seems great.

The whole of the Mediterranean does actually flow, according to the depth of the basins and the number of rivers. Maeotis flows into Pontus and Pontus into the Aegean. After that the flow of the remaining seas is not so easy to observe. The current of Maeotis and Pontus is due to the number of rivers (more rivers flow into the Euxine and Maeotis than into areas many times their size), and to their own shallowness. For we find the sea getting deeper and deeper. Pontus is deeper than Maeotis, the Aegean than Pontus, the Sicilian sea than the Aegean; the Sardinian and Tyrrhenic being the deepest of all. (Outside the pillars of Herakles the sea is shallow owing to the mud, but calm, for it lies in a hollow.) We see, then, that just as single rivers flow from mountains, so it is with the earth as a whole: the greatest

[16]Retaining ταμιευομένων.
[17]Retaining ἦν.
[18]Retaining ἀπαντᾷ.

volume of water flows from the higher regions in the north. Their alluvium makes the northern seas shallow, while the outer seas are deeper. Some further evidence of the height of the northern regions of the earth is afforded by the view of many of the ancient meteorologists. They believed that the sun did not pass below the earth, but round its northern part, and that it was the height of this which obscured the sun and caused night.

So much to prove that there cannot be sources of the sea and to explain its observed flow.

2 · We must now discuss the origin of the sea, if it has an origin, and the 354b1 cause of its salt and bitter taste.

What made earlier writers consider the sea to be the source and main body of all water is this. It seems reasonable to suppose that, just as each of the other elements has a main bulk which by reason of its mass is the origin of that element, and any parts which change and mix with the other elements come from it—thus the main body of fire is in the upper region; that of air occupies the place next inside the region of fire; while the mass of the earth is that round which the rest of the elements are seen to lie. So we must clearly look for something analogous in the case of water. But here we can find no such single mass, as in the case of the other elements, except the sea. River water is not a unity, nor is it stable, but is seen to be in a continuous process of becoming from day to day. It was this difficulty which made people regard the sea as the source of moisture and of all water. And so we find it maintained that rivers not only flow into the sea but originate from it, the salt water becoming sweet by filtration.

But this view involves another difficulty. If this body of water is the source of all water, why is it salt and not sweet? The reason for this, besides answering this question, will ensure our having a right first conception of the nature of the sea.

The earth is surrounded by water, just as that is by the sphere of air, and that again by the sphere called that of fire (which is the outermost both on the common view and on ours). Now the sun, moving as it does, sets up processes of change and becoming and decay, and by its agency the finest and sweetest water is every day carried up and is dissolved into vapour and rises to the upper region, where it is condensed again by the cold and so returns to the earth. This, as we have said before, is the regular course of nature.

Hence all my predecessors who supposed that the sun was nourished by moisture are absurdly mistaken. Some go on to say that the solstices are due to this, 355a1 the reason being that the same places cannot always supply the sun with nourishment and that without it he must perish. For the fire we are familiar with lives as long as it is fed, and the only food for fire is moisture. This supposes that the moisture that is raised reaches the sun or that its ascent is really like that performed by flame as it comes into being, and to which they supposed the case of the sun to be analogous. Really there is no similarity. A flame is in a process of becoming, involving a constant interchange of moist and dry. It cannot be said to be nourished since it scarcely persists as one and the same for a moment. This cannot be true of the sun; for if it were nourished like that, as they say it is, we should obviously not only have a new sun every day, as Heraclitus says, but a new sun every moment. Again, when the sun causes the moisture to rise, this is like fire heating water. So, as the fire is not fed by the water above it, it is absurd to suppose that the sun is, even if its heat made all the water in the world evaporate. Again, it is absurd, considering the number and size of the stars, that these thinkers should consider the sun only and overlook the question how the rest of the heavenly bodies survive. Again, they are met by the same difficulty as those who say that at first the earth itself was moist and the world round the earth was warmed by the sun, and so air was generated and the whole firmament grew, and the air caused winds and the solstices. For we always plainly see the water that has been carried up coming down again. Even if the same amount does not come back in a year or in a given country, yet in a certain fixed period all that has been carried up is returned. This implies that the celestial bodies do not feed on it, and that we cannot distinguish between some air which preserves its character once it is generated and some other which is generated but becomes water again and so perishes; on the contrary, all the moisture alike is dissolved and all of it condensed back into water.

The drinkable, sweet water, then, is light and is all of it drawn up: the salt water is heavy and remains behind, but not in its proper place. For this is a question which has been sufficiently discussed (for it would be unreasonable if there were no
355b1 place for water as there is for the other elements), and the answer is this. The place which we see the sea filling is not its place but that of water. It seems to belong to the sea because the weight of the salt water makes it remain there, while the sweet, drinkable water which is light is carried up. The same thing happens in animal bodies. Here, too, the food when it enters the body is sweet, yet the residuum and dregs of liquid food are found to be bitter and salt. This is because the sweet and drinkable part of it has been drawn away by the natural heat and has passed into the flesh and the other parts of the body according to their several natures. Now just as here it would be wrong[19] for any one to refuse to call the belly the place of liquid food because that disappears from it soon, and to call it the place of the residuum because this is seen to remain, so in the case of our present subject. This place, we say, is the place of water. Hence all rivers and all the water that is generated flow into it; for water flows into the deepest place, and the deepest part of the earth is filled by the sea. But part of it is all quickly carried up by the sun, while the rest remains for the reason we have explained. It is quite natural that some people should have been puzzled by the old question why such a mass of water leaves no trace anywhere (for the sea does not increase though innumerable and vast rivers are flowing into it every day). But if one considers the matter the solution is easy. The same amount of water does not take as long to dry up when it is spread out as when it is gathered in a body, and indeed the difference is so great that in the one case it might persist the whole day long while in the other it might all disappear in a moment—as for instance if one were to spread out a cup of water over a large table.

[19]Omitting ἄτοπον.

This is the case with the rivers: all the time they are flowing their water forms a compact mass, but when it arrives at a vast wide place it quickly and imperceptibly evaporates.

But the theory of the *Phaedo*[20] about rivers and the sea is impossible. There it is said that the earth is pierced by intercommunicating channels and that the original head and source of all waters is what is called Tartarus—a mass of water 356ᵃ1
about the centre, from which all waters, flowing and standing, are derived. This primary and original water is always surging to and fro, and so it causes the rivers to flow; for it has no fixed seat but is always oscillating about the centre. Its motion up and down is what fills rivers. Many of these form lakes in various places (our sea is an instance of one of these), but all of them come round again in a circle to the source of their flow, many at the same point, but some at a point opposite to that from which they issued; for instance, if they started from the other side of the earth's centre, they might return from this side of it. They descend only as far as the centre, for after that all motion is upwards. Water gets its tastes and colours from the kind of earth the rivers happened to flow through.

But on this theory rivers do not always flow in the same sense. For since they flow to the centre from which they issue forth they will not be flowing down any more than up, but in whatever direction the surging of Tartarus inclines to. But at this rate we shall get the proverbial rivers flowing upwards, which is impossible. Again, where is the water that is generated and what goes up again as vapour to come from? For this must all of it simply be ignored, since the quantity of water is always the same and all the water that flows out from the original source flows back to it again. Yet all rivers are seen to end in the sea except where one flows into another. Not one of them ends in the earth, but even when one is swallowed up it comes to the surface again. And those rivers are large which flow for a long distance through a low-lying country, for by their situation and length they cut off the course of many others and swallow them up. This is why the Istrus and the Nile are the greatest of the rivers which flow into our sea. Indeed, so many rivers fall into them that there is disagreement as to the sources of them both.[21] All of which is plainly impossible on the theory, and the more so as it derives the sea from Tartarus.

Enough has been said to prove that this is the natural place of water and not of the sea, and to explain why sweet water is only found in rivers, while salt water is stationary and to show that the sea is the end rather than the source of water, 356ᵇ1
analogous to the residual matter of all food, and especially liquid food, in animal bodies.

3 · We must now explain why the sea is salt, and ask whether it is always the same, or whether it did not exist at all once and some day will exist no longer, but will dry up as some people think.

Every one admits this, that if the whole world originated the sea did too; for

[20] *Phaedo* 111 Cff.
[21] Omitting αἰτίας.

they make them come into being at the same time. It follows that if the universe is eternal the same must be true of the sea. Any one who thinks like Democritus that the sea is diminishing and will disappear in the end reminds us of Aesop's tales. His story was that Charybdis had twice sucked in the sea: the first time she made the mountains visible; the second time the islands; and when she sucks it in for the last time she will dry it up entirely. Such a tale is appropriate enough to Aesop in a rage with the ferryman, but not to serious inquirers. Whatever made the sea remain at first, whether it was its weight, as some even of those who hold these views say (for it is easy to see the cause here), or some other reason—clearly the same thing must make it persist for ever. They must either deny that the water raised by the sun will return at all, or, if it does, they must admit that the sea persists for ever or as long as this process goes on, and again, that for the same period of time that sweet water must be carried up beforehand. So the sea will never dry up; for before that can happen the water that has gone up beforehand will return to it;[22] for if you say that this happens once you must admit its recurrence. If you stop the sun's course there is no drying agency. If you let it go on it will draw up the sweet water as we have said whenever it approaches, and let it descend again when it recedes. This notion about the sea was derived from the fact that many places are found to be drier now than they once were. Why this is so we have explained. The phenomenon is due to temporary excess of rain and not to any process of becoming in which the universe or its parts are involved. Some day the opposite will take place and after that the
357a1 earth will grow dry once again. We must recognize that this process always goes on thus in a cycle; for that is more reasonable than to suppose a change in the whole world in order to explain these facts. But we have dwelt longer on this point than it deserves.

To return to the saltness of the sea: those who create the sea once for all, or indeed generate it at all, cannot account for its saltness. It makes no difference whether the sea is the residue of all the moisture that is about the earth and has been drawn up by the sun, or whether all the flavour existing in the whole mass of sweet water is due to the admixture of a certain kind of earth. Since the total volume of the sea is the same once the water that evaporated has returned, it follows that it must either have been salt at first too, or, if not at first, then not now either. If it was salt from the very beginning, then we want to know why that was so; and why, if salt water was drawn up then, that is not the case now.

Again, if it is maintained that an admixture of earth makes the sea salt (for they say that earth has many flavours and is washed down by the rivers and so makes the sea salt by its admixture), it is strange that rivers should not be salt too. How can the admixture of this earth have such a striking effect in a great quantity of water and not in each river singly? For the sea, differing in nothing from rivers but in being salt, is evidently simply the totality of river water, and the rivers are the vehicle in which that is carried to their common destination.

[22]Omitting τήν.

It is equally absurd to suppose that anything has been explained by calling the sea 'the sweat of the earth', like Empedocles. Metaphors are poetical and so that expression of his may satisfy the requirements of a poem, but as to knowledge of nature it is unsatisfactory. Even in the case of the body it is a question how the sweet liquid drunk becomes salt sweat—whether it is merely by the departure of some element in it which is sweetest, or by the admixture of something, as when water is strained through ashes. Actually the saltness seems to be due to the same cause as in the case of the residual liquid that gathers in the bladder. That, too, becomes bitter and salt though the liquid we drink and that contained in our food is sweet. If then the bitterness is due in these cases (as with the water strained through lye) to the presence of a certain sort of stuff that is carried along by the urine (as indeed we actually find a salt deposit settling in chamber-pots) and is secreted from the flesh in sweat (as if the departing moisture were washing the stuff out of the body), then no doubt the admixture of something earthy with the water is also what makes the sea salt.

Now in the body stuff of this kind, viz. the sediment of food, is due to failure to digest; but how there came to be any such thing in the earth requires explanation. Besides, how can the drying and warming of the earth cause the secretion of such a great quantity of water; especially as that must be a mere fragment of what is left in the earth? Again, waiving the question of quantity, why does not the earth sweat now when it happens to be in process of drying? (For the moisture and the sweat are bitter.) For if it did so then, it ought to do so now. But it does not: on the contrary, when it is dry it grows moist, but when it is moist it does not secrete anything at all. How then was it possible for the earth at the beginning when it was moist to sweat as it grew dry? Indeed, the theory that maintains that most of the moisture departed and was drawn up by the sun and that what was left over is the sea is more reasonable; but for the earth to sweat when it is moist is impossible.

Since all the attempts to account for the saltness of the sea seem unsuccessful let us explain it by the help of the principle we have used already.

Since we recognize two kinds of exhalation, one moist, the other dry, it is clear that the latter must be recognized as the source of phenomena like those we are concerned with.

But there is a question which we must discuss first. Does the sea always remain numerically one and consisting of the same parts, or is it one in form and volume while its parts are in continual change, like air and sweet water and fire? All of these are in a constant state of change, but the form of the quantity of each of them is fixed, just as in the case of a flowing river or a burning flame. The answer is clear, and it is plausible that the same account must hold good of all these things alike. They differ in that some of them change more rapidly or more slowly than others; and they all are involved in a process of perishing and becoming which yet affects them all in a regular course.

This being so we must go on to try to explain why the sea is salt. There are many signs which make it clear that this taste is due to the admixture of something.

First, in animal bodies what is least digested, the residue of liquid food, is salt and bitter, as we said before. All animal excreta are undigested, but especially that which gathers in the bladder (its extreme lightness indicates this; for everything that is digested is condensed), and also sweat; in these then is excreted (along with other matter) an identical substance to which this flavour is due. The case of things burnt is analogous. What heat fails to overcome becomes the excrementary residue in animal bodies, and, in things burnt, ashes. That is why some people say that the sea itself was made from burnt earth. To say that it was burnt earth is absurd; but to say that it was something like burnt earth is true. We must suppose that just as in the cases we have described, so in the world as a whole, everything that grows and is naturally generated always leaves a residue, like that of things burnt, consisting of this sort of earth, and all exhalation on dry land is of this nature; for it is this which accounts for its great quantity. Now since, as we have said, the moist and the dry exhalations are mixed, some quantity of this stuff must always be included in the clouds and the water that are formed by condensation, and must redescend to the earth in rain. This process must always go on with such regularity as this world admits of, and it is the answer to the question how the sea comes to be salt.

It also explains why rain that comes from the south, and the first rains of autumn, are brackish. The south is the warmest of winds, both in size and strength, and it blows from dry and hot regions. Hence it carries little moist vapour and that is why it is hot. (It makes no difference even if this is not its true character and it is originally a cold wind, for it becomes warm on its way by incorporating with itself a great quantity of dry exhalation from the places it passes over.) The north wind, on the other hand, coming from moist regions, is full of vapour and therefore cold. It brings fine weather in our part of the world because it drives the clouds away before it, but in the south it is rainy; just as the south in Libya. So the rain that falls is charged with a great quantity of this stuff. Autumn rain is brackish because the heaviest water must fall first; so that that which contains the greatest quantity of this kind of earth descends quickest.

This, too, is why the sea is warm. Everything that has been exposed to fire contains heat potentially, as we see in the case of lye and ashes and the dry and liquid excreta of animals. Indeed those animals which are hottest in the belly have the hottest excreta.

The action of this cause is continually making the sea more brackish, but some part of it is always being drawn up with the sweet water. This is less than the sweet water in the same ratio in which the salt and brackish element in rain is less than the sweet, and so the saltness of the sea remains constant on the whole. When it turns into vapour it becomes sweet, and the vapour does not form salt water when it condenses again. This I know by experiment. The same thing is true in every case of the kind: wine and all fluids that evaporate and condense back into a liquid state become water. They all are water modified by a certain admixture, the nature of which determines their flavour. But this subject must be considered on another more suitable occasion.

For the present let us say this. The sea is there and some of it is continually being drawn up and becoming sweet; this returns from above with the rain. But it is now different from what it was when it was drawn up, and its weight makes it sink below the sweet water. This process prevents the sea, as it does rivers, from drying up except locally (this must happen to sea and rivers alike); nor do the parts either of the earth or of the sea remain constant but only their whole bulk. (For the same thing is true of the earth as of the sea.) Some of it is carried up and some comes down with the rain, and both that which remains on the surface and that which comes down again change their situations.

There is more evidence to prove that saltness is due to the admixture of some substance, besides that which we have adduced. Make a vessel of wax and put it in the sea, fastening its mouth in such a way as to prevent any water getting in. Then the water that percolates through the wax sides of the vessel is sweet, the earthy stuff, the admixture of which makes the water salt, being separated off as it were by a filter. It is this stuff which makes salt water heavy (it weighs more than fresh water) and thick. The difference in consistency is such that ships with the same weight of cargo very nearly sink in a river when they are quite fit to navigate in the sea. Ignorance of this has before now caused loss to shippers freighting their ships in a river. That the bulk is more dense when something[23] is mixed in is indicated by the fact that if you make strong brine by the admixture of salt, eggs, even when they are full, float in it. It almost becomes like mud; such a quantity of matter is there in the sea. The same thing is done in salting fish.

Again if, as is fabled, there is a lake in Palestine, such that if you bind a man or beast and throw it in it floats and does not sink beneath the water, this would bear out what we have said. They say that this lake is so bitter and salt that no fish live in it and that if you soak clothes in it and shake them it cleans them. The following signs all of them support our theory that it is some earthy stuff in the water which makes it salt. In Chaonia there is a spring of brackish water that flows into a neighbouring river which is sweet but contains no fish. The local story is that when Heracles came from Erytheia driving the oxen and gave the inhabitants the choice, they chose salt in preference to fish. They get the salt from the spring. They boil off some of the water and let the rest stand; when it has cooled and the heat and moisture have evaporated together it gives them salt, not in lumps but loose and light like snow. It is weaker than ordinary salt and must be added freely for seasoning, and it is not as white as salt generally is. Another instance of this is found in Umbria. There is a place there where reeds and rushes grow. They burn some of these, put the ashes into water and boil it off. When a little water is left and has cooled it gives a quantity of salt.

Most salt rivers and springs must once have been hot. Then the original fire in them was extinguished but the earth through which they percolate preserves the character of lye or ashes. Springs and rivers with all kinds of flavours are found in many places. These flavours must in every case be due to the fire that is present or produced in them; for if you expose earth to different degrees of heat it assumes

[23]Reading τινος for τό.

various kinds and shades of flavour. It becomes full of alum and lye and other things of the kind, and the fresh water percolates through these and changes its character. Sometimes it becomes acid as in Sicania, a part of Sicily. There they get a salt and acid water which they use as vinegar to season some of their dishes. In the neighbourhood of Lyncus, too, there is a spring of acid water, and in Scythia a bitter spring. The water from this makes the whole of the river into which it flows bitter. These differences are explained by a knowledge of the particular mixtures that determine different savours. But these have been explained in another treatise.

We have now given an account of water and the sea, why they always persist, how they change, what their nature is, and have explained their natural operations and affections.

4 · Let us proceed to the theory of winds. Its basis is a distinction we have already made. We recognize two kinds of exhalation, one moist, the other dry. The former is called vapour: for the other there is no general name but we must call it a sort of smoke, applying to the whole of it a word that is proper to one of its forms. The moist cannot exist without the dry nor the dry without the moist: whenever we speak of either we mean that it predominates. Now when the sun in its circular course approaches, it draws up by its heat the moist evaporation: when it recedes the cold makes the vapour that had been raised condense back into water which falls and is distributed over the earth. (This explains why there is more rain in winter and more by night than by day: though the fact is not recognized because rain by night is more apt to escape observation than by day.) But there is a great quantity of fire and heat in the earth, and the sun not only draws up the moisture that lies on the surface of it, but warms and dries the earth itself. Consequently, since there are two kinds of exhalation, as we have said, one like vapour, the other like smoke, both of them are necessarily generated. That in which moisture predominates is the source of rain, as we explained before, while the dry one is the source and substance of all winds. That things must necessarily take this course is clear from the facts themselves, for the exhalations must necessarily differ; and the sun and the warmth in the earth not only can but must produce them.

Since the two are specifically distinct, wind and rain obviously differ and their substance is not the same, as those say who maintain that one and the same air when in motion is wind, but when it condenses again is water. Air, as we have explained in an earlier book, is made up of these as constituents. Vapour is moist and cold (for its fluidity is due to its moistness, and because it derives from water it is naturally cold, like water that has not been warmed); whereas smoke is hot and dry. Hence each contributes a part, and air is moist and hot. It is absurd that this air that surrounds us should become wind when in motion, whatever be the source of its motion—on the contrary the case of winds is like that of rivers. We do not call water that flows anyhow a river, even if there is a great quantity of it, but only if the flow comes from a spring. So too with the winds; a great quantity of air might be moved by the fall of some large object without flowing from any source or spring.

The facts bear out our theory. It is because the exhalation takes place uninterruptedly but differs in degree and quantity that clouds and winds always 360b1 appear in their natural season; and it is because there is now a great excess of the vaporous, now of the dry and smoky exhalation, that some years are rainy and wet, others windy and dry. Sometimes there is much drought or rain, and it prevails over a continuous stretch of country. At other times it is local; the surrounding country often getting seasonable or even excessive rains while there is drought in a certain part; or, contrariwise, all the surrounding country gets little or even no rain while a certain part gets rain in abundance. The reason for all this is that while the same affection is generally apt to prevail over a considerable district because adjacent places (unless there is something special to differentiate them) stand in the same relation to the sun, yet sometimes the dry exhalation will prevail in one part and the moist in another, and sometimes the reverse. Again the reason for this latter is that each exhalation goes over to that of the neighbouring district: for instance, the dry evaporation circulates in its own place while the moist migrates to the next district or is even driven by winds to some distant place; or else the moist remains and the dry moves away. Just as in the case of the body when the stomach is dry the lower belly is often in the contrary state, and when it is dry the stomach is moist and cold, so it often happens that the exhalations reciprocally take one another's place and interchange.

Further, after rain wind generally rises in those places where the rain fell, and when rain has come on the wind ceases. These are necessary effects of the principles we have explained. After rain the earth is being dried by its own heat and that from above and gives off the exhalation which we saw to be the body of the wind. And whenever this separation occurs and winds prevail, then when they drop (since the heat is continually being separated and rising to the upper region), then the fall in temperature makes vapour form and condense into water. Water also forms and cools the dry exhalation when the clouds are driven together and the cold 361a1 concentrated in them. These are the causes that make wind cease on the advent of rain, and rain fall on the cessation of wind.

The cause of the predominance of winds from the north and from the south is the same. (Most winds, as a matter of fact, are north winds or south winds.) These are the only regions which the sun does not visit: it approaches them and recedes from them, but its course is always over the west and the east. Hence clouds collect on either side, and when the sun approaches it provokes the moist exhalation, and when it recedes to the opposition side there are storms and rain. So summer and winter are due to the sun's motion to and from the solstices, and water ascends and falls again for the same reason. Now since most rain falls in those regions towards which and from which the sun turns and these are the north and the south, and since most exhalation must take place where the earth receives the greatest rainfall, just as green wood gives most smoke, and since this exhalation is wind, it is reasonable that the most and most important winds should come from these quarters. (The winds from the north are called Boreae, those from the south Noti.)

The course of winds is oblique; for though the exhalation rises straight up from the earth, they blow round it because all the surrounding air follows the motion of the heavens. Hence the question might be asked whether winds originate from above or from below. The motion comes from above: before[24] we feel the wind blowing the air betrays its presence even if there are clouds or a mist; for they show that the wind has begun to blow before it has actually reached us; and this implies that the source of winds is above. But since wind is a quantity of dry exhalation from the earth moving round the earth, it is clear that while the origin of the motion is from above, the matter and the generation of wind come from below. For the direction of flow of the rising exhalation is caused from above; for the motion of the heavens determines the processes that are at a distance from the earth, and the motion from below is vertical and every cause is more active where it is nearest to the effect; but in its generation and origin wind plainly derives from the earth.

The facts bear out the view that winds are formed by the gradual union of many exhalations just as rivers derive their sources from the water that oozes from the earth. Every wind is weakest in the spot from which it blows; as they proceed and leave their source at a distance they gather strength. (Again, the winter in the north is windless and calm: that is, in the north itself; but the breeze that blows from there so gently as to escape observation becomes a great wind as it passes on.

We have explained the nature and origin of wind, the occurrence of drought and rains, the reason why winds rise and fall after rain, the prevalence of north and south winds and also why wind moves in the way it does.

5 · The sun both checks the formation of winds and stimulates it. When the exhalation is small in amount and faint the sun wastes it and[25] dissipates by its greater heat the lesser heat contained in the exhalation. It also dries up the earth before the outflow has appeared in bulk: just as, when you throw a little fuel into a great fire, it is often burnt up before giving off any smoke. In these ways the sun checks winds and prevents them from rising at all: it checks them by wasting, and prevents their rising by drying up the earth quickly. Hence calm is very apt to prevail about the rising of Orion and lasts until the coming of the etesian winds and their forerunners.

Calm is due to two causes. Either cold quenches the exhalation, for instance a sharp frost; or excessive heat wastes it. In the intermediate periods, too, the causes are generally either that the exhalation has not had time to develop or that it has passed away and there is none as yet to replace it.

Both the setting and the rising of Orion are considered to be treacherous and stormy, because they take place at a change of season (namely of summer or winter; and the size of the constellation makes its rise last over many days) and a state of change is always indefinite and therefore liable to disturbance.

The etesian winds blow after the summer solstice and the rising of the dog-star: not at the time when the sun is closest nor when it is distant; and they blow by day and cease at night. The reason is that when the sun is near it dries up the earth before exhalation has taken place, but when it has receded a little its heat and the

[24]Omitting δέ.
[25]Placing καί after μαραίνει instead of before διακρίνει.

exhalation are present in the right proportion; so the ice melts and the earth, dried by its own heat and that of the sun, smokes and vapours. They abate at night because the cold of the nights checks the melting of the ice. What is frozen gives off no evaporation, nor does that which contains no dryness at all: it is only where something dry contains moisture that it gives off evaporation under the influence of heat.

The question is sometimes asked: why do the north winds which we call etesian blow continuously after the summer solstice, when there are no corresponding south winds after the winter solstice? The facts are reasonable enough: for the so-called 'white south winds' do blow at the corresponding season, though they are not equally continuous and so escape observation and give rise to this inquiry. The reason for this is that the north wind blows from the arctic regions which are full of water and much snow. The sun thaws them and so the etesian winds blow after rather than at the summer solstice. (For the greatest heat is developed not when the sun is nearest to the north, but when its heat has been felt for a considerable period and it has not yet receded far. The 'bird winds' blow in the same way after the winter solstice. They, too, are weak etesian winds, but they blow less and later than the etesians. They begin to blow only on the seventieth day because the sun is distant and therefore weaker. They do not blow so continuously because only things on the surface of the earth and offering little resistance evaporate then, the thoroughly frozen parts requiring greater heat to melt them. So they blow intermittently till the true etesians come on again at the summer solstice; for from that time onwards the wind has an especial tendency to blow continuously.) But the south wind blows from the tropic of Cancer and not from the antarctic region.

There are two inhabitable sections of the earth: one near our upper, or northern pole, the other near the other or southern pole; and their shape is like that of a drum. If you draw lines from the centre of the earth they cut out a drum-shaped 362b1
figure. The lines form two cones; the base of the one is the tropic, of the other the ever visible circle, their vertex is at the centre of the earth. Two other cones towards the south pole give corresponding segments of the earth. These sections alone are habitable. Beyond the tropics no one can live; for there the shade would not fall to the north, whereas the earth is known to be uninhabitable before the shadow disappears or is thrown to the south; and the regions below the Bear are uninhabitable because of the cold.

[The Crown, too, moves over this region; for it is in the zenith when it is on our meridian].[26]

So we see that the way in which they now draw maps of the earth is ridiculous. They depict the inhabited earth as round, but both observation and reason show this to be impossible. For reason proves that the inhabited region is limited in breadth, while the climate admits of its extending all round the earth. For we meet with no excessive heat or cold in the direction of its length but only in that of its breadth; so that there is nothing to prevent our travelling round the earth unless the extent of the sea presents an obstacle anywhere. The observations made on journeys by sea

[26] Webster thinks that this sentence is a learned—but irrelevant—interpolation.

and land bear this out. They make the length far greater than the breadth. If we compute these voyages and journeys the distance from the Pillars of Heracles to India exceeds that from Aethiopia to Maeotis and the northernmost Scythians by a ratio of more than 5 to 3, as far as such matters admit of accurate statement. Yet we know the whole breadth of the region we dwell in up to the uninhabited parts: in one direction no one lives because of the cold, in the other because of the heat.

But it is the sea which divides as it seems the parts beyond India from those beyond the Pillars of Heracles and prevents the earth from being inhabited all round.

Now since there must be a region bearing the same relation to the southern pole as the place we live in bears to our pole, it will clearly correspond in the ordering of its winds as well as in other things. So just as we have a north wind, here they must have a corresponding wind from their pole. This wind cannot reach us since our own north wind is like a land breeze and does not even reach[27] the limits of the region we live in. The prevalence of north winds here is due to our lying near the north. Yet even here they give out and fail to penetrate far: in the southern sea beyond Libya east and west winds are always blowing alternately, like north and south winds with us. So it is clear that the south wind is not the wind that blows from the south pole. It is neither that nor the wind from the winter tropic. For symmetry would require another wind blowing from the summer tropic, which there is not, since we know that only one wind blows from that quarter. So the south wind clearly blows from the torrid region. Now the sun is so near to that region that it has no water, or snow[28] which might melt[29] and cause etesian winds. But because that place is far more extensive and open the south wind is greater and stronger and warmer than the north and penetrates farther to the north than the north wind does to the south.

The cause of these winds and their relation to one another has now been explained.

6 · Let us now explain the position of the winds, their oppositions, which can blow simultaneously with which, and which cannot, their names and number, and any other of their affections that have not been treated among the particular problems. What we say about their position must be followed with the help of the diagram. For clearness' sake we have drawn the circle of the horizon—that is why it is round—and it[30] must be taken to represent the zone in which we live; for the other section too can be divided in the same way. Let us begin by laying down that those things are locally contrary which are locally most distant from one another just as things specifically most remote from one another are specific contraries. Now things that face one another from opposite ends of a diameter are locally most distant from one another.

[27]Omitting ἐστιν.
[28]Reading χίονας for νομάς.
[29]Reading τῆξιν for πῆξιν.
[30]Reading αὐτόν.

Let A be the point where the sun sets at the equinox and B, the point opposite, the place where it rises at the equinox. Let there be another diameter cutting this at 363b1 right angles, and let the point G on it be the north and its diametrical opposite H the south. Let F be the rising of the sun at the summer solstice and E its setting at the summer solstice; D its rising at the winter solstice, and C its setting at the winter solstice. Draw a diameter from F to C and from D to E. Then since those things are locally contrary which are locally most distant from one another, and points diametrically opposite are most distant from one another, those winds must necessarily be contrary to one another that blow from opposite ends of a diameter.

The names of the winds according to their position are these. Zephyrus is the wind that blows from A, this being the point where the sun sets at the equinox. Its contrary is Apeliotes blowing from B the point where the sun rises at the equinox. The wind blowing from G, the north, is Boreas or Aparctias; while Notus blowing from H is its contrary; for this point is the south and H is contrary to G, being diametrically opposite to it. Caecias blows from F, where the sun rises at the summer solstice. Its contrary is not the wind blowing from E but Lips blowing from C. For Lips blows from the point where the sun sets at the winter solstice and is diametrically opposite to Caecias: so it is its contrary. Eurus blows from D, coming from the point where the sun rises at the winter solstice. It borders on Notus, and so we often find that people speak of Euro-Noti. Its contrary is not Lips blowing from C but the wind that blows from E which some call Argestes, some Olympias, and some Sciron. This blows from the point where the sun sets at the summer solstice, and is the only wind that is diametrically opposite to Eurus. These are the winds that are diametrically opposite to one another and which have contraries.

There are other winds which have no contraries. The wind they call Thrascias, which lies between Argestes and Aparctias, blows from I; the wind called Meses, which lies between Caecias and Aparctias, from K. (The diameter IK nearly coincides with the ever visible circle, but not quite.) These winds have no contraries. Meses has not, or else there would be a wind blowing from the point M which is diametrically opposite. Thraskias corresponding to the point I has not, for then 364a1 there would be a wind blowing from N, the point which is diametrically opposite. (But perhaps a local wind which the inhabitants of those parts call Phoenicias blows from that point.)

These are the most important and definite winds and these their places.

There are more winds from the north than from the south. The reason for this is that the region in which we live lies nearer to the north. Also, much more water and snow is pushed aside into this quarter because the other lies under the sun and its course. When this thaws and soaks into the earth and is exposed to the heat of the sun and the earth it necessarily causes exhalation to rise in greater quantities and over a greater space.

Of the winds we have described Aparctias is the north wind in the strict sense. Thracias and Meses are north winds too. (Caecias is half north and half east). South are that which blows from due south and Lips. East, the wind from the rising of the sun at the equinox and Eurus. Phoenicias is half south and half east. West, the wind from the true west and that called Argestes. More generally these winds are classified as northerly or southerly. The west winds are counted as northerly, for they blow from the place of sunset and are therefore colder; the east winds as southerly, for they are warmer because they blow from the place of sunrise. So the distinction of cold and hot or warm is the basis for the division of the winds into northerly and southerly. East winds are warmer than west winds because the sun shines on the east longer, whereas it leaves the west sooner and reaches it later.

Since this is the distribution of the winds it is clear that contrary winds cannot blow simultaneously. They are diametrically opposite to one another and one of the two must be overpowered and cease. Winds that are not diametrically opposite to one another may blow simultaneously: for instance the winds from F and from D. Hence it sometimes happens that both of them, though different winds and blowing from different quarters, are favourable to sailors making for the same point.

Contrary winds commonly blow at opposite seasons. Thus Caecias and in
364b1 general the winds north of the summer solstice blow about the time of the spring equinox, but about the autumn equinox Lips; and Zephyrus about the summer solstice, but about the winter Solstice Eurus.

Aparctias, Thracias, and Argestes are the winds that fall on others most and stop them. Their source is so close to us that they are greater and stronger than other winds. They bring fair weather most of all winds for the same reason; for, blowing as they do, from close at hand, they overpower the other winds and stop them; they also blow away the clouds that are forming and leave a clear sky—unless they happen to be very cold. Then they do not bring fair weather, but being colder than they are strong they condense the clouds before driving them away.

Caecias does not bring fair weather because it returns upon itself. Hence the saying: 'Bringing it on himself as Caecias does clouds'.

When they cease, winds are succeeded by their neighbours in the direction of the movement of the sun. For an effect is most apt to be produced in the neighbourhood of its source, and the source of winds moves with the sun.

Contrary winds have either the same or contrary effects. Thus Lips and Caecias, sometimes called Hellespontias, are both rainy.[31] Argestes and Eurus are dry: the latter being dry at first and rainy afterwards. Meses and Aparctias are coldest and bring most snow. Aparctias, Thrascias, and Argestes bring hail. Notus, Zephyrus, and Eurus are hot. Caecias covers the sky with heavy clouds, Lips with lighter ones. Caecias does this because it returns upon itself and combines the qualities of Boreas and Eurus. By being cold it condenses and gathers the vaporous air, and because it is easterly it carries with it and drives before it a great quantity of such vaporous matter. Aparctias, Thrascias, and Argestes bring fair weather for the reason we have explained before. These winds and Meses are most commonly accompanied by lightning. They are cold because they blow from nearby, and lightning is due to cold, being ejected when the clouds contract. Some of these same
365a1 winds bring hail with them for the same reason; namely, that they cause a sudden condensation.

[31]Omitting καὶ εὖρος ὁ ἀπηλιώτην.

Hurricanes are commonest in autumn, and next in spring: Aparctias, Thrascias, and Argestes give rise to them most. This is because hurricanes are generally formed when some winds are blowing and others fall on them; and these are the winds which are most apt to fall on others that are blowing; the reason for which, too, we have explained before.

The etesian winds veer round, for dwellers in the west from Aparctias to Thrascias, Argestes, and Zephyrus, beginning from the north and ending far away;[32] for dwellers in the east they veer round as far as Apeliotes.

So much for the winds, their origin and nature and the properties common to them all or peculiar to each.

7 · We must go on to discuss earthquakes and tremors of the earth next, for their cause is akin to our last subject.

The theories that have been put forward up to the present date are three, and their authors three men, Anaxagoras of Clazomenae, and before him Anaximenes of Miletus, and later Democritus of Abdera.

Anaxagoras says that the ether, which naturally moves upwards, is caught in hollows below the earth and so shakes it; for though the earth is really all of it equally porous, its surface is clogged up by rain. This implies that part of the whole sphere is above and part below: above being the part on which we live, below the other.

This theory is perhaps too primitive to require refutation. It is absurd to think of up and down otherwise than as meaning that heavy bodies move to the earth from every quarter, and light ones, such as fire, upwards; especially as we see that, as far as our knowledge of the earth goes, the horizon always changes with a change in our position, which proves that the earth is convex and spherical. It is absurd, too, to maintain that the earth rests on the air because of its size, and then to say that impact upwards from below shakes it right through. Besides he gives no account of the circumstances attendant on earthquakes; for not every country or every season is subject to them.

Democritus says that the earth is full of water and that when a quantity of 365b1
rain-water is added to this an earthquake is the result. The hollows in the earth being unable to admit the excess of water it forces its way in and so causes an earthquake. Or again, the earth as it dries draws the water from the fuller to the emptier parts, and the inrush of the water as it changes its place causes the earthquake.

Anaximenes says that the earth breaks up when it grows, wet or dry, and earthquakes are due to the fall of these masses as they break away. Hence earthquakes take place in times of drought and again of heavy rain, since, as we have explained, the earth grows dry in time of drought and breaks up, whereas the rain makes it sodden and destroys its cohesion.

But if this were the case the earth ought to be found to be sinking in many places. Again, why do earthquakes frequently occur in places which are not

[32] Omitting ὁ γὰρ ἀπαρκτίας ζέφυρός ἐστιν.

excessively subject to drought or rain, as they ought to be on the theory? Besides, on this view, earthquakes ought always to be getting fewer, and should come to an end entirely some day: the notion of contraction by packing together implies this. So if this is impossible the theory must be impossible too.

8 · We have already shown that wet and dry must both give rise to an exhalation: earthquakes are a necessary consequence of this fact. The earth is essentially dry, but rain fills it with moisture. Then the sun and its own fire warm it and give rise to a quantity of wind both outside and inside it. This wind sometimes flows outwards in a single body, sometimes inwards, and sometimes it is divided. If this cannot but be so, we must next find out what body has the greatest motive force. This will certainly be the body that naturally moves farthest and is most violent. Now that which has the most rapid motion is necessarily the most violent; for its swiftness gives it impact the greatest force. Again, the rarest body, that which can most readily pass through every other body, is that which naturally moves farthest.
366a1 If, then, the nature of wind is of this kind, wind must be the body with the most motive force; for fire only becomes flame and moves rapidly when wind accompanies it: so that not water nor earth is the cause of earthquakes but wind—that is, the inrush of the external exhalation.

Hence, since the exhalation generally follows in a continuous body in the direction in which it first started, and either all of it flows inwards or all outwards, most earthquakes and the greatest are accompanied by calm. It is true that some take place when a wind is blowing, but this presents no difficulty. We sometimes find several winds blowing simultaneously. If one of these enters the earth we get an earthquake attended by wind. Only these earthquakes are less severe because their source and cause is divided.

Again most earthquakes and the severest occur at night or, if by day, about noon, that being generally the calmest part of the day. For when the sun exerts its full power (as it does about noon) it shuts the exhalation into the earth. Night, too, is calmer than day because of the absence of the sun. So the flood turns inward again, like a sort of ebb tide, in the opposite direction to the outward flow; especially towards dawn, for the winds, as a rule, begin to blow then, and if their source changes about like the Euripus and flows inwards the quantity is greater and a more violent earthquake results.

The severest earthquakes take place where the sea is full of currents or the earth spongy and cavernous: so they occur near the Hellespont and in Achaea and Sicily, and those parts of Euboea—where the sea is supposed to flow in channels below the earth. The hot springs, too, near Aedepsus are due to a cause of this kind. It is the confined character of these places that makes them so liable to earthquakes. A violent wind which would naturally blow away from the earth, is thrust back into the earth by the onrush of the sea in a great mass. The countries that are spongy
366b1 below the surface are exposed to earthquakes because they have room for so much wind.

For the same reason earthquakes usually take place in spring and autumn and in times of wet and of drought—because these are the windiest seasons. Summer with its heat and winter with its frost cause calm: winter is too cold, summer too dry for winds to form. In time of drought the air is full of wind; drought is just the predominance of the dry over the moist exhalation. Again, excessive rain causes more of the exhalation to form in the earth. Then this secretion is shut up in a narrow compass and forced into a smaller space by the water that fills the cavities. Thus a great wind is compressed into a smaller space and so gets the upper hand, and then breaks out and beats against the earth and shakes it violently.

We must suppose the action of the wind in the earth to be analogous to the tremors and throbbings caused in us by the force of the wind contained in our bodies. Thus some earthquakes are a sort of tremor, others a sort of throbbing. Again, we must think that the earth is affected as we often are after urinating—for a sort of tremor runs through the body as the wind returns inwards from without in one volume.

The force wind can have may be gathered not only from what happens in the air (where one might suppose that it owed its power to produce such effects to its volume), but also from what is observed in animal bodies. Tetanus and spasms are motions of wind, and their force is such that the united efforts of many men do not succeed in overcoming the movements of the patients. We must suppose, then (to compare great things with small), that what happens in the earth is just like that.

Our theory has been verified by actual observation in many places. It has been known to happen that an earthquake has continued until the wind that caused it burst through the earth into the air and appeared visibly like a hurricane. This happened lately near Heracleia in Pontus and some time past at the island Hiera, 367a1 one of the group called the Aeolian islands. Here a portion of the earth swelled up and sort of crested lump rose with a noise: finally it burst, and a great wind came out of it and threw up cinders and ashes which buried the neighbouring town of Lipara and reached some of the towns in Italy. The spot where this eruption occurred is still to be seen.

Indeed, this must be recognized as the cause of the fire that is generated in the earth: the air is first broken up in small particles and then the wind is beaten about and so catches fire.

A phenomenon in these islands affords further evidence of the fact that winds move below the surface of the earth. When a south wind is going to blow there is a premonitory indication: a sound is heard in the places from which the eruptions issue. This is because the sea is being pushed on from a distance and its advance thrusts back into the earth the wind that was issuing from it. The reason why there is a noise and no earthquake is that the underground spaces are so extensive in proportion to the quantity of the air that is being driven on that the wind overflows into the void beyond.

Again, our theory is supported by the facts that the sun appears hazy and is darkened in the absence of clouds, and that there is sometimes calm and sharp frost before earthquakes at sunrise. The sun is necessarily obscured and darkened when the wind which dissolves and rarefies the air begins to withdraw into the earth; and there must be calm and cold towards sunrise and dawn. The calm we have already explained. There must as a rule be calm because the wind flows back into the earth, and it must be most marked before the more violent earthquakes; for when the wind is not part outside the earth, part inside, but moves in a single body, its strength must be greater. The cold comes because the exhalation which is naturally and essentially hot enters the earth. (Wind is not recognized to be hot, because it sets the air in motion, and that is full of a quantity of cold vapour. It is the same with the breath we blow from our mouth: close by it is warm, as it is when we huff, but there is so little of it that it is scarcely noticed, whereas at a distance it is cold for the same reason as wind.) Well, when this disappears into the earth the vaporous exhalation concentrates because of the moisture and causes cold in any place in which this disappearance occurs.

A sign which sometimes precedes earthquakes can be explained in the same way. Either by day or a little after sunset, in fine weather, a little, light, long-drawn cloud is seen, like a long very straight line. This is because the wind is leaving the air and dying down. Something analogous to this happens on the sea-shore. When the sea breaks in great waves the breakers are very thick and crooked, but when the sea is calm they are slight and straight (because the secretion is small). As the sea is to the earth so the wind is to the cloudy air; so, when the wind drops, this very straight and thin cloud is left, a sort of breaker in the air.

An earthquake sometimes coincides with an eclipse of the moon for the same reason. When the earth is on the point of being interposed, but the light and heat of the sun has not quite vanished from the air but is dying away, the wind which causes the earthquake before the eclipse, turns off into the earth, and calm ensues. For there often are winds before eclipses: at nightfall if the eclipse is at midnight, and at midnight if the eclipse is at dawn. They are caused by the lessening of the warmth from the moon when its path approaches the point at which the eclipse is going to take place. So the influence which restrained and quieted the air weakens and the air moves again and a wind rises, and does so later, the later the eclipse.

A severe earthquake does not stop at once or after a single shock, but first the shocks go on, often for about forty days; after that, for one or even two years it gives premonitory indications in the same place. The severity of the earthquake is determined by the quantity of wind and the shape of the passages through which it flows. Where it is beaten back and cannot easily find its way out the shocks are most violent, and there it must remain in a cramped space like water in a vessel that cannot escape. Any throbbing in the body does not cease suddenly or quickly, but by degrees according as the affection passes off. So here the source which created the exhalation and the impulse of the wind clearly does not at once exhaust the whole of the material from which it forms the wind which we call an earthquake. So until the rest of this is exhausted the shocks must continue, though more gently, and they must go on until there is too little of the exhalation left to have any perceptible effect on the earth at all.

Subterranean noises, too, are due to the wind; sometimes they precede earthquakes but sometimes they have been heard without any earthquake following. Just as the air gives off various sounds when it is struck, so it does when it strikes other things; for striking involves being struck and so the two cases are the same. The sound precedes the shock because sound is thinner and passes through things more readily than wind. But when it is too weak by reason of thinness to cause an earthquake the absence of a shock is due to its filtering through readily, though by striking hard and hollow masses of different shapes it makes various noises, so that the earth sometimes seems to bellow as the marvel-mongers say.

Water has been known to burst out during an earthquake. But that does not make water the cause of the earthquake. The wind is the cause whether it exerts its force along the surface or up from below: just as winds are the causes of waves and not waves of winds. Else we might as well say that earth was the cause; for it is upset in an earthquake, just like water (for effusion is a form of upsetting). No, earth and water are material causes (being patients, not agents): the source is the wind.

The combination of a tidal wave with an earthquake is due to the presence of contrary winds. It occurs when the wind which is shaking the earth does not entirely succeed in driving off the sea which another wind is bringing on, but pushes it back 368b1
and heaps it up in a great mass in one place. Given this situation it follows that when this wind gives way the whole body of the sea, driven on by the opposite wind, will burst out and cause a flood. This is what happened in Achaea. There a south wind was blowing, but outside[33] a north wind; then there was a calm and the wind entered the earth, and then the tidal wave came on and simultaneously there was an earthquake. This was the more violent as the sea allowed no exit to the wind that had entered the earth, but shut it in. So in their struggle with one another the wind caused the earthquake, and the wave by its settling down the inundation.

Earthquakes are local and often affect a small district only; whereas winds are not local. Such phenomena are local when the exhalations at a given place are joined by those from the next and unite; this, as we explained, is what happens when there is drought or excessive rain locally. Now earthquakes do come about in this way but winds do not. For the former have their source inside the earth, so that the exhalations all move in one direction; the sun has less power over them than over those in the air so that, when once they have been given a start by its motion, which is determined by its various positions, they flow in one direction.

When the wind is present in sufficient quantity it causes an earthquake which is horizontal like a tremor; except occasionally, in a few places, it runs vertically, upwards from below, like a throbbing. It is the vertical direction which makes this kind of earthquake so rare. The source does not easily accumulate in great quantity in the position required, since the surface of the earth secretes far more than its depths. Wherever an earthquake of this kind does occur a quantity of stones comes to the surface of the earth (as when you throw up things in a winnowing fan), as we see from Sipylus and the Phlegraean plain and the district in Liguria, which were devastated by this kind of earthquake.

Islands in the middle of the sea are less exposed to earthquakes than those near

[33]Transposing ἔξω and ἐκεῖ.

land. For the volume of the sea cools the exhalations and overpowers them by its weight and so crushes them. Again, the sea flows rather than shakes when mastered by the winds. Again, it is so extensive that exhalations do not collect in it but issue from it, and these draw the exhalations from the earth after them. Islands near the continent form part of it: the intervening sea is not enough to make any difference; but those in the open sea can only be shaken if the whole of the sea that surrounds them is shaken too.

We have now explained earthquakes, their nature and cause, and the most important of the circumstances attendant on their appearance.

9 · Let us go on to explain lightning and thunder, and further whirlwind, fire-wind, and thunderbolts; for the cause of them all must be supposed the same.

As we have said, there are two kinds of exhalation, moist and dry, and their combination contains them both potentially. It, as we have said before, condenses into cloud, and the density of the clouds is highest at their upper limit. (For they must be denser and colder on the side where the heat escapes to the upper region and leaves them. This explains why hurricanes and thunderbolts and all analogous phenomena move downwards in spite of the fact that everything hot has a natural tendency upwards. Just as the pips that we squeeze between our fingers are heavy but often jump upwards: so these things are necessarily squeezed out away from the densest part of the cloud.) Now the heat that escapes disperses to the upper region. But if any of the dry exhalation is caught in the process as the air cools, it is squeezed out as the clouds contract, and is forcibly carried on and collides with the neighbouring clouds, and the sound of this collision is what we call thunder. This collision is analogous, to compare small with great, to the sound we hear in a flame which men call the laughter or the threat of Hephaestus or of Hestia. This occurs when the wood dries and cracks and the exhalation rushes on the flame in a body. So in the clouds, the exhalation is projected and its impact on dense clouds causes thunder: the variety of the sound is due to the irregularity of the clouds and the hollows that intervene where their density is interrupted. This, then, is thunder, and this its cause.

It usually happens that the wind that is ejected is inflamed and burns with a thin and faint fire: this is what we call lightning, where we see as it were the exhalation coloured in the act of its ejection. It comes into existence after the collision and the thunder, though we see it earlier because sight is quicker than hearing. The rowing of triremes illustrates this: the oars are going back again before the sound of their striking the water reaches us.

However, there are some who maintain that there is actually fire in the clouds. Empedocles says that it consists of some of the sun's rays which are intercepted; Anaxagoras that it is part of the upper ether (which he calls fire) which has descended from above. Lightning, then, is the gleam of this fire, and thunder the hissing noise of its extinction in the cloud.

But this involves the view that lightning actually is prior to thunder and does not merely appear to be so. Again, this intercepting of the fire is unreasonable on either theory, but especially when it is said to be drawn down from the upper ether.

Some reason ought to be given why that which naturally ascends should descend, and why it should not always do so, but only when it is cloudy—for when the sky is clear there is no lightning. The theory seems altogether too hasty.

The view that the heat of the sun's rays intercepted in the clouds is the cause of these phenomena is equally implausible: this, too, is a most careless explanation. Thunder, lightning, and the rest must have a separate and determinate cause assigned to them on which they ensue. But this theory does nothing of the sort. It is like supposing that water, snow, and hail existed all along and emerged when the time came and were not generated at all, as if the atmosphere brought each to hand out of its stock from time to time. They are concretions in the same way as thunder and lightning are discretions, so that if it is true of either that they are not generated but pre-exist, the same account must fit both. Again, how can any distinction be made about the intercepting between this case and that of interception in denser substances? Water, too, is heated by the sun and by fire; yet when it contracts again and grows cold and freezes no such ejection as they describe occurs, though it ought on their theory to take place on a proportionate scale.[34] Boiling is due to the wind generated by fire; but it is impossible for it to exist in the water beforehand; and besides they call the noise hissing, not boiling. But hissing is really boiling on a small scale; for when that which is brought into contact with moisture and is in process of being extinguished gets the better of it, then it boils and makes the noise in question.

Some—Cleidemus is one of them—say that lightning does not exist but appears. They compare it to what happens when you strike the sea with a rod by night and the water is seen to shine. They say that the moisture in the cloud is beaten about in the same way, and that lightning is the appearance of brightness that ensues.

These men were not yet familiar with the theory of reflection, which is the cause of that phenomenon. The water appears to shine when struck because our sight is reflected from it to some bright object; hence the phenomenon occurs mainly by night: the appearance is not seen by day because the daylight is too intense and obscures it.

These are the theories of others about thunder and lightning: some maintaining that lightning is a reflection, the others that lightning is fire shining through the cloud and thunder its extinction, the fire not being generated in each case but existing beforehand. We say that the same stuff is wind on the earth, and earthquake under it, and in the clouds thunder. The substance of all these phenomena is the same: namely, the dry exhalation. If it flows in one way it is wind, in another it causes earthquakes; in the clouds, when they are in a process of change[35] and contract and condense into water, it is ejected[36] and causes thunder and lightning and the other phenomena of the same nature.

So much for thunder and lightning.

[34]Reading μεγέθους. τὴν δὲ ζέσιν ποιεῖ. . . .
[35]Reading μεταβάλλουσι.
[36]Reading ἐκκρινομένη.

BOOK III

1 · Let us explain the remaining operations of this ejection in the same way as we have treated the rest. When this wind is ejected in small and scattered quantities and frequently, and spreads, and its constitution is rare, it gives rise to thunder and lightning. But if it is ejected in a body and is denser, that is, less rare, we get a hurricane. That is why it is violent: it is due to the rapidity of the ejection. Now when this ejection issues in a great and continuous current the result corresponds to what we get when the opposite development takes place and rain and a quantity of water are produced. As far as the matter from which they are developed goes both sets of phenomena are potentially present. As soon as a stimulus to the development of either potentiality appears, that of which there is the greater quantity present in the cloud is at once secreted from it, and there results either rain, or if the other exhalation prevails, a hurricane.

Sometimes the wind in the cloud, when it is being secreted, collides with another under circumstances like those found when a wind is forced from an open into a narrow space in a gateway or a road. It often happens in such cases that the first part of the moving body is deflected because of the resistance due either to the narrowness or to a contrary current, and so the wind forms a circle and eddy. It is prevented from advancing in a straight line: at the same time it is pushed on from behind; so it is compelled to move sideways in the direction of least resistance. The same thing happens to the next part, and the next, till the series becomes one, that is, till a circle is formed; for if a figure is described by a single motion that figure must itself be one. This is how eddies are generated on the earth, and the case is the same in the clouds as far as the beginning of them goes. Only here (as in the case of the hurricane when the cloud is continually separated off and there is a continuous wind) the cloud follows the exhalation unbroken, and the wind failing to break away from the cloud because of its density, first moves in a circle for the reason given and
371a1 then descends, because clouds are always densest on the side where the heat escapes. This phenomenon is called a whirlwind when it is colourless; and it is[37] a sort of undigested hurricane. There is never a whirlwind when the weather is northerly, nor a hurricane when there is snow. The reason is that all these phenomena are wind, and wind is a dry and warm exhalation. Now frost and cold prevail over this principle and quench it at its birth: that they do prevail is clear or there could be no snow or northerly rain, since these occur when the cold does prevail.

So the whirlwind originates in the failure of an incipient hurricane to escape from its cloud: it is due to the resistance of the eddy, and occurs when the spiral descends to the earth and drags with it the cloud which it cannot shake off. It moves things by its wind in the direction in which it is blowing in a straight line, and whirls round by its circular motion and forcibly snatches up whatever it meets.

When the cloud burns as it is drawn downwards,—that occurs when the wind

[37]Reading *τυφῶν ἄνεμος, ὢν οἷον. . . .*

becomes rarer—it is called a fire-wind; for its fire colours the neighbouring air and inflames it.

When there is a great quantity of wind and it is rare and is squeezed out in the cloud itself we get a thunderbolt. If it is exceedingly rare this rareness prevents the thunderbolt from scorching and the poets call it 'bright'; if the rareness is less it does scorch and they call it 'smoky'. The former moves onward because of its rareness, and because of its rapidity passes through an object before setting fire to it or dwelling on it so as to blacken it: the slower one does blacken the object, but passes through it before it can actually burn it. That is why resisting substances are affected, unresisting ones are not. For instance, it has happened that the bronze of a shield has been melted while the woodwork remained intact because its texture was so loose that the wind filtered through without affecting it. So it has passed through[38] clothes, too, without burning them, and has merely reduced them to shreds.

Such evidence is enough to show that the wind is at work in all these cases, but we sometimes get ocular evidence as well, as in the case of the conflagration of the temple at Ephesus which we lately witnessed. There independent sheets of flame left the main fire and were carried bodily in many directions. Now that smoke is wind and that smoke burns is certain, and has been stated in another place before; but when the flame moves bodily, then it can be seen clearly that it is wind. On this occasion what is seen in small fires appeared on a much larger scale because of the quantity of matter that was burning. The beams which were the source of the wind split, and a quantity of it rushed in a body from the place from which it issued forth and went up in a blaze; so that the flame seemed to move away and to fall on the houses. For we must recognize that wind accompanies and precedes thunderbolts though it is colourless and so not seen. Hence, where the thunderbolt is going to strike, the object moves before it is struck, showing that the wind which is its origin falls on the object first. Thunder, too, splits things not by its noise but because the wind that strikes the object and makes the noise is ejected simultaneously. This splits the thing it strikes but does not scorch it at all.

We have now explained thunder and lightning and hurricane, and further fire-winds, whirlwinds, and thunder-bolts, and shown that they are all the same thing and wherein they all differ.

2 · Let us now explain the nature and cause of halo, rainbow, mock suns, and rods, since the same causes account for them all.

We must first describe the phenomena and the circumstances in which each of them occurs. The halo often appears as a complete circle: it is seen round the sun and the moon and bright stars, by night as well as by day, and at midday or in the afternoon, more rarely about sunrise or sunset.

The rainbow never forms a full circle, nor any segment greater than a semicircle. At sunset and sunrise the circle is smallest and the segment largest: as the sun rises higher the circle is larger and the segment smaller. After the autumn equinox in the shorter days it is seen at every hour of the day, in the summer not

[38]Punctuating after διηθηθέν.

about midday. There are never more than two rainbows at one time. Each of them is three-coloured; the colours are the same in both and their number is the same, but in the outer rainbow they are fainter and their position is reversed. In the inner rainbow the first and largest band is red; in the outer rainbow the band that is nearest to this one and smallest is of the same colour: the other bands correspond on the same principle. These are almost the only colours which painters cannot manufacture; for there are colours which they create by mixing, but no mixing will give red, green, or purple. Those are the colours of the rainbow, though between the red and the green an orange colour is often seen.

Mock suns and rods are always seen by the side of the sun, not above or below it nor in the opposite quarter of the sky. They are not seen at night but always in the neighbourhood of the sun, either as it is rising or setting but more commonly towards sunset. They have scarcely ever appeared when the sun was on the meridian, though this once happened in Bosporus where two mock suns rose with the sun and followed it all through the day till sunset.

These are the facts about each of these phenomena: the cause of them all is the same, for they are all reflections. But they differ in the manner of the reflection and in the reflecting surfaces and according as the reflection to the sun or some other bright object is.

The rainbow is seen by day, and it was formerly thought that it never appeared by night as a moon rainbow. This opinion was due to the rarity of the occurrence: it was not observed; for though it does happen it does so rarely. The reason is that the colours are not so easy to see in the dark and that many other conditions must coincide, and all that in a single day in the month. For if there is to be one it must be at full moon, and then as the moon is either rising or setting. So we have only met with two instances of a moon rainbow in more than fifty years.

We must accept from the theory of optics the fact that sight is reflected from air and any object with a smooth surface just as it is from water; also that in some mirrors the shapes of things are reflected, in others only their colours. Of the latter kind are those mirrors which are so small as to be indivisible for sense. It is impossible that the shape of a thing should be reflected in them; for if it is the mirror will seem divisible—for every shape is at once a shape and divisible. But since something must be reflected in them and shape cannot be, it remains that colour alone should be reflected. The colour of a bright object sometimes appears bright in the reflection, but it sometimes, either owing to the admixture of the colour of the mirror or to weakness of sight, gives rise to the appearance of another colour.

However, we must accept the account we have given of these things in the investigation of sensation, and take some things for granted while we explain others.

3 · Let us begin by explaining the shape of the halo; why it is a circle and why it appears round the sun or the moon or one of the other stars: the explanation being in all these cases the same.

Sight is reflected in this way when air and vapour are condensed into a cloud and the condensed matter is uniform and consists of small parts. Hence it is a sign of rain, but if it fades away, of fine weather, if it is broken up, of wind. For if it does not fade away and is not broken up but is allowed to attain its normal state, it is naturally a sign of rain since it shows that a process of condensation is proceeding which must, when it is carried to an end, result in rain. For the same reason these halos are the darkest in colour. It is a sign of wind when it is broken up because its breaking up is due to a wind which exists there but has not reached us. This view finds support in the fact that the wind blows from the quarter in which the main division appears in the halo. Its fading away is a sign of fine weather because if the air is not yet in a state to get the better of the heat it contains and proceed to condense into water, this shows that the moist vapour has not yet separated from the dry and firelike exhalation: and this is a cause of fine weather.

So much for the atmospheric conditions under which the reflection takes place. Sight is reflected from the mist that forms round the sun or the moon, and that is 373a1
why the halo is not seen opposite the sun like the rainbow. Since the reflection takes place in the same way from every point the result is necessarily a circle or a segment of a circle; for if the lines start from the same point and end at the same point and are equal, the points where they form an angle will always lie on a circle.

Let ACB and AFB and ADB be lines each of which goes from the point A to the point B and forms an angle. Let the lines AC, AF, AD be equal and those at B—viz. CB, FB, DB— equal too. Draw the line AEB. Then the triangles are equal; for their base AEB is equal. Draw perpendiculars to AEB from the angles; CE from C, FE from F, DE from D. Then these perpendiculars are equal, being in equal triangles and all in one plane; for they are all at right angles to AEB and meet at a single point E. So if you draw the line it will be a circle and E its centre. Now B is the sun, A the eye, and the circumference passing through the points CFD the cloud from which the sight is reflected to the sun.

The mirrors must be thought of as continuous: each of them is too small to be visible, but their contiguity makes the whole made up of them all to seem one. The bright band is the sun, which is seen as a circle, appearing successively in each of the mirrors as a point indivisible to sense. The halo is formed rather near the earth because that is calmer; for where there is wind it is clear that no halo can maintain its position. Next to this is a dark ring, which seems to be darker because of the brightness of the halo.

Haloes are commoner round the moon because the greater heat of the sun dissolves the condensations of the air more rapidly.

Haloes are formed round stars for the same reasons, but they are not prognostic in the same way because the condensation they imply is so insignificant as to be barren.

4 · We have already stated that the rainbow is a reflection: we have now to explain what sort of reflection it is, to describe its various concomitants, and to assign their causes.

Sight is reflected from all smooth surfaces, such as are air and water among others. Air must be condensed if it is to act as a mirror, though it often gives a 373b1
reflection even uncondensed when the sight is weak. Such was the case of a man

whose sight was faint and indistinct. He always saw an image in front of him and facing him as he walked. This was because his sight was reflected back to him. Its morbid condition made it so weak and delicate that the air close by acted as a mirror, just as distant and condensed air normally does, and his sight could not push it back. That is why promontories in the sea loom when there is a south-east wind, and everything seems bigger, and in a mist, too, things seem bigger—as the sun and the stars seem bigger when rising and setting than on the meridian. But things are best reflected from water, and even in process of formation it is a better mirror than air; for each of the particles, the union of which constitutes a raindrop, is necessarily a better mirror than mist. Now it is obvious and has already been stated that a mirror of this kind renders the colour of an object only, but not its shape. Hence it follows that when it is on the point of raining and the air in the clouds is in process of forming into raindrops but the rain is not yet actually there, if the sun is opposite, or any other object bright enough to make the cloud a mirror and cause the sight to be reflected to the object, then the reflection must render the colour of the object without its shape. Since each of the mirrors is so small as to be invisible and what we see is the continuous magnitude made up of them all, the reflection necessarily gives us a continuous magnitude made up of one colour, each of the mirrors contributing the same colour to the whole. Hence since these conditions are realizable there will be an appearance due to reflection whenever the sun and the cloud are related in the way described and we are between them. But these are just the conditions under which the rainbow appears. So it is clear that the rainbow is a reflection of sight to the sun.

So the rainbow always appears opposite the sun whereas the halo is round it. They are both reflections, but the rainbow is distinguished by the variety of its
374a1 colours. The reflection in the one case is from water which is dark and from a distance; in the other from air which is nearer and lighter in nature. Bright light through a dark medium or on a dark surface (it makes no difference) looks red. We can see how red the flame of green wood is: this is because so much smoke is mixed with the bright white firelight: so, too, the sun appears red through smoke and mist. That is why in the rainbow reflection the outer circumference is red (the reflection being from small particles of water), but not in the case of the halo. The other colours shall be explained later. Again, a condensation of this kind cannot persist in the neighbourhood of the sun itself: it must either turn to rain or be dissolved; but opposite to the sun there is an interval during which the water is formed. If there were not this distinction haloes would be coloured like the rainbow. Actually no complete or circular halo presents this appearance, only small and fragmentary ones called 'rods'. But if a haze due to water or any other dark substance formed there we should have had, as we maintain, a complete rainbow like that which we do find round lamps. A rainbow appears round these in winter, generally with southerly winds. Persons whose eyes are moist see it most clearly because their sight is weak and easily reflected. It is due to the moistness of the air and the soot which the flame gives off and which mixes with the air; for a mirror is then formed actually because of the blackness—for soot is smoky. The light of the lamp appears as a circle which is not white but purple. It shows the colours of the rainbow; but

because the sight that is reflected is too weak and the mirror too dark, red is absent. The rainbow that is seen when oars are raised out of the sea involves the same relative positions as that in the sky, but its colour is more like that round the lamps, being purple rather than red. The reflection is from very small particles continuous with one another, and in this case the particles are fully formed water. We get a rainbow, too, if a man sprinkles fine drops in a room turned to the sun so that the sun is shining in part of the room and throwing a shadow in the rest. Then if one man sprinkles in the room, another, standing outside, sees a rainbow where the sun's rays cease and make the shadow. Its nature and colour is like that from the oars and its cause is the same, for the sprinkling hand corresponds to the oar.

That the colours of the rainbow are those we described and how the other colours come to appear in it will be clear from the following considerations. We must recognize, as we have said, and lay down first, that white colour on a black surface or seen through a black medium gives red; second, that sight when strained to a distance becomes weaker and less; third, that black is in a sort the negation of sight: an object appears black because sight fails; so everything at a distance looks blacker, because sight does not reach it. The theory of these matters belongs to the account of the senses, which are the proper subjects of such an inquiry; here we need only state about them what is necessary for us. At all events, that is the reason why distant objects and objects seen in a mirror look darker and smaller and smoother, and why the reflection of clouds in water is darker than the clouds themselves. This latter is clearly the case: the reflection diminishes the sight that reaches them. It makes no difference whether the change is in the object seen or in the sight, the result being in either case the same. The following fact further is worth noticing. When there is a cloud near the sun and we look at it it does not look coloured at all but white, but when we look at the same cloud in water it shows a trace of rainbow colouring. Clearly, then, when sight is reflected it is weakened and, as it makes dark look darker, so it makes white look less white, changing it and bringing it nearer to black. When the sight is relatively strong the change is to red; the next stage is green, and a further degree of weakness gives violet. No further change is visible, but three completes the series of colours (as we find three does in most other things), and the change into the rest is imperceptible. Hence also the rainbow appears with three colours; this is true of each of the two, but in a contrary way. The outer band of the primary rainbow is red; for the largest band reflects most sight to the sun, and the outer band is largest. The middle band and the third go on the same principle. So if the principles we laid down about the appearance of colours are true the rainbow necessarily has three colours, and these three and no others. The appearance of yellow is due to contrast; for the red is whitened by its juxtaposition with green. We can see this from the fact that the rainbow is purest when the cloud is blackest; and then the red shows more yellow. (Yellow in the rainbow comes between red and green.) So the whole of the red shows white by contrast with the blackness of the cloud around; for it is white compared to them. Again, when the rainbow is fading away[39] and the red is dissolving, the white cloud is brought into

[39] Omitting ἐγγύτατα.

contact with the green and becomes yellow. But the moon rainbow affords the best instance of this: it looks quite white—this is because it appears on the dark cloud and at night. So, just as fire is intensified by added fire, black beside black makes that which is in some degree white look quite white; and red is like that. Bright dyes too show the effect of contrast. In woven and embroidered stuffs the appearance of colours is profoundly affected by their juxtaposition with one another (purple, for instance, appears different on white and on black wool), and also by differences of illumination. Thus embroiderers say that they often make mistakes in their colours when they work by lamplight, and use the wrong ones. We have now shown why the rainbow has three colours and that these are its only colours.

The same cause explains the double rainbow and the faintness of the colours in the outer one and their inverted order. When sight is strained to a greater distance the appearance of the distant object is affected in a certain way; and the same thing holds good here. So the reflection from the outer rainbow is weaker because it takes place from a greater distance and less of it reaches the sun, and so the colours seen are fainter. Their order is reversed because more reflection reaches the sun from the smaller, inner band. For that reflection is nearer to our sight which is reflected from the band which is nearest to the primary rainbow. Now the smallest band in the outer rainbow is that which is nearest, and so it will be red; and the second and the third will follow the same principle. Let B be the outer rainbow, A the inner and primary one; let C stand for the red colour, D for green, E for violet; yellow appears at the point F. Three rainbows or more are not found because even the second is fainter, so that the third reflection can have no strength whatever and cannot reach the sun.

5 · The rainbow can never be a circle nor a segment of a circle greater than a semicircle. The consideration of the diagram will show this and the other properties of the rainbow.

Let A be a hemisphere resting on the circle of the horizon, let its centre be K and let G be another point appearing on the horizon. Then, if the lines that fall in a cone from K have GK as their axis, and, K and M being joined, the lines KM are reflected from the hemisphere to G over the greater angle, the lines from K will fall on the circumference of a circle. If the reflection takes place when the luminous body is rising or setting the segment of the circle above the earth which is cut off by the horizon will be a semicircle; if the luminous body is above the horizon it will always be less than a semicircle, and it will be smallest when the luminous body reaches its meridian.

First let the luminous body be rising at the point G, and let KM be reflected to G, and let the plane[40] determined by the triangle GKM be produced. Then the section of the sphere will be a great circle. Let it be A (for it makes no difference which of the planes passing through the line GK and determined by the triangle KMG is produced). Now the lines drawn for G and K to any other point on the

[40]Omitting ἐφ' ᾧ ἡ A.

semicircle A will not stand in this ratio to one another. For since both the points G and K and the line KG are given, the line MG will be given too; consequently the ratio of the line MG to the line MK will be given too. So M will touch a given circumference. Let this be NM. Then the intersection of the circumferences is given, and the same ratio cannot hold between lines in the same plane drawn from the same points to any other circumference but MN.

Draw a line DB outside of the figure and divide it so that D is to B as MG is to MK. But MG is greater than MK since the reflection of the cone is over the greater angle (for it subtends the greater angle of the triangle KMG). [Therefore D is greater than B.][41] Then add to B a line F such that BF is to D as D is to B. Then make another line KP having the same ratio as to B as KG has to F, and join MP.

Then P is the pole of the circle on which the lines from K fall. For the ratio of D to PM is the same as that of F to KG and of B to KP. If not, let D be in the same ratio to a line lesser or greater than PM—it will not matter—and let this line be PR. Then GK and KP and PR will have the same ratios to one another as F, B, and D. But the ratios between F, B, and D were such that FB is to D as D is to B. Therefore PG is to PR as PR is to PK. Now, if the points K, G be joined with the point R by the lines GR, KR these lines will be to one another as PG is to PR; for the sides of the triangles GPR, KPR about the angle P are homologous. Therefore, GR too will be to KR as GP is to PR. But this is also the ratio of MG to MK; for the ratio of both is the same as that of D to B. Therefore, from the points G, K there will have been drawn lines with the same ratio to one another, not only to the circumference MN but to another point as well, which is impossible. Since then D cannot bear that ratio to any line either lesser or greater than PM (the proof being in either case the same), it follows that it must stand in that ratio to MP itself. Therefore as MP is to PK so PG will be to MP [and finally MG to MK].[42]

If, then, a circle be described with P as pole at the distance MP it will touch all the angles which the lines from H and K[43] make by their reflection. If not, it can be shown, as before, that lines drawn to different points in the semicircle will have the same ratio to one another, which was impossible. If, then, the semicircle A be revolved about the diameter GKP, the lines reflected from the points G, K at the point M will have the same ratio, and will make the angle KMG equal, in every plane. Further, the angle which GM[44] and MP make with GP will always be the same. So there are a number of triangles on GP and KP equal to the triangles GMP and KMP. Their perpendiculars will fall on GP at the same point and will be equal. Let O be the point on which they fall. Then O is the centre of the circle, half of which, MN, is cut off by[45] the horizon.

For the sun does not master the parts above, but does master those near the earth and dissolve the air. And that is why the rainbow does not make a complete circle. A rainbow at night from the moon occurs rarely: for the moon is not always

[41]Fobes excises this sentence. [42]Fobes excises this clause.
[43]Reading αἱ ἀπὸ τοῦ Η καὶ Κ.
[44]Reading HM.
[45]Reading ὑπό.

full and is too weak in its nature to master the air. Rainbows stand most firmly when the sun is most mastered; for then most moisture remains in them.[46]

Again, let the horizon be AKC, and let G have risen above it; and let the axis now be GP. The proof will be the same for the rest as before, but the pole P of the
377a1 circle will be below the horizon AC since the point G has risen above the horizon. But the pole, and the centre of the circle, and the centre of that circle (namely GP) which now determines the rising of the sun are on the same line. But since KG lies above the diameter AC, the centre will be at O[47] on the line KP below the plane of the circle AC which determined the position of the sun before. So the segment XY which is above the horizon will be less than a semicircle. For XYZ[48] was a semicircle and it has now been cut off by[49] the horizon AC. So part of it, YZ,[50] will be invisible when the sun has risen above the horizon, and the segment visible will be smallest when the sun is on the meridian; for the higher G is the lower the pole and the centre of the circle will be.

In the shorter days after the autumn equinox there may be a rainbow at any time of the day, but in the longer days from the spring to the autumn equinox there cannot be a rainbow about midday. The reason for this is that the northerly segments are all greater than a semicircle, and go on increasing, while the invisible segment is small; but as to the segments south of the equator, the upper one is small and the one below the earth large—and the further away they get, the larger it becomes. Consequently, in the days near the summer solstice, the size of the segment is such that before the point A reaches the middle of the segment—its meridian—the point P is well below the horizon; the reason for this being the great size of the segment, and the consequent distance of the meridian from the earth. But in the days near the winter solstice the segments of the circles are small, and the contrary is necessarily the case: for the sun is on the meridian before the point G has risen far.

6 · Mock suns, and rods too, are due to the causes we have described. A mock sun is caused by the reflection of sight to the sun. Rods are seen when sight reaches the sun under circumstances like those which we described, when there are clouds near the sun and sight is reflected from some liquid surface to the cloud. Here the
377b1 clouds themselves are colourless when you look at them directly, but in the water they are full of rods. The only difference is that in this latter case the colour of the cloud seems to reside in the water, but in the case of rods on the cloud itself. Rods appear when the composition of the cloud is uneven, dense in part and in part rare, and more and less watery in different parts. For when the sight is reflected to the sun its shape is not seen but its colour is; and bright white light of the sun, to which the sight is reflected, being seen on the uneven mirror, appears partly red, partly

[46]This paragraph is out of place and textually odd: most editors regard it as an interpolation.

[47]Reading ἐφ' οὗ τὸ O. [48]Reading ΨΥΩ.

[49]Reading ὑπό.

[50]Reading ΥΩ.

green or yellow. It makes no difference whether sight passes through or is reflected from a medium of that kind; the colour is the same in both cases; if it is red in the first case it must be red in the other.

Rods then are occasioned by the unevenness of the mirror—as regards colour, not shape. The mock sun, on the contrary, appears when the air is very uniform, and of the same density throughout. This is why it appears white: the uniform character of the mirror gives the reflection in it a single colour, while the fact that the sight is reflected in a body and is thrown on the sun all together by the mist, which is dense and watery though not yet quite water, causes the sun's true colour to appear just as it does when the reflection is from the dense, smooth surface of copper. So the sun's colour being white, the mock sun appears white too. This too, is the reason why the mock sun is a surer sign of rain than the rods; for the air is in a more favourable condition for the production of water. Further a mock sun to the south is a surer sign of rain than one to the north; for the air in the south is readier to turn into water than that in the north.

Mock suns and rods are found, as we stated, about sunset and sunrise, not above the sun nor below it, but beside it. They are not found very close to the sun, nor very far from it; for the sun dissolves the condensation if it is near, but if it is far off the reflection cannot take place, since sight weakens when it is reflected from a small mirror to a very distant object. (This is why a halo is never found opposite to the sun.) If the condensation is above the sun and close to it the sun will dissolve it; if it is at a distance the sight is too weak for the reflection to take place, and so it will not reach the sun. But at the side of the sun, it is possible for the mirror to be at such an interval that the sun does not dissolve it, and yet sight reaches it in a body because it moves close to the earth[51] and is not as it were dissipated in its journey through space. It cannot occur below the sun because close to the earth the sun's rays would dissolve it, but if it were high up in the heavens sight would be dissipated. Indeed, even by the side of the sun, it is not found in the middle of the sky; for then the line of vision is not close to the earth,[52] and so but little sight reaches the mirror and the reflection from it is altogether feeble.

Some account has now been given of the effects of the exhalation above the surface of the earth; we must go on to describe its operations below, when it is shut up in the parts of the earth.

Its own twofold nature gives rise here to two varieties of bodies, just as it does in the upper region. We maintain that there are two exhalations, one vaporous the other smoky, and there correspond two kinds of bodies that originate in the earth, things quarried and things mined. The heat of the dry exhalation is the cause of all things quarried. Such are the kinds of stones that cannot be melted, and realgar, and ochre, and ruddle, and sulphur, and the other things of that kind, most things quarried being either coloured lye or, like cinnabar, a stone compounded of it. The vaporous exhalation is the cause of all things mined—things which are either fusible or malleable such as iron, copper, gold. All these originate from the

[51]Reading πρὸς τῇ γῇ. [52]Reading πρὸς τῇ γῇ.

imprisonment of the vaporous exhalation in the earth, and especially in stones. Their dryness compresses it, and it congeals just as dew or hoar-frost does when it has been separated off, though in the present case the metals are generated before that separation occurs. Hence, they are water in a sense, and in a sense not. Their matter was that which might have become water, but it can no longer do so; nor are they, like savours, due to a qualitative change in actual water. Copper and gold are not formed like that, but in every case the evaporation congealed before water was formed. Hence, they all (except gold) are affected by fire, and they possess an admixture of earth; for they still contain the dry exhalation.

This is the general theory of all these bodies, but we must take up each kind of them and discuss it separately.

BOOK IV

1 · We have explained that the causes of the elements are four, and that their combinations determine the number of the elements to be four.

Two of the causes, the hot and the cold, are active; two, the dry and the moist, passive. We can satisfy ourselves of this by looking at instances. In every case heat and cold determine, conjoin, and change things of the same kind and things of different kinds, moistening, drying, hardening, and softening them. Things dry and moist, on the other hand, both in isolation and when present together in the same body are the subjects of that determination and of the other affections enumerated. The account we give when we define their natures shows this too. Hot and cold we describe as active, for combining is a sort of activity; moist and dry are passive, for it is in virtue of its being acted upon in a certain way that a thing is said to be easy to determine or difficult to determine. So it is clear that some are active and some passive.

Next we must describe the operations of the active qualities and the forms taken by the passive. First of all, unqualified becoming and natural change are the work of these powers and so is the corresponding natural destruction; and these are found in plants and animals and their parts. Unqualified natural becoming is a change introduced by these powers into the matter underlying a given natural thing when they are in a certain ratio; and matter is the passive qualities we have mentioned. When the hot and the cold are masters of the matter they generate a thing; if they are not, the object is imperfectly boiled or otherwise unconcocted. But the strictest general opposite of unqualified becoming is putrefaction. All natural destruction is on the way to it, as are, for instance, growing old or growing dry. Putrescence is the end of all these things,[53] that is of all natural objects, except such as are destroyed by violence:[54] you can burn, for instance, flesh, bone, or anything else, but the natural course of their destruction ends in putrefaction. Hence things

[53]Omitting τῶν ἄλλων.
[54]Comma after φθαρῇ.

that putrefy begin by being moist and end by being dry. For the moist and the dry were their matter, and the operation of the active qualities caused the dry to be determined by the moist.

Destruction supervenes when the determined gets the better of the determining by the help of the environment (though in a special sense the word putrefaction is applied to partial destruction, when a thing's nature is perverted). Hence everything, except fire, is liable to putrefy; for earth, water, and air putrefy, being all of them matter relatively to fire. Putrefaction is the destruction of the peculiar and natural heat in any moist subject by external heat, that is, by the heat of the environment. So since lack of heat is the ground of this affection and everything which lacks heat is cold, both heat and cold will be the causes of putrefaction, which will be due indifferently to cold in the putrefying subject or to heat in the environment.

This explains why everything that putrefies grows drier and ends by becoming earth or dung. The subject's own heat departs and causes the natural moisture to evaporate with it, and then there is nothing left to draw in moisture; for it is a thing's peculiar heat that attracts moisture and draws it in. Again, putrefaction takes place less in cold than in hot seasons; for in winter the surrounding air and water contain but little heat and it has no power, but in summer there is more. Again, what is frozen does not putrefy; for its cold is greater than the heat of the air and so is not mastered, whereas what affects a thing does master it. Nor does that which is boiling or hot putrefy; for the heat in the air being less than that in the object does not master it or set up any change. So too anything that is flowing or in motion is less apt to putrefy than a thing at rest; for the motion set up by the heat in the air is weaker than that pre-existing in the object, and so it causes no change. For the same reason a great quantity of a thing putrefies less readily than a little; for the greater quantity contains too much proper fire and cold for the corresponding qualities in the environment to get the better of. Hence, the sea putrefies quickly when broken up into parts, but not as a whole; and all other waters likewise. Animals too are generated in putrefying bodies, because the heat that has been expelled, being natural, organizes the particles thrown out with it.

So much for the nature of becoming and of destruction.

2 · We must now describe the next kinds of processes which the qualities already mentioned set up in actually existing natural objects as matter.

Of these concoction is due to heat; its species are ripening, boiling, broiling. Inconcoction is due to cold and its species are rawness, parboiling, scorching. (We must recognize that the things are not properly denoted by these words: the various classes of similar objects have no names universally applicable to them; consequently we must think of the species enumerated as being not what those words denote but something like it.) Let us say what each of them is. Concoction is a process in which the natural and proper heat of an object perfects the corresponding passive qualities, which are the proper matter of any given object. For when concoction has taken place we say that a thing has been perfected and has come to be itself. It is the proper heat of a thing that sets up this perfecting, though external influences may contribute in some degree to its fulfilment. Baths, for instance, and other things of the kind contribute to the concoction of food, but the primary source is the proper heat of the body. In some cases of concoction the end of the process is the nature of the thing—nature, that is, in the sense of the form and essence. In other cases it leads to some latent form which is attained when the moisture has acquired certain properties or a certain magnitude in the process of being broiled or boiled or of putrefying, or however else it is being heated; for then the thing has some use and we say that concoction has taken place. Must is an instance of this, and the matter in boils when it becomes purulent, and tears when they become rheum, and so with the rest.

Concoction ensues whenever the matter, the moisture, is mastered. For the matter is what is determined by the natural heat in the object, and as long as the ratio between them exists in it a thing maintains its nature. Hence things like the liquid and solid excreta and waste-stuffs in general are signs of health, and concoction is said to have taken place in them; for they show that the proper heat has mastered the indeterminate matter.

Things that undergo a process of concoction necessarily become thicker and hotter; for the action of heat is to make things more compact, thicker, and drier.

This then is the nature of concoction: inconcoction is an imperfect state due to lack of proper heat, that is, to cold. That *of* which the imperfect state is, is the corresponding passive qualities which are the natural matter of anything.

So much for a definition of concoction and inconcoction.

3 · Ripening is a sort of concoction; for we call it ripening when there is a concoction of the nutriment in fruit. And since concoction is a sort of perfecting, the process of ripening is perfect when the seeds in fruit are able to reproduce the fruit in which they are found; for in all other cases as well this is what we mean by perfect. This is what ripening means when the word is applied to fruit. However, many other things that have undergone concoction are said to be ripe, the general character of the process being the same, though the word is applied by an extension of meaning. The reason for this extension is, as we explained before, that the various modes in which natural heat and cold perfect the matter they determine have not special names appropriated to them. In the case of boils and phlegm, and the like, the process of ripening is the concoction of the moisture in them by their natural heat; for only that which gets the better of matter can determine it. So everything that ripens turns from an airy into a watery state, and from a watery into an earthy state, and in general from being rare becomes dense. In this process nature incorporates some of the matter in itself,[55] and some it rejects. So much for the definition of ripening.

Rawness is its opposite and is therefore an inconcoction of the nutriment in the fruit, namely, of the undetermined moisture. Consequently a raw thing is either airy or watery or contains both air and water. Ripening being a kind of perfecting,

[55]Reading αὐτήν.

rawness will be an imperfect state, and this state is due to a lack of natural heat and its disproportion to the moisture that is undergoing the process of ripening. (Nothing moist ripens by itself without the admixture of some dry matter: water alone of liquids does not thicken.) This may be due either to defect of heat or to 380b1 excess of the matter to be determined; hence the juice of raw things is thin, cold rather than hot, and unfit for food or drink. Rawness, like ripening, is spoken of in a variety of ways. Thus the liquid and solid excreta and catarrhs are called raw for the same reason; for in every case the word is applied to things because their heat has not got the mastery in them and compacted them. If we go further, brick is called raw and so is milk and many other things too when they are such as to admit of being changed and compacted by heat but have remained unaffected. Hence, while we speak of boiled water, we cannot speak of raw water, since it does not thicken. We have now defined ripening and rawness and assigned their causes.

Boiling is, in general, a concoction by moist heat of the indeterminate matter contained in the moisture, and the word is strictly applicable only to things boiled in the way of cooking. The indeterminate matter, as we said, will be either airy or watery. The cause of the concoction is the fire contained in the moisture; for what is cooked in a frying-pan is broiled: it is the heat outside that affects it and, as for the moisture in which it is contained, it dries this up and draws it into itself. But a thing that is being boiled behaves in the opposite way: the moisture contained in it is drawn out of it by the heat in the liquid outside. Hence boiled meats are drier than broiled; for, in boiling, things do not draw the moisture into themselves, since the external heat gets the better of the internal: if the internal heat had got the better it would have drawn the moisture to itself. Not every body admits of the process of boiling: if there is no moisture in it, it does not (for instance, stones), nor does it if there is moisture in it but the density of the body is too great for it to be mastered, as in the case of wood. But only those bodies can be boiled that contain moisture which can be acted on by the heat contained in the liquid outside. It is true that gold and wood and many other things are said to be boiled; but this is not the same kind of process, and the word is used in an extended sense—the reason for the usage being that the various cases have no names appropriated to them. Liquids too, like milk and must, are said to undergo a process of boiling when the external fire that surrounds and heats them changes the savour in the liquid into a given form, the process being thus in a way like what we have called boiling.

The end of the things that undergo boiling, or indeed any form of concoction, is 381a1 not always the same: some are meant to be eaten, some drunk, and some are intended for other uses; for instance drugs, too, are said to be boiled.

All those things then admit of boiling which can grow denser, smaller, or heavier; also those which do that with a part of themselves and with a part do the opposite, dividing in such a way that one portion thickens while the other grows thinner, like milk when it divides into whey and curd. Oil by itself is affected in none of these ways, and therefore cannot be said to admit of boiling. Such then is the species of concoction known as boiling, and the process is the same in an artificial and in a natural instrument, for the cause will be the same in every case.

Parboiling is the form of inconcoction opposed to boiling. Now the opposite of boiling, and the primary form of parboiling, is an inconcoction of the undetermined matter in a body due to lack of heat in the surrounding liquid. (Lack of heat implies, as we have pointed out, the presence of cold.) The motion which causes parboiling is different from that which causes boiling, for the heat which operates the concoction is driven out. The lack of heat is due either to the amount of cold in the liquid or to the quantity of moisture in the object undergoing the process of boiling. Where either of these conditions is realized the heat in the surrounding liquid is too great to have no effect at all, but too small to carry out the process of concoction uniformly and thoroughly. Hence things are harder when they are parboiled than when they are boiled, and the moisture in them more distinct from the solid parts. So much for the definition and causes of boiling and parboiling.

Broiling is concoction by dry foreign heat. Hence if a man were to boil a thing but the change and concoction in it were due, not to the heat of the liquid but to that of the fire, the thing will have been broiled and not boiled when the process has been carried to completion: if the process has gone too far we use the word 'charred' to describe it. If the process leaves the thing drier at the end the agent has been dry heat. Hence the outside is drier than the inside, the opposite being true of things boiled. Where the process is artificial, broiling is more difficult than boiling, for it is difficult to heat the inside and the outside uniformly, since the parts nearer to the fire are the first to get dry and consequently get more intensely dry. In this way the
381b1 outer pores contract and the moisture in the thing cannot be expelled but is shut in by the closing of the pores. Now broiling and boiling are artificial processes, but the same general kind of thing, as we said, is found in nature too. The affections produced are similar though they lack a name; for art imitates nature. For instance, the concoction of food in the body is like boiling, for it takes place in a hot and moist medium and the agent is the heat of the body. So, too certain forms of indigestion are like parboiling. And it is not true that animals are generated in the concoction of food, as some say. Really they are generated in the excretion which putrefies in the lower belly, and they ascend afterwards. For concoction goes on in the upper belly but the excretion putrefies in the lower: the reason for this has been explained elsewhere.

We have seen that the opposite of boiling is parboiling: now there is something correspondingly opposed to the species of concoction called broiling, but it is more difficult to find a name for it. It would be the kind of thing that would happen if there were scorching instead of broiling proper through lack of heat due to deficiency in the external fire or the quantity of water in the thing undergoing the process. For then we should get too much heat for no effect to be produced, but too little for concoction to take place.

We have now explained concoction and inconcoction, ripening and rawness, boiling and broiling, and their opposites.

4 · We must now describe the forms taken by the passive qualities the moist and the dry. The elements of bodies, that is, the passive ones, are the moist and the dry; the bodies themselves are compounded of them and whichever predominates

determines the nature of the body; thus some bodies partake more of the dry, others of the moist. All the forms to be described will exist either actually, or potentially and in their opposite: for instance, there is actual melting and on the other hand that which admits of being melted.

Since the moist is easily determined and the dry determined with difficulty, their relation to one another is like that of a dish and its condiments. The moist is what makes the dry determinable, and each serves as a sort of glue to the other—as Empedocles said in his poem on Nature, 'glueing meal together by means of water'.[56] Thus the determined body involves them both. Of the elements earth is especially representative of the dry, water of the moist, and therefore all determinate bodies in our world involve earth and water. Every body shows the quality of that element which predominates in it. It is because earth and water are the material elements of all bodies that animals live in them alone and not in air or fire.

Of the qualities of bodies hardness and softness are those which must primarily belong to a determined thing, for anything made up of the dry and the moist is necessarily either hard or soft. Hard is that the surface of which does not yield into itself; soft that which does yield but not by interchange of place: water, for instance, is not soft, for its surface does not yield to pressure or sink in but there is an interchange of place. Those things are absolutely hard and soft which satisfy the definiton absolutely, and those things relatively so which do so compared with another thing. Now relatively to one another hard and soft are indefinable, because it is a matter of degree, but since all the objects of sense are determined by reference to the faculty of sense it is clearly the relation to touch which determines that which is hard and soft absolutely, and touch is that which we use as a standard or mean. So we call that which exceeds it hard and that which falls short of it soft.

5 · A body determined by its own boundary must be either hard or soft, for it either yields or does not.

It must also be concrete: or it could not be so determined. So since everything that is determined and solid is either hard or soft and these qualities are due to concretion, all composite and determined bodies must involve concretion. Concretion therefore must be discussed.

Now there are two causes besides matter, the agent and the quality brought about, the agent being the efficient cause, the quality the formal cause. Hence concretion and dispersal, drying and moistening, must have these two causes.

As we have explained, the agent operates by means of two qualities and the patient is acted on in virtue of two qualities: action takes place by means of heat or cold, and the quality is produced either by the presence or by the absence of heat or cold since concretion is a form of drying, let us deal with drying first. Now that which is acted upon is moist or dry or a compound of both. Water is the element characterized by the moist, earth that characterized by the dry, for these among the

[56] Frag. 34 Diels-Kranz.

elements that admit the qualities moist and dry are passive. Therefore cold, too, being found in water and earth (both of which we recognize to be cold), must be reckoned rather as a passive quality. It is active only as contributing to destruction or incidentally in the manner described before; for cold is sometimes actually said to burn and to warm, but not in the same way as heat does, but by collecting and concentrating heat.

The subjects of drying are water and the various watery fluids and those bodies which contain water either foreign or connatural. By foreign I mean like the water in wool, by connatural, like that in milk. The watery fluids are wine, urine, whey, and in general those fluids which have no sediment or only a little, except where this absence of sediment is due to viscosity. For in some cases, in oil and pitch for instance, it is the viscosity which prevents any sediment from appearing.

It is always a process of heating or cooling that dries things, but the agent in both cases is heat, either internal or external. For even when things are dried by cooling, like a garment, where the moisture exists separately it is the internal heat that dries them. It carries off the moisture in the shape of vapour (if there is not too much of it), being itself driven out by the surrounding cold. So everything is dried, as we have said, by a process either of heating or cooling, but the agent is always heat, either internal or external, carrying off the moisture in vapour. By external heat I mean as where things are boiled; by internal where the heat breathes out and takes away and uses up its moisture. So much for drying.

6 · Liquefaction is, first, condensation into water; second, the melting of a solidified body. The first, condensation, is due to the cooling of vapour: what melting is will appear from the account of solidification.

Whatever solidifies is either water or a mixture of earth and water, and the
383a1 agent is either dry heat or cold. Hence those of the bodies solidified by heat or cold which are soluble at all are dissolved by their opposites. Bodies solidified by dry heat are dissolved by water, which is moist cold, while bodies solidified by cold are dissolved by fire, which is hot. Some things seem to be solidified by water, e.g. boiled honey, but really it is not the water but the cold in the water which effects the solidification. Aqueous bodies are not solidified by fire: for it is fire that dissolves them, and the same cause in the same relation cannot have opposite effects upon the same thing. Again, water solidifies owing to the departure of heat; so it will clearly be dissolved by the entry into it of heat: cold, therefore, must be the agent in solidifying it.

Hence aqueous bodies do not thicken when they solidify; for thickening occurs when the moisture goes off and the dry matter comes together, but water is the only liquid that does not thicken. Those bodies that are made up of both earth and water are solidified both by fire and by cold and in either case are thickened. The operation of the two is in a way the same and in a way different. Heat acts by drawing off the moisture, and as the moisture goes off in vapour the dry matter thickens and collects. Cold acts by driving out the heat, which is accompanied by the moisture as this goes off in vapour with it. Bodies that are soft but not liquid do not thicken but solidify when the moisture leaves them, e.g. potter's clay in process of baking: but those mixed bodies that are liquid thicken besides solidifying, like milk. Those bodies which have first been thickened or hardened by cold often begin by becoming moist: thus potter's clay at first in the process of baking steams and grows softer, and is liable to distortion in the ovens for that reason.

Now of the bodies solidified by cold which are made up both of earth and water but in which the earth preponderates, those which solidify by the departure of heat melt by heat when it enters into them again; this is the case with frozen mud. But those which solidify by refrigeration and the evaporation of all their heat, like iron and horn, cannot be dissolved except by excessive heat, but they can be softened—though manufactured iron does melt, to the point of becoming fluid and then solidifying again. This is how steel is made. The dross sinks to the bottom and is purged away: when this has been done often and the metal is pure we have steel. The process is not repeated often because the purification of the metal involves great waste and loss of weight. But the iron that has less dross is the better iron. The stone *pyrimachus,* too, melts and forms into drops and becomes fluid; after having been in a fluid state it solidifies and becomes hard again. Millstones, too, melt and become fluid: when the fluid mass begins to solidify it is black but its consistency comes to be like that of lime. Mud and earth, too, melt.

Of the bodies which are solidified by dry heat some are insoluble, others are dissolved by liquid. Pottery and some kinds of stone that are formed out of earth burnt up by fire, such as millstones, cannot be dissolved. Natron and salt are soluble by liquid, but not all liquid but only such as is cold. Hence water and any of its varieties melt them but oil does not. For the opposite of dry heat is moist cold and what the one solidified the other will dissolve, and so opposites will have opposite effects.

7 · If a body contains more water than earth fire only thickens it: if it contains more earth fire solidifies it. Hence natron and salt and stone and potter's clay must contain more earth.

The nature of oil presents the greatest problem. If water preponderated in it, cold ought to solidify it; if earth preponderated, then fire ought to do so. Actually neither solidifies, but both thicken it. The reason is that it is full of air (hence it floats on the top of water, since air tends to rise). Cold thickens it by turning the air in it into water, for any mixture of oil and water is thicker than either. Fire and the lapse of time thicken and whiten it. The whitening follows on the evaporation of any water that may have been in it; the thickening is due to the change of the air into water as the heat in the oil is dissipated. The effect in both cases is the same and the cause is the same, but the manner of its operation is different. Both heat and cold thicken it, but neither dries it (neither the sun nor cold dries oil), not only because it is viscous but because it contains air. Its viscous nature prevents it from giving off vapour and so fire does not dry the water or boil it off.

Those bodies which are made up of earth and water may be classified according to the preponderance of either. There is a kind of wine, for instance, which both solidifies and thickens by boiling—I mean, must. All bodies of this kind lose their water as they dry. That it is their water may be seen from the fact that the vapour from them condenses into water when collected. So wherever some sediment is left this is of the nature of earth. Some of these bodies, as we have said, are also thickened and dried by cold. For cold not only solidifies but also dries water, and thickens things by turning air into water. (Solidifying, as we have said, is a form of drying.) Now those things that are not thickened by cold, but solidified, belong rather to water, e.g. wine, urine, vinegar, lye, whey. But those things that are thickened (not by evaporation due to fire) are made up either of earth or of water and air: honey of earth, while oil contains air. Milk and blood, too, are made up of both water and earth, though earth generally predominates in them. So, too, are the liquids out of which natron and salt are formed; and stones are also formed from some mixtures of this kind. Hence, if the whey has not been separated, it burns away if you boil it over a fire. But the earthy element in milk can also be coagulated by the help of fig-juice, if you boil it in a certain way as doctors do when they treat it with fig-juice, and this is how the whey and the cheese are commonly separated. Whey, once separated, does not thicken, but boils away like water. Sometimes, however, there is little or no cheese in milk, and such milk is not nutritive and is more like water. The case of blood is similar: cold dries and so solidifies it. Those kinds of blood that do not solidify, like that of the stag, belong rather to water and are very cold. Hence they contain no fibres: for the fibres are of earth and solid, and blood from which they have been removed does not solidify. This is because it cannot dry; for what remains is water, just as what remains of milk when cheese has been removed is water. The fact that diseased blood will not solidify is evidence of the same thing, for such blood is of the nature of serum and that is phlegm and water, nature having failed to get the better of it and digest it.

Some of these bodies are soluble, e.g. natron, some insoluble, e.g. pottery: of
384b1 the latter, some, like horn, can be softened by heat, others, like pottery and stone cannot. The reason is that opposite causes have opposite effects; consequently, if solidification is due to two causes, the cold and the dry, solution must be due to the hot and the moist, that is, to fire and to water (these being opposites): water dissolving what was solidified by fire alone, fire what was solidified by cold alone. Consequently, if any things happen to be solidified by the action of both, these are least apt to be soluble. Such a case we find where things have been heated and are then solidified by cold. When the heat in leaving them has caused most of the moisture[57] to evaporate, the cold so compacts these bodies together again as to leave no entrance even for moisture. Therefore heat does not dissolve them (for it only dissolves those bodies that are solidified by cold alone), nor does water (for it does not dissolve what cold solidifies, but only what is solidified by dry heat). But iron is melted by heat and solidified by cold. Wood consists of earth and air and is therefore combustible but cannot be melted or softened. (For the same reason it floats in water—all except ebony. This does not, for other kinds of wood contain a

[57]Punctuating after ὑγρόν, not after ἐξιόν.

preponderance of air, but in black ebony the air has escaped and so earth preponderates in it.) Pottery consists of earth alone because it solidified gradually in the process of drying. Water cannot get into it, for the pores were only large enough to admit of vapour escaping: and seeing that fire solidified it, that cannot dissolve it either.

So solidification and melting, their causes, and the kinds of subjects in which they occur have been described.

8 · All this makes it clear that bodies are formed by heat and cold and that these agents operate by thickening and solidifying. It is because these qualities fashion bodies that we find heat in all of them, and in some cold in so far as heat is absent. These qualities, then, are present as active, and the moist and the dry as passive, and consequently all four are found in mixed bodies. So water and earth are the constituents of homogeneous bodies both in plants and in animals and of metals such as gold, silver, and the rest—water and earth and their respective exhalations shut up in the compound bodies, as we have explained elsewhere.

All these mixed bodies are distinguished from one another, firstly by the qualities special to the various senses, that is, by their capacities of action. (For a thing is white, fragrant, noisy, sweet, hot, cold in virtue of a power of acting on sense.) Secondly by other more characteristic affections which express their aptitude to be affected: I mean, for instance, the aptitude to melt or solidify or bend and so forth, all these qualities, like moist and dry, being passive. These are the qualities that differentiate bone, flesh, sinew, wood, bark, stone and all other homogeneous natural bodies. Let us begin by enumerating these qualities expressing the aptitude or inaptitude of a thing to be affected in a certain way. They are as follows: to be apt or inapt to solidify, melt, be softened by heat, be softened by water, bend, break, be fragmented, impressed, moulded, squeezed; to be tractile or non-tractile, malleable or non-malleable, to be fissile or non-fissile, apt or inapt to be cut; to be viscous or friable, compressible or incompressible, combustible or incombustible; to be apt or inapt to give off fumes. These affections differentiate most bodies from one another. Let us go on to explain the nature of each of them.

We have already given a general account of that which is apt or inapt to solidify or to melt, but let us return to them again now. Of all the bodies that admit of solidification and hardening, some are brought into this state by heat, others by cold. Heat does this by drying up their moisture, cold by driving out their heat. Consequently some bodies are affected in this way by defect of moisture, some by defect of heat: watery bodies by defect of heat, earthy bodies of moisture. Now those bodies that are so affected by defect of moisture are dissolved by water, unless like pottery they have so contracted that their pores are too small for the particles of water to enter. All those bodies in which this is not the case are dissolved by water, e.g. natron, salt, dry mud. Those bodies that solidified through defect of heat are melted by heat, e.g. ice, lead, copper. So much for the bodies that admit of solidification and of melting, and those that do not admit of melting.

The bodies which do not admit of solidification are those which contain no aqueous moisture and are not watery, but in which heat and earth preponderate, like honey and must (for these are in a sort of state of effervescence), and those which do possess some water but have a preponderance of air, like oil and quicksilver, and all viscous substances such as pitch and birdlime.

9 · Those bodies admit of softening which are not (like ice) made up of water, but in which earth predominates. All their moisture must not have left them (as in the case of natron and salt), nor must the relation of dry to moist in them be incongruous (as in the case of pottery). They must be tractile (without admitting water) or malleable (without consisting of water), and the agent in softening them is fire. Such are iron and horn.[58]

Both of bodies that can melt and of bodies that cannot, some do and some do not admit of softening in water. Copper, for instance, which can be melted, cannot be softened in water, whereas wool and earth can be softened in water, for they can be soaked. (It is true that though copper can be melted the agent in its case is not water, but some of the bodies that can be melted by water too such as natron and salt cannot be softened in water; for nothing is said to be so affected unless the water soaks into it and makes it softer.) Some things, on the other hand, such as wool and grain, can be softened by water though they cannot be melted. Any body that is to be softened by water must be of earth and must have its pores larger than the particles of water, and the pores must be harder[59] than the water, whereas bodies that can be melted by water must have pores throughout.

Why is it that earth is both melted and softened by moisture, while natron is melted but not softened? Because natron is pervaded throughout by pores so that the parts are immediately divided by the water, but earth has also pores which do not connect and is therefore differently affected according as the water enters by one or the other set of pores.

Some bodies can be bent or straightened, like the reed or the withy, some cannot, like pottery and stone. Those bodies are apt to be bent and straightened which can change from being curved to being straight and from being straight to being curved, and bending and straightening consist in the change or motion to the straight or to a curve, for a thing is said to be in process of being bent whether it is
386a1 being made to assume a convex or a concave shape. So bending is defined as motion to the convex or the concave without a change of length. For if we added 'or to the straight', we should have a thing bent and straight at once, and it is impossible for that which is straight to be bent. And if all bending is a bending up or a bending down, the former being a change to the convex, the latter to the concave, a motion that leads to the straight cannot be called bending, but bending and straightening are two different things. These, then, are the things that can, and those that cannot be bent, and be straightened.

Some things can be both broken and fragmented, others admit only one or the other. Wood, for instance, can be broken but not fragmented, ice and stone can be

[58]Omitting καὶ ξύλα.
[59]Reading ὄντας σκληροτέρους.

fragmented but not broken, while pottery may either be fragmented or broken. The distinction is this: breaking is a division and separation into large parts, fragmentation into parts of any size, but there must be more of them than two. Now those solids that have many pores not communicating with one another can be fragmented (for the limit to their subdivision is set by the pores), but those whose pores stretch continuously for a long way are breakable, while those which have pores of both kinds can be either fragmented or broken.

Some things, e.g. copper and wax, are impressible, others, e.g. pottery and water, are not. The process of being impressed is the sinking of a part of the surface of a thing in response to pressure or a blow, in general to contact. Such bodies are either soft,[60] like wax, where part of the surface is depressed while the rest remains, or hard, like copper. Non-impressible[61] bodies are either hard, like pottery (its surface does not give way and sink in), or liquid, like water (for though water does give way it is not in a part of it, for there is a reciprocal change of place of all its parts). Those impressibles that retain the shape impressed on them and are easily moulded by the hand are called plastic; those that are not easily moulded, such as stone or wood, or are easily moulded but do not retain the shape impressed, like wool or a sponge, are not plastic. The last group are said to be squeezable. Things are squeezable when they can contract into themselves under pressure, their surface sinking in without being broken and without the parts interchanging position as happens in the case of water. (We speak of pressure when there is movement and the motor remains in contact with the thing moved, of impact when the movement is due to the local movement of the motor.) Those bodies are subject to squeezing which have empty pores—empty, that is, of the stuff of which the body itself consists—and that can sink into the void spaces within them, or rather into their pores. For sometimes the pores into which a body sinks are not empty[62] (a wet sponge, for instance, has its pores full). But the pores, if full, must be full of something softer than the body itself which is to contract into them. Examples of things squeezable are the sponge, wax, flesh. Those things are not squeezable which cannot be made to contract into their own pores by pressure, either because they have no pores or because their pores are full of something too hard. Thus iron, stone, water and all liquids are incapable of being squeezed.

Things are tractile when their surface can be made to elongate, for being drawn out is a movement of the surface, remaining unbroken, in the direction of the mover. Some things are tractile, e.g. hair, thongs, sinew, dough, birdlime, and some are not, e.g. water, stone. Some things are both tractile and squeezable, e.g. wool; in other cases the two qualities do not coincide; phlegm, for instance, is tractile but not squeezable, and a sponge squeezable but not tractile.

Some things are malleable, like copper. Some are not, like stone and wood. Things are malleable when their surface can be made to move (but only in part) both downwards and sideways with one and the same blow: when this is not possible

[60]Reading *μαλακά*.

[61]Reading *χαλκός. καὶ τὰ ἄθλαστα*.

[62]Fobes excises 'For sometimes . . . empty'.

a body is not malleable. All malleable bodies are impressible, but not all impressible bodies are malleable, e.g. wood, though on the whole the two go together. Of squeezable things some are malleable and some not: wax and mud are malleable, wool is not.

Some things are fissile, e.g. wood, some are not, e.g. potter's clay. A thing is fissile when it is apt to divide in advance of the instrument dividing it, for a body is said to split when it divides to a further point than that to which the dividing instrument divides it and the act of division advances: which is not the case with cutting. Those bodies which cannot behave like this are non-fissile. Nothing soft is fissile (by soft I mean absolutely soft and not relatively: for iron itself may be relatively soft); nor are all hard things fissile, but only such as are neither liquid nor
387a1 impressible nor capable of being fragmented. Such are the bodies that have the pores along which they cohere lengthwise and not crosswise.

Those hard or soft solids are apt to be cut which do not necessarily either split in advance of the instrument or break into minute fragments when they are being divided; and everything that is not moist cannot be cut. Some things can be both split and cut, like wood, though generally it is lengthwise that a thing can be split and crosswise that it can be cut. For, a body being divided into many parts, in so far as its unity is made up of many lengths it is apt to be split, in so far as its unity is made up of many lengths it is apt to be split, in so far as it is made up of many breadths it is apt to be cut.

A thing is viscous when, being moist or soft, it is tractile. Bodies owe this property to the interlocking of their parts when they are composed like chains, for them they can be drawn out to a great length and contracted again. Bodies that are not like this are friable.

Bodies are compressible when they are squeezable and retain the shape they have been squeezed into; incompressible when they are either inapt to be squeezed at all or do not retain the shape they have been squeezed into.

Some bodies are combustible and some are not. Wood, wool, bone are combustible; stone, ice are not. Bodies are combustible when their pores are such as to admit fire and their longitudinal pores contain moisture weaker than fire. If they have no moisture, or if, as in ice or very green wood, the moisture is stronger than fire, they are not combustible.

Those bodies give off fumes which contain moisture, but in such a form that it does not go off separately in vapour when they are exposed to fire. For vapour is a moist exhalation into air and wind produced from a liquid by the agency of burning heat. Bodies that give off fumes give off secretions of the nature of air by the lapse of time: as they perish away they dry up or become earth. But the kind of secretion we are concerned with now differs from others in that it is not moist nor does it become wind (which is a continuous flow of air in a given direction). Fumes are a common secretion of dry and moist together caused by the agency of burning heat. Hence they do not moisten things but rather colour them.

387b1 The fumes of a woody body are called smoke. (I mean to include bones and hair and everything of this kind in the same class. For there is no name common to all the objects that I mean, but, for all that, these things are all in the same class by analogy. Compare with Empedocles says: 'They are one and the same, hair and leaves and the thick wings of birds and scales that grow on stout limbs.'[63]) The fumes of fat are a sooty smoke and those of oily substances a greasy steam. Oil does not boil away or thicken by evaporation because it does not give off vapour but fumes. Water on the other hand does not give off fumes, but vapour. Sweet wine does give off fumes, for it contains fat and behaves like oil. It does not solidify under the influence of cold and it is apt to burn. Really it is not wine at all in spite of its name; for it does not taste like wine and consequently does not inebriate as ordinary wine does. It contains but little fumigable stuff and consequently is inflammable.

All bodies are combustible that dissolve into ashes, and all bodies do this that solidify under the influence either of heat or of both heat and cold; for we find that all these bodies are mastered by fire. Of stones the precious stone called carbuncle is least amenable to fire.

Of combustible bodies some are inflammable and some are not, and some of the former are reduced to coals. Those are called inflammable which produce flame and those which do not are called non-inflammable. Those fumigable bodies that are not liquid are inflammable, but pitch, oil, wax are inflammable in conjunction with other bodies rather than by themselves. Most inflammable are those bodies that give off smoke. Of bodies of this kind those that contain more earth than smoke are apt to be reduced to coals. Some bodies that can be melted are not inflammable, e.g. copper; and some bodies that cannot be melted are inflammable, e.g. wood; and some bodies can be melted and are also inflammable, e.g. frankincense. The reason is that wood has its moisture all together and this is continuous throughout and so it burns up: whereas copper has it in each part but not continuous, and insufficient in quantity to give rise to flame. In frankincense it is disposed in both of these ways. Fumigable bodies are inflammable when earth predominates in them and they are consequently such as to be unable to melt. These are inflammable because they are dry like fire. When this dry comes to be hot there is fire. This is why flame is 388a1
burning smoke or dry exhalation. The fumes of wood are smoke, those of wax and frankincense and such-like, and pitch and whatever contains pitch or such-like, are sooty smoke, while the fumes of oil and oily substances are a greasy steam; so are those of all substances which are not at all combustible by themselves because there is too little of the dry in them (the dry being the means by which the transition to fire is effected), but burn very readily in conjunction with something else. (For the fat is just the conjunction of the oily with the dry.) So those bodies[64] that give off fumes, like oil and pitch, belong rather to the moist, but those that burn to the dry.

10 · Homogeneous bodies differ to touch by these affections and differences, as we have said. They also differ in respect of their smell, taste, and colour.

By homogeneous bodies I mean, for instance, the stuffs that are mined—gold, copper, silver, tin, iron, stone, and everything else of this kind and the bodies that

[63]Frag. 82 Diels-Kranz.
[64]Omitting τῶν ὑγρῶν.

are extracted from them; also the substances found in animals and plants, for instance, flesh, bones, sinew, skin, viscera, hair, fibres, veins (these are the elements of which the non-homogeneous bodies like the face, a hand, a foot, and everything of that kind are made up), and in plants, wood, bark, leaves, roots, and the rest like them.

The homogeneous bodies, it is true, are constituted by a different cause, but the matter of which they are composed is the dry and the moist, that is, water and earth (for these bodies exhibit those qualities most clearly). The agents are the hot and the cold; for they constitute and make concrete the homogeneous bodies out of earth and water. Let us consider, then, which of the homogeneous bodies are made of earth and which of water, and which of both.

Of organized bodies some are liquid, some soft, some hard. The soft and the hard are constituted by a process of solidification,[65] as we have already explained.

Those liquids that go off in vapour are made of water, those that do not are either of the nature of earth, or a mixture either of earth and water, like milk, or of earth and air, like wood, or of water and air, like oil. Those liquids which are thickened by heat are a mixture. (Wine is a liquid which raises a difficulty; for it is both liable to evaporation and it also thickens; for instance new wine does. The reason is that there is more than one kind of liquid called wine and different kinds behave in different ways. New wine is more earthy than old, and for this reason it is more apt to be thickened by heat and less apt to be congealed by cold. For it contains much heat and a great proportion of earth, as in Arcadia, where it is so dried up in its skins by the smoke that you scrape it to drink. If all wine has some sediment in it then it will belong to earth or to water according to the quantity of the sediment it possesses.) The liquids that are thickened by cold are of the nature of earth; those that are thickened either by heat or by cold consist of more than one element, like oil and honey and sweet wine.

Of solid bodies those that have been solidified by cold are of water, e.g. ice, snow, hail, hoar-frost. Those solidified by heat are of earth, e.g., pottery, cheese, natron, salt. Some bodies are solidified by both heat and cold. Of this kind are those solidified by refrigeration, that is by the privation both of heat and of the moisture which departs with the heat. For salt and the bodies that are purely of earth solidify by privation of moisture only, ice by that of heat only, these bodies by that of both. So both the active qualities and both kinds of matter were involved in the process. Of these bodies those from which all the moisture has gone are all of them of earth, like pottery or amber. (For amber, also, and the bodies called 'tears' are formed by refrigeration, like myrrh, frankincense, gum. Amber, too, appears to belong to this class of things: the animals enclosed in it show that it is formed by solidification. The heat is driven out of it by the cold of the river and causes the moisture to evaporate with it, as in the case of honey when it has been heated and is immersed in water.) Some of these bodies cannot be melted or softened; for instance, amber and certain stones, e.g. the stalactites in caves. (For these stalactites, too,are formed in the same way: the agent is not fire, but cold which drives out the heat, which, as it

[65]Reading ὅτι πήξει.

leaves the body, draws out the moisture with it: in the other class of bodies the agent is external fire.) In those from which the moisture has not wholly gone earth still preponderates, but they admit of softening by heat, e.g. iron and horn. (Frankincense and things of that sort give off vapour in the same way as wood does.)

Now since we must include among meltables those bodies which are melted by fire, these contain some water; indeed some of them, like wax, are common to earth and water alike. But those that are melted by water are of earth. Those that are not 389a1 melted either by fire or water are of earth, or of earth and water.

Since, then, all bodies are either liquid or solid, and since the things that display the affections we have enumerated belong to these two classes and there is nothing intermediate, it follows that we have given a complete account of the criteria for distinguishing whether a body consists of earth or of water or of more elements than one, and whether fire was the agent in its formation, or cold, or both.

Gold, then, and silver and copper and tin and lead and glass and many nameless stones are of water; for they are all melted by heat. Of water, too, are some wines and urine and vinegar and lye and whey and serum; for they are all congealed by cold. In iron, horn, nails, bones, sinews, wood, hair, leaves, bark, earth preponderates. So, too, in amber, myrrh, frankincense, and all the substances called 'tears', and stalactites, and fruits, such as leguminous plants, and corn. For things of this kind are, to a greater or less degree, of earth. For of all these bodies some admit of softening by heat, the rest give off fumes and are formed by refrigeration. So again in natron, salt, and those kinds of stones that are not formed by refrigeration and cannot be melted. Blood, on the other hand, and semen are made up of earth and water and air. If the blood contains fibres, earth preponderates in it; consequently it solidifies by refrigeration and is melted by liquids; if not, it is of water and therefore does not solidify. Semen solidifies by refrigeration, its moisture leaving it together with its heat.

11 · We must investigate in the light of the results we have arrived at what solid or liquid bodies are hot and what cold.

Bodies consisting of water are commonly cold, unless (like lye, urine, wine) they contain foreign heat. Bodies consisting of earth, on the other hand, are commonly hot because heat was active in forming them: for instance lime and ashes.

We must recognize that cold is in a sense the matter of bodies. For the dry and the moist are matter (being passive) and earth and water are the elements that primarily embody them, and they are characterized by cold. Consequently cold must predominate in every body that consists of one or other of the elements simply, 389b1 unless such a body contains foreign heat as water does when it boils or when it has been strained through ashes. This latter, too, has acquired heat from the ashes; for everything that has been burnt contains more or less heat. This explains the generation of animals in putrefying bodies: the putrefying body contains the heat which destroyed its proper heat.

Bodies made up of earth and water are hot; for most of them derive their existence from concoction and heat, though some, like the waste products of the body, are the products of putrefaction. Thus blood, semen, marrow, fig-juice, and all things of the kind are hot as long as they are in their natural state, but when they perish and fall away from that state they are so no longer. For what is left of them is their matter and what is earth or water. Hence both views are held about them, some people maintaining them to be cold and others to be warm; for they are observed to be hot when they are in their natural state, but to solidify when they have fallen away from it. That, then, is the case of mixed bodies. However, the distinction we laid down holds good: if its matter is predominantly water a body is cold (water being the complete opposite of fire), but if earth or air it tends to be warm.

It sometimes happens that the coldest bodies can be raised to the highest temperature by foreign heat; for the most solid and the hardest bodies are coldest when deprived of heat and most burning after exposure to fire: thus water is more burning than smoke and stone than water.

12 · Having explained all this we must describe the nature of flesh, bone, and the other homogeneous bodies severally.

Our account of the formation of the homogeneous bodies has given us the elements out of which they are compounded and the classes into which they fall, and has made it clear to which class each of those bodies belongs. The homogeneous bodies are made up of the elements, and all the works of nature in turn of the homogeneous bodies as matter. All the homogeneous bodies consist of the elements described, as matter, but their essence is determined by their definition. This fact is always clearer in the case of the later products, of those, in fact, that are instruments, as it were, and have an end: it is clearer, for instance, that a dead man is a man only in name. And so the hand of a dead man, too, will in the same way be a
390a1 hand in name only, just as stone flutes might still be called flutes; for these too, seem to be instruments of a kind. But in the case of flesh and bone the fact is not so clear to see, and in that of fire and water even less. For the end is least obvious there where matter predominates most. If you take the extremes, matter is pure matter and the essence is pure definition; but the bodies intermediate between the two are related to each in proportion as they are near to either. For each of these elements has an end and is not water or fire in any and every condition of itself, just as flesh is not flesh nor viscera viscera, and the same is true in a higher degree with face and hand. What a thing is is always determined by its function: a thing really is itself when it can perform its function; an eye, for instance, when it can see. When a thing cannot do so it is that thing only in name, like a dead eye or one made of stone, just as a wooden saw is no more a saw than one in a picture. The same, then, is true of flesh, except that its function is less clear than that of the tongue. So, too, with fire; but its function is perhaps even harder to specify by physical inquiry than that of flesh. The parts of plants, and inanimate bodies like copper and silver, are in the same case. They all are what they are in virtue of a certain power of action or passion—just like flesh and sinew. But we cannot state their definitions accurately,

and so it is not easy to tell when they are really there and when they are not unless the body is thoroughly corrupted and its shape only remains. So ancient corpses suddenly become ashes in the grave and very old fruit preserves its shape only but not its sensible qualities; so, too, with the solids that form from milk.

Now heat and cold and the motions they set up as the bodies are solidified by the hot and the cold are sufficient to form all such parts as are the homogeneous bodies, flesh, bone, hair, sinew, and the rest. For they are all of them differentiated by the various qualities enumerated above, tension, ductility, fragmentability, hardness, softness, and the rest of them: all of which are derived from the hot and the cold and the mixture of their motions. But no one would go as far as to consider them sufficient in the case of the non-homogeneous parts (like the head, the hand, or the foot) which these homogeneous parts go to make up. Cold and heat and their motion would be admitted to account for the formation of copper or silver, but not for that of a saw, a bowl, or a box. So here, save that in the examples given the cause is art, but in the non-homogeneous bodies nature or some other cause.

Since, then, we know to what class each of the homogeneous bodies belongs, we must now find the definition of each of them, i.e. what is blood, flesh, semen, and the rest? For we know the cause of a thing and its definition when we know its matter and its definition—and best when we know both the material and the formed factors of its generation and destruction, and also the source of the origin of its motion.

After the homogeneous bodies have been explained we must consider the non-homogeneous too, and lastly the bodies made up of these, such as man, plants, and the rest.

ON THE UNIVERSE**

E. S. Forster

1 · Many a time, Alexander, has Philosophy seemed to me truly divine and supernatural, especially when in solitude she soars to the contemplation of things universal and strives to recognize the truth that is in them, and while all others abstain from the pursuit of this truth owing to its sublimity and vastness, she has not shrunk from the task nor thought herself unworthy of the fairest pursuits, but has deemed the knowledge of such things at once most natural to herself and most fitting. For seeing that it was not possible (as once the foolish Aloadae attempted) by means of the body to reach the heavenly region and leaving the earth behind to spy out that holy country, the soul by means of philosophy, taking the intellect as her guide, finding an easy path has traversed the intervening space and fared forth, and by intelligence comprehended things very far removed in space from one another, easily, I think, recognizing those things which have kinship with herself, and by the divine eye of the soul apprehending things divine and interpreting them to mankind. This she felt, being desirous, as far as in her lay, freely to give to all men a share of her honours. And so men who have laboriously described to us either the nature of a single region or the plan of a single city or the dimensions of a river or the scenery of a mountain, as some before now have done,—telling of Ossa or Nysa or the Corycian cave or giving us some other limited description,—such men one should pity for their small-mindedness in admiring ordinary things and making much of some quite insignificant spectacle. They are thus affected because they have never contemplated what is nobler—the Universe and the greatest things of the Universe; for if they had properly attended to these things, they would never marvel at anything else, but all else would appear insignificant and, compared to the surpassing excellence of these things, of no account. Let us therefore treat of all these matters and, as far as possible, inquire into their divine nature, and discuss the nature and position and movement of each of them. And I think that it is but fitting that even you, who are the noblest of rulers, should pursue the inquiry into the greatest of all subjects and that philosophy should entertain no trivial thoughts, but make the noblest among men welcome to these her gifts.

TEXT: W. L. Lorimer, Paris, 1933

2 · The Universe then is a system made up of heaven and earth and the natural things which are contained in them. But the word is also used in another sense of the ordering and arrangement of all things, preserved by and through God. Of this Universe the centre, which is immovable and fixed, is occupied by the life-bearing earth, the home and the mother of diverse creatures. The upper portion of the Universe, a whole with a fixed upper limit everywhere, the home of the gods, is called Heaven. Heaven is full of divine bodies, which we usually call stars, and moves with an eternal motion, and in one circular orbit revolves in stately measure with all the heavenly bodies unceasingly for ever. The whole heaven and universe being spherical and moving, as I have said, continually, there must of necessity be two points which do not move, exactly opposite to one another (as in a sphere being turned on a lathe), points which remain fixed and hold the sphere together and round which the whole mass revolves in a circle; and these points are called poles. If we imagine a straight line drawn so as to join them (the axis, as it is sometimes called), it will form the diameter of the Universe, having the earth as its centre and the two poles as its extremities. Of these fixed poles the one is always visible, being above our heads in the northern region of the sky, and is called the Arctic Pole; the other is always hidden beneath the earth to the south and is called the Antarctic Pole.

The substance of the heaven and stars we call ether, not because it blazes, owing to its fiery nature (as some explain the word, mistaking its nature, which is very far removed from fire), but because it is in continual motion,[1] revolving in a circle, being an element other than the four pure and divine. Of the stars which are contained in it, some revolve fixedly with the whole heaven, always occupying the same positions. A belt is formed through their midst by the so-called Circle of the Zodiac, which passes crosswise through the tropics, being divided up into the twelve regions of the Signs of the Zodiac. Others, which are the planets, do not naturally move with the same velocity as those stars of which I have already spoken, nor with the same velocity as one another, but each in a different course, so that one will be nearer the earth, another higher in the heavens. Now the number of the fixed stars cannot be ascertained by man, although they move in one surface, which is that of the whole heaven. But the planets fall into seven divisions in seven successive circles, so situated that the higher is always greater than the lower, and the seven circles are successively encompassed by one another and are all surrounded by the sphere containing the fixed stars. The position nearest to this sphere is occupied by the so-called circle of the Shining star, or Saturn; next is that of the Beaming star, which also bears the name of Jupiter; then follows the circle of the Fiery star, called by the names both of Heracles and of Mars; next comes the Glistening star, which some call sacred to Mercury, others sacred to Apollo; after that is the circle of the Light-bearing star, which some call the star of Venus, others the star of Hera; then comes the circle of the Sun, and lastly that of the Moon—and there is the limit of the ether which encompasses the heavenly bodies and the area over which they are ordained to move.

[1]'Ether', *αἰθήρ*, is derived from *ἀεὶ θεῖν* not from *αἴθεσθαι*.

After the ethereal and divine nature, which we declare to be orderly and to be, moreover, free from disturbance, change, and external influence, there follows immediately an element which is subject throughout to external influence and disturbance and is, in a word, corruptible and perishable. In the first portion of this occurs the substance which is made up of small particles and is fiery, being kindled 392b1 by the ethereal element owing to its superior size and the rapidity of its movement. In this so-called fiery and disordered element flashes shoot and fires dart, and so-called 'beams' and 'pits' and comets have their fixed position and often become extinguished.

Next beneath this spreads the air, which is in its nature murky and cold as ice, but becomes illuminated and set on fire by the fiery element, and thus grows brighter and warm. And since the air too admits of influence and undergoes every kind of change, clouds form in it, rain-storms beat down, and snow, hoar-frost, hail, blasts of winds and of hurricanes, and thunder too and lightning and falling bolts, and crashing together of countless storm-clouds.

3 · Next to the aerial element the earth and sea have their fixed position, teeming with plant and animal life, and fountains and rivers, either being spent in the earth or discharging their waters into the sea. The earth is diversified by countless kinds of verdure and lofty mountains and densely wooded copses and cities, which that intelligent animal man has founded, and islands set in the sea and continents. Now the usual account divides the inhabited world into islands and continents, ignoring the fact that the whole of it forms a single island round which the sea that is called Atlantic flows. But it is probable that there are many other continents far away across the seas from ours, some larger and others smaller than it, but all, save our own, invisible to us. For as our islands are in relation to our seas, so is the inhabited world in relation to the Atlantic, and so are many other continents in relation to the whole sea; for they are as it were immense islands surrounded by immense seas. The general element of moisture, covering the earth's surface and allowing the so-called inhabited countries to show through where the earth projects, may be said to come immediately after the aerial element. Next to it the whole earth has been formed, firmly fixed in the lowest position at the midmost centre of the Universe, closely compacted, immovable and unshakable. This forms the whole of what we call the lower portion of the Universe.

393a1 Thus then five elements, situated in spheres in five regions, the less being in each case surrounded by the greater—namely, earth surrounded by water, water by air, air by fire, and fire by ether—make up the whole Universe. All the upper portion represents the dwelling of the gods, the lower the abode of mortal creatures. Of the latter, part is moist, to which we are accustomed to give the names of rivers, springs, and seas; while part is dry, which we call land and continents and islands.

Of the islands, some are large, like the whole of what we call the inhabited world (and there are many other such surrounded by mighty seas); other islands are smaller, which are visible to us and in our own sea. Of these some are of considerable size, Sicily, Sardinia, Corsica, Crete, Euboea, Cyprus, and Lesbos;

others are less extensive, such as the Sporades and Cyclades and others bearing various names.

Again, the sea which lies outside the inhabited world is called the Atlantic or Ocean, flowing round us. Opening in a narrow passage towards the West, at the so-called Pillars of Heracles, the Ocean forms a current into the inner sea, as into a harbour; then gradually expanding it spread out, embracing great bays adjoining one another, here contracting into narrow straits and there widening out again. First, then, on the right as one sails in through the Pillars of Heracles it is said to form two bays, the so-called Syrtes, the Greater and the Lesser as they are called; on the other side it does not make such bays, but forms three seas, the Sardinian, the Gallic, and the Adriatic. Next to these comes the Sicilian sea, lying crosswise, and after it the Cretan. Continuing it come the Egyptian, Pamphylian, and Syrian seas in one direction, and the Aegean and Myrtoan seas in the other. Over against the seas already mentioned extends the Pontus, which is made up of several parts; the innermost portion is called Maeotis, while the outer portion in the direction of the Hellespont is connected by a straight with the so-called Propontis. Towards the East 393b1
the Ocean again flows in and opens up the Indian and Persian Gulfs, and displays the Erythraean sea continuous with these, embracing all three. With its other branch it passes through a long narrow strait and then expands again, marking off the Hyrcanian and Caspian seas. Beyond this it occupies the deeps beyond the Lake of Maeotis; then beyond the Scythians and the land of the Celts it gradually confines the width of the habitable world, as it approaches the Gallic Gulf and the Pillars of Heracles already mentioned, outside which the Ocean flows round the earth. In this sea are situated two very large islands, the so-called British Isles, Albion and Ierne, which are greater than any which we have yet mentioned and lie beyond the land of the Celts. (The island of Taprobane opposite India, situated at an angle to the inhabited world, is quite as large as the British Isles, as also is the island called Phebol which lies over against the Arabian Gulf.) There is a large number of small islands round the British Isles and Iberia, forming a belt round the inhabited world, which as we have already said is itself an island. The width of the inhabited world at the greatest extent of its mainland is rather less than 40,000 stades, so the best geographers say, and its length about 70,000 stades. It is divided in Europe, Asia, and Libya.

Europe is the tract bounded in a circle by the Pillars of Heracles, the inner recesses of the Pontus, and the Hyrcanian sea, where a very narrow isthmus stretches to the Pontus. Some have held that the river Tanais is the boundary rather than the isthmus. Asia extends from the said isthmus and the Pontus and the Hyrcanian sea to the other isthmus which lies between the Arabian Gulf and the inner sea, being surrounded by the inner sea and the Ocean which flows round the world. Some, however, define the bounds of Asia as from the Tanais to the mouths of the Nile. Libya extends from the Arabian isthmus to the Pillars of Heracles; though some describe it as stretching from the Nile to the Pillars; Egypt, which is 394a1
surrounded by the mouths of the Nile, is given by some to Asia, by others to Libya; some exclude the islands from both continents, others attach them to their nearest neighbour.

Such is our account of the nature of land and sea and their position—the inhabited world as we call it.

4 · Let us now deal with the most remarkable conditions which are produced in and around the earth, summarizing them in the barest outline. There are two kinds of exhalation which rise continually from the earth into the air above us, composed of small particles and entirely invisible, except that sometimes in the mornings they are seen rising from rivers and streams. Of these one kind being given off from the earth is dry and resembles smoke, while the other being exhaled from the element of moisture is damp and vaporous. From the latter are produced mist and dew and the various forms of frost, clouds and rain and snow and hail; while from the dry exhalation come the winds and the different kinds of breezes, and thunder and lightning, and fiery bolts and thunderbolts, and all other cognate phenomena. Mist is a vaporous exhalation which does not produce water, denser than air but less dense than cloud; it arises either from the first beginnings of a cloud or else from the remnant of a cloud. The contrary of this is what is called a clear sky, being simply air free from cloud and mist. Dew is moisture of fine composition falling from a clear sky; ice is water congealed in a condensed form from a clear sky; hoar-frost is congealed dew, and 'dew-frost' is dew which is half congealed. Cloud is a vaporous mass, concentrated and producing water. Rain is produced from the compression of a closely condensed cloud, varying according to the pressure exerted on the cloud; when the pressure is slight it scatters gentle drops; when it is great it produces a more violent fall, and we call this a downpour, being heavier than rain, and forming continuous masses of water falling over earth. Snow is produced by the breaking up of condensed clouds, the cleavage taking place before the change into water; it is the process of cleavage which causes its resemblance to foam and its intense whiteness, while the cause of its coldness is the
394b1 congelation of the moisture in it before it is dispersed or rarefied. When snow is violent and falls heavily we call it a blizzard. Hail is produced when snow becomes densified and acquires impetus for a swifter fall from its close mass; the hailstones become greater and the fall more violent in proportion to the size of the broken fragments of cloud. Such then are the phenomena which occur as the result of moist exhalation.

From dry exhalation, impelled into motion by cold, is produced wind; for wind is merely a quantity of air set in motion in a mass. Wind is also called breath, a word used in another sense of the vital and generative substance which is found in plants and living creatures, and permeates all things; but with this we need not deal here. The breath which breathes in the air we call wind, while to the expirations from moisture we give the name of breezes. The winds which blow from moist land we call land-winds, those which spring up from the gulfs we call gulf-winds; somewhat similar to these are those which blow from rivers and lakes. Winds which are produced by the bursting of a cloud causing an expansion of its density in their own direction, are called cloud-winds. Those which burst out all at once accompanied by a mass of water are called rain-winds.

The winds which blow continuously from the rising sun are called Euri; those from the north, Boreae; those from the setting sun, Zephyri; those from the south, Noti. Of the east winds, that which blows from the region of the summer sunrise is called Caecias; that which blows from the region of the equinoctial sunrise is known as Apeliotes; while the name of Eurus is given to the wind which blows from the quarter of the winter sunrise. Of the west winds, which blow in the contrary direction, that which blows from the summer setting is Argestes, though some call it Olympias, others Iapyz; that which blows from the equinoctial setting is Zephyrus, and that which blows from the winter setting is Lips. Of the north winds that which is next to Caecias is called Boreas in the specific sense of the word. Aparctias is next to it, and blows in a southerly direction from the pole. Thracias is the wind which blows next to Argestes; by some it is called Circias. Of the south winds, that which comes from the invisible pole and immediately faces Aparctias is called Notus; that between Notus and Eurus is called Euronotus. The wind on the other side between Lips and Notus is called by some Liponotus, by others Libophoenix.

Some winds are direct, those, that is, which blow along a straight line; others follow a bending course, as for instance the wind called Caecias. Some winds hold 395a1
sway in the winter, the south winds for example; others in the summer, such as the Etesian winds, which are a mixture of northerly and westerly winds. The so-called Ornithian winds, which occur in the spring, are a northerly type of wind.

Of violent blasts of wind, a squall is one which suddenly strikes down from above; a gust is a violent blast which springs up in a moment; a whirlwind, or tornado, is a wind which revolves in an upward direction from below. An eruption of wind from the earth is a blast caused by the emission of air from a deep hold or cleft; when it comes forth in a whirling mass it is called an earth-storm. A wind which is whirled along in a dense watery cloud and being driven forth through it violently breaks up the continuous masses of the cloud, causes a roar and crash, which we call thunder, similar to the noise made by wind driven violently through water. When the wind is breaking forth from a cloud catches fire and flashes it is called lightning. The lightning reaches our perception sooner than the thunder, though it actually occurs after it, since it is the nature of that which is heard to travel less quickly than that which is seen; for the latter is visible at a distance, while the former is only heard when it reaches the ear, especially since the one, the fiery element, travels faster than anything else, while the other, being of the nature of air, is less swift and only reaches the ear by actually striking upon it. If the flashing body is set on fire and rushes violently to the earth it is called a thunderbolt; if it be only half of fire, but violent also and massive, it is called a fiery bolt; if it is entirely free from fire, it is called a smoking bolt. They are all called swooping bolts, because they swoop down upon the earth. Lightning is sometimes smoky, and is then called smouldering lightning; sometimes it darts quickly along, and is then said to be vivid; at other times it travels in crooked lines, and is called forked lightning; when it swoops down upon the earth it is called swooping lightning.

To sum up, some of the phenomena which occur in the air are merely appearances, while others have actual substance. Rainbows and rods and the like are only appearances, while flashes and shooting-stars and comets and the like have real substance. A rainbow is the reflection of a segment of the sun or of the moon, seen, as in a mirror, in a cloud which is moist, hollow, and continuous in appearance, and taking a circular form. A rod is a rainbow appearing in the form of a straight 395b1 line. A halo is an appearance of brightness shining round a star; it differs from a rainbow, because the latter appears opposite the sun and moon, while the halo is formed all round a star. A light in the sky is caused by the kindling of a mass of fire in the air; some lights shoot along, other are fixed. The shooting is the generation of fire by friction, when the fire moves quickly through the air and by its quickness produces an impression of length; the fixture is a prolonged extension without movement, an elongated star as it were. A light which broadens out towards one end is called a comet. Some lights often last a considerable time, others are extinguished immediately. There are numerous other kinds of appearances seen in the sky, the so-called torches, beams, barrels, and pits, which derive their names from their similarity to these objects. Some of them appear in the west, others in the east, others in both these quarters, but rarely in the north or south. None of them are stable; for none of them have been discovered to be always visible in a fixed position. Such are the phenomena of the air.

As the earth contains many sources of water, so also it contains many sources of wind and fire. Of these some are subterranean and invisible, but many have vents and blow-holes, as Lipara, Etna, and those in the Aeolian islands—and they frequently flow like rivers and cast up red-hot lumps. Some, which are under the earth near springs of water, warm them and cause some streams to flow tepid, others very hot, others tempered to a pleasant heat. Similarly, many vent-holes for wind open in every part of the earth; some of them cause those who draw near to them to become frenzied, others cause them to waste away, others inspire them to utter oracles, as at Delphi and Lebadia, others utterly destroy them, as the one in Phrygia. Often, too, a moderate wind engendered in the earth, being driven aside into deep crannies of the earth and displaced from its proper locality, causes shocks in many parts. Often, too, a strong current from without becomes caught in the hollows of the earth, and, being cut off, it shakes the earth violently, seeking an exit, and sets up the condition which we commonly call an earthquake. Earthquakes of 396a1 which the shock is oblique, at a sharp angle, are known as horizontal earthquakes; those which lift the earth up and down at right angles are known as heaving earthquakes; those which cause the earth to settle down into hollows are called sinking earthquakes; those which open up chasms and break up the earth's surface are called rending earthquakes. Some of them also emit winds, others stones or mud, while others cause springs to appear which did not exist before. Some earthquakes cause a disturbance by means of a single shock and are known as thrusting earthquakes. Others which swing to and fro and by inclinations and waves in each direction remedy the effect of their shock, are called vibrating earthquakes, setting up a condition which resembles trembling. There are also bellowing earthquakes, which shake the earth with a roar. Underground bellowing, however, is often heard unaccompanied by earthquakes, when the wind, though insufficient to cause a shock, is compressed together in the earth and beats with the force of its impetus. Blasts which penetrate into the earth are materialized also from moisture concealed underground.

We find analogous phenomena occurring in the sea. Chasms form in it and its waters often retire or the waves rush in; this is sometimes followed by a recoil and sometimes there is merely a forward surge of water, as is said to have occurred at Helice and Bura. Often, too, there are exhalations of fire from the sea, and springs gush out and river-mouths are formed and trees suddenly grow up, and currents and eddies appear, like those caused in the air by blasts of wind, sometimes in the middle of the sea, sometimes in straits and channels. Many tides and tidal waves are said always to accompany the periods of the moon at fixed intervals. In short, owing to the mingling of the elements together, it is reasonable that similar conditions are produced in the air and in the earth and in the sea, causing decay and generation in parts, but preserving the whole free from destruction and generation.

5 · Yet some have wondered how it is that the Universe, if it be composed of contrary principles—namely, dry and moist, hot and cold—has not long ago perished and been destroyed. It is just as though one should wonder how a city 396b1
continues to exist, being, as it is, composed of the most opposite classes—rich and poor, young and old, weak and strong, good and bad. They fail to notice that this has always been the most striking characteristic of civic concord, that it evolves unity out of plurality, and similarity out of dissimilarity, admitting every kind of nature and chance. It may perhaps be that nature has a liking for contraries and evolves harmony out of them and not out of similarities (just as she joins the male and female together and not members of the same sex), and has devised the original harmony by means of contraries and not similarities. The arts, too, apparently imitate nature in this respect. The art of painting, by mingling in the picture the elements of white and black, yellow and red, achieves representations which correspond to the original object. Music, too, mingling together notes, high and low, short and prolonged, attains to a single harmony amid different voices; while writing, mingling vowels and consonants, composes of them all its art. The saying of Heracleitus the obscure was to the same effect: 'Graspings: wholes and not wholes, that which agrees and that which differs, that which produces harmony and that which produces discord; from all one and from one all.'[2]

Thus then a single harmony orders the composition of the whole—heaven and earth and the whole Universe—by the mingling of the most contrary principles. The dry mingling with the moist, the hot with the cold, the light with the heavy, the straight with the curved, all the earth, the sea, the ether, the sun, the moon, and the whole heaven are ordered by a single power extending through all, which has created the whole universe out of separate and different elements—air, earth, fire, and water—embracing them all in one spherical surface and forcing the most contrary natures in it to live in agreement with one another and thus contriving the

[2]Frag. 10 Diels-Kranz.

permanence of the whole. The cause of this permanence is the agreement of the elements, and the reason of this agreement is their equal proportion and the fact that no one of them is more powerful than any other; for the heavy is equally balanced with the light and the hot with the cold. Thus nature teaches us in the greater principles of the world that equality somehow tends to preserve harmony, whilst harmony preserves the universe which is the parent of all things and itself the fairest thing of all. For what natural thing is more excellent? Any that one can name is but a part of the Universe. All that is beauteous bears its name, and all that which is arranged well; for it is said to be well ordered, being thus called after the ordered Universe.[3] And what particular phenomenon could be likened to the ordered system of the heavens and the march of the stars and the sun and the moon, which move on in most accurate measure through age after age? Where else could be found such regularity as is observed by the goodly seasons, which produce all things and bring in due order summer and winter, day and night, to the accomplishment of the month and the year? Moreover, in greatness the universe is pre-eminent, in motion swiftest, in radiance most bright, and in might it knows not old age or corruption. It has divided the various creatures that live in the sea, on the earth, and in the air, and regulated their lives by its movements. Of it all living things breathe and have their life. Even all the unexpected changes which occur in it are really accomplished in an ordered sequence—diverse winds conflicting together, thunderbolts falling from heaven, and violent storms bursting forth. The expulsion of moisture and the exhalation of fire by these means restores the whole to harmony and stability. The earth, too, clothed with diverse vegetation, gushing forth with streams and trodden by the feet of living creatures, in due season bringing forth, nurturing, and receiving back all things, producing countless varieties and changes, none the less always preserves its nature untouched by age, though shaken by earthquakes, washed by floods, and in parts burnt up by fires. All these things seem to work its welfare and to ensure its eternal permanence. For when it is shaken by earthquakes and winds which have been diverted into it escape forth, finding vents through the clefts, as we have already said; when it is washed by rain, it is cleansed of all that is unhealthy; and when the breezes blow about it, it is purified above and beneath. Again, the fires soften that which is frost-bound, while the frosts abate the fires. Of particular things some are coming into being, others are at their prime, others are decaying; and birth checks decay and decay lightens birth. Thus an unbroken permanence, which all things conspire to secure, counteracting one another—at one time dominating, at another being dominated—preserves the whole unimpaired through all eternity.

6 · There still remains for us to treat briefly, as we have discussed the other subjects, of the cause which holds all things together. For in dealing with the universe, not perhaps in exact detail, yet at any rate so as to give a general idea of the subject, it would be wrong to omit that which is the most important thing in the universe. The old explanation which we have all inherited from our fathers, is that

[3]Things are said *κεκοσμῆσθαι* after the *κόσμος*.

all things are from God and were framed by God, and that no natural thing is of itself sufficient for itself, deprived of the permanence which it derives from him. Therefore some of the ancients went so far as to say that all those things are full of gods which are presented to us through the eyes and the hearing and all the other senses, thus propounding a theory which, though it accords with the divine power, does not accord with the divine nature. For God is in very truth the preserver and creator of all that is in any way being brought to perfection in this universe; yet he endures not all the weariness of a being that administers and labours, but exerts a power which never wearies; whereby he prevails even other things which seem far distant from him. He has himself obtained the first and highest place and is therefore called Supreme, dwelling, in the words of the poet,[4] 'on the topmost crest' of the whole heaven; and the body which is nearest to him most enjoys his power, and afterwards the next nearest, and so on successively until the regions wherein we dwell are reached. That is why the earth and the things upon the earth, being farthest removed from the benefit which proceeds from God, seem feeble and incoherent and full of much confusion; nevertheless, inasmuch as it is the nature of the divine to penetrate to all things, the things also of our earth receive their share of it in the same way as the things above us, according to their nearness to or distance from God receiving more or less of divine benefit. It is therefore better, even as it is 398a1 more seemly and befitting God, to suppose that the power which is established in the heavens is the cause of permanence even in those things which are furthest removed from it, as we might say, and indeed in everything, rather than to hold that it passes forth and travels to and fro to places which becomes and befit it not, and personally administers the affairs of this earth. For indeed, to superintend any and every operation does not become even the rulers among mankind—the chief, for example, of an army or a city, or the head of a household, if it were necessary to bind up a sack of bedding or perform any other somewhat menial task, such as could be performed by any ordinary slave—but rather they should act as it is recorded was done in the time of the Great King. For the pomp of Cambyses and Xerxes and Darius was magnificently ordered with the utmost state and splendour. The king himself, so the story goes established himself at Susa or Ecbatana, invisible to all, dwelling in a wondrous palace within a fence gleaming with gold and amber and ivory. And it had many gateways one after another, and porches many furlongs apart from one another, secured by bronze doors and mighty walls. Outside these the chief and most distinguished men had their appointed place, some being the king's bodyguard and attendants, others the guardians of each of the enclosing walls, the so-called janitors and 'listeners', that the king himself, who was called their master and deity, might thus see and hear all things. Besides these, others were appointed as stewards of his revenues and leaders in war and hunting, and receivers of gifts, and others charged with all the other necessary functions. All the Empire of Asia, bounded on the west by the Hellespont and on the east by the Indus, was apportioned according to races among generals and satraps and Kings, slaves of the Great King; and there were couriers and watchmen and messengers and superinten-

[4] Homer, *Iliad* I 499.

dents of signal-fires. So effective was the organization, in particular the system of signal-fires, which formed a chain of beacons from the furthest bounds of the empire to Susa and Ecbatana, that the king received the same day the news of all 398b1 that was happening in Asia. Now we must suppose that the majesty of the Great King falls as far short of that of the God who possesses the universe, as that of the feeblest and weakest creature is inferior to that of the king of Persia. Thus, if it was beneath the dignity of Xerxes to appear himself to administer all things and to carry out his own wishes and superintend the government of his kingdom, such functions would be still less becoming for a god. It is more worthy of his dignity and more befitting that he should be enthroned in the highest region, and that his power, extending through the whole universe, should move the sun and moon and make the whole heaven revolve and be the cause of permanence to all that is on this earth. For he needs no contrivance or the service of others, as our earthly rulers, owing to their feebleness, need many hands to do their work; but it is most characteristic of the divine to be able to accomplish diverse kinds of work with ease and by simple movement, even as machine-operators by one turn on a machine accomplish many different operations. And just as puppet-showmen by pulling a single string make the neck and hand and shoulder and eye and sometimes all the parts of the figure move with a certain harmony; so too the divine nature, by simple movement of that which is nearest to it, imparts its power to that which next succeeds, and thence further and further until it extends over all things. For one thing, moved by another, itself in due order moves something else, each acting according to its own constitution, and not all following the same course but different and various and sometimes even contrary courses; although the first prelude, as it were, to the movement is single. It is just as though one should cast from one vessel at the same time a sphere, a cube, a cone, and a cylinder; each of them will move according to its particular shape. Or if one should hold in the folds of a garment a water-animal, a land-animal, and a bird, and let them go; clearly the animal that swims will leap into its own element and swim away, the land-animal will creep away to its own haunts and pastures, the bird of the air will raise itself aloft from the earth and fly away, though one original cause gave each its aptitude for movement. So is it with 399a1 the universe; by a single revolution of the whole within the bounds of day and night, the different orbits of all the heavenly bodies are produced, though all are enclosed in a single sphere, some moving more quickly, others more slowly, according to the distances between them and the individual composition of each. For the moon accomplishes her circuit in a month, waxing and waning and disappearing; the sun and the heavenly bodies whose course is of equal length, namely those called the 'Lightbearer' and Mercury, perform their revolution in a year; the Fiery star in double that period; the star of Jupiter in six years; and lastly the so-called star of Saturn in a period two and a half times as long as the heavenly body next below it. The single harmony produced by all the heavenly bodies singing and dancing together springs from one source and ends by achieving one purpose, and has rightly bestowed the name not of 'disordered' but of 'ordered universe' upon the whole. And just as in a chorus, when the leader gives the signal to begin, the whole chorus of men, or it may be of women, joins in the song, mingling a single studied harmony among different voices, some high and some low; so too is it with the God that rules the whole world. For at the signal given from on high by him who may well be called their chorus-leader, the stars and the whole heaven always move, and the sun that illumines all things travels forth on its double course, whereby it both divides day and night by its rising and setting, and also brings the four seasons of the year, as it moves forwards towards the north and backwards towards the south. And in their own due season the rain, the winds, and the dews, and all the other phenomena which occur in the region which surrounds the Earth, are produced by the first, primaeval cause. These are followed by the flowing of rivers, the swelling of the sea, the growth of trees, the ripening of fruits, the birth of animals, the nurturing and the prime and decay of all things, to which, as I have said, their individual composition also contributes. When, therefore, the ruler and parent of all, invisible save to the power of reason, gives the word to all nature that moves between heaven and earth, the whole revolves unceasingly in its own circuits and within its own bounds, sometimes unseen and sometimes appearing, revealing and again hiding diverse manners of things, from one and the same cause. Very like is it to that which happens in times of war, when the trumpet sounds to the army; then each soldier hears its note, and one takes up his shield, another dons his breast-plate; another puts on his greaves or his helmet or his swordbelt; one puts the bit in his horse's mouth, another mounts his chariot, another passes along the watchword; the captain betakes himself straightway to his company, the commander to his division, the horseman to his squadron, the light-armed warrior hastens to his appointed place, all is hurry and movement in obedience to one word of command, to carry out the orders of the leader who is supreme over all. Even so must we suppose concerning the universe; by one impelling force, unseen and hidden from our eyes, all things are stirred and perform their individual functions. That this force is unseen stands in the way neither of its action nor of our belief in it. For the soul whereby we live and dwell in houses and communities, though invisible, is yet seen in its operations; for by it the whole ordering of life has been discovered and organized and is held together—the ploughing and planting of the earth, the discovery of the arts, the use of law, the ordering of constitutions, the administration of home affairs and war outside our borders and peace. Thus, too, must we think of God, who in might is most powerful, in beauty most fair, in life immortal, in virtue supreme; for, though he is invisible to all mortal nature, yet is he seen in his very works. For all that happens in the air, on the earth, and in the water, may truly be said to be the work of God, who possesses the universe; from whom, in the words of Empedocles, the natural philosopher,

> Whatsoever hath been and is now and shall be hereafter,
> All alike hath its birth—men, women, trees of the forest,
> Beasts of the field and fowls of the air and fish in the water.[5]

To use a somewhat humble illustration, we might with truth compare it to the so-called 'key-stones' in arches, which, placed at the junction of the two sides,

[5]Frag. 21 Diels-Kranz.

ensure the balance and arrangement of the whole structure of the arch and give it stability. Moreover, they say that the sculptor Pheidias, when he was setting up the Athena on the Acropolis, represented his own features in the centre of her shield, and so attached it to the statue by a hidden contrivance, that any one who tried to cut it out, thereby necessarily shattered and overthrew the whole statue. The position of God in the universe is analogous to this, for he preserves the harmony and permanence of all things; save only that he has his seat not in the midst, where the earth and this our troubled world is situated, but himself pure he has gone up into a pure region, to which we rightly give the name of heaven, for it is the furthest boundary[6] of the upper world, and the name of Olympus, because it is all-bright[7] and free from all gloom and disordered motion, such as is caused on our earth by storms and the violence of the wind. Even thus speaks the poet Homer—

> Unto Olympus' height, where men say that the gods have their dwelling,
> Always safe and secure; no wind ever shaketh its stillness,
> Nor is it wet with the rain; no snow draweth nigh; but unclouded,
> Even the air is outspread, and a white sheen floateth about it.[8]

This, too, is borne out by the general habit of mankind, which assigns the regions above to God; for we all stretch up our hands to heaven when we offer prayers. Hence too these words of the poet are not spoken amiss,

> Heaven belongeth to Zeus, wide spread mid the clouds and the ether.[9]

Therefore also the objects of sense which are held in the highest esteem occupy the same region, to wit the stars and the sun and the moon. For this cause the heavenly bodies alone are so arranged that they ever preserve the same order, and never alter or move from their course, while the things of earth, being mutable, admit of many changes and conditions. For before now mighty earthquakes have rent the earth in diverse places, and violent rains have burst forth and flooded it, and the inroads and withdrawals of waves have often turned the dry land into sea and sea into dry land, and the might of winds and hurricanes has sometimes overthrown whole cities, and fires and flames have consumed the earth, either coming forth from heaven in former times, even as men say that in the days of Phaethon they burnt up the eastern regions of the earth, or else gushing forth and erupting from the earth in the west, as when the craters of Etna burst and flowed like a torrent over the earth. (There also the favour of heaven bestowed especial honour upon the generation of the pious; for when they were overtaken by the fiery stream, because they were carrying their aged parents upon their shoulders and seeking to save them, when the river of fire drew near to them, it was parted asunder and turned part of its flame this way and part that way, and preserved the young men and their parents unscathed.)

[6] οὐρανός being derived from ὅρος ἄνω.
[7] Ὄλυμπος being derived from ὁλολαμπής.
[8] *Odyssey* VI 42-5.
[9] *Iliad* XV 192.

To sum up the matter, as is the steersman in the ship, the charioteer in the chariot, the leader in the chorus, the lawgiver in the city, the general in the army, even so is God in the Universe; save that to them their rule is full of weariness and disturbance and care, while to him it is without toil or labour and free from all bodily weakness. For, enthroned amid the immutable, he moves and revolves all things where and how he will, in different forms and natures; just as the law of a city, immutable in the souls of those who are under it, orders all the life of the state. For in obedience to it, it is plain, the magistrates go forth to their duties, the judges to their several courts of justice, the councillors and members of the assembly to their appointed places of meeting, and one man proceeds to his meals in the prytaneum, another to make his defence before the jury, and another to die in prison. So too the customary public feasts and yearly festivals take place. and sacrifices to the gods and worship of heroes and libations in honour of the dead. The various activities of the citizens in obedience to one ordinance or lawful authority are well expressed in the words of the poet,

> And all the town is full of incense smoke,
> And full of cries for aid and loud laments.[10]

So must we suppose to be the case with that greater city, the universe. For God is to us a law, impartial, admitting not of correction or change, and better, I think, and surer than those which are engraved upon tablets. Under his motionless and harmonious rule the whole ordering of heaven and earth is administered, extending over all natural things through the seeds of life in each both to plants and to animals, according to genera and species. For vines and date-palms and peach-trees 401a1
and 'sweet fig-trees and olives',[11] as the poet says, and trees which, though they bear no fruits, have other uses, plane-trees and pines and box-trees,

> Alder and poplar-tree and cypress breathing sweet odours,[12]

and trees which produce autumn crops pleasant but also difficult to store,

> Pear-trees and pomegranate-trees and apple-trees glorious-fruited,[13]

and animals, both wild and tame, feeding in the air or on the earth or in the water, all are born and come to their prime and decay in obedience to the ordinances of God; for, in the words of Heraclitus, 'every creeping thing grazes at the blow of God's goad'.[14]

7 · God being one yet has many names, being called after all the various conditions which he himself inaugurates. We call him Zen and Zeus, using the two names in the same sense, as though we should say him through whom we live.[15] He

[10]Sophocles, *Oedipus Tyrannus* 4–5.
[11]*Odyssey* XV 116. [12]*ib* V 64. [13]*ib* XI 589.
[14]Frag. 11 Diels-Kranz.
[15]*Ζῆνα* from *ζῆν*, *Δία* from *δι' ὅν*.

is called the son of Kronos and of Time, for he endures from eternal age to age. He is God of Lightning and Thunder, God of the Clear Sky and of Ether, God of the Thunderbolt and of Rain, so called after the rain and the thunderbolts and other physical phenomena. Moreover, after the fruits he is called the Fruitful God, after cities the City-God; he is God of the Family, God of the Household, God of Kindred and God of our Fathers from his participation in such things. He is God of Comradeship and Friendship and Hospitality, God of Armies and of Trophies, God of Purification and of Vengeance and of Supplication and of Propitiation, as the poets name him, and in very truth the Saviour and God of Freedom, and to complete the tale of his titles, God of Heaven and of the World Below, deriving his names from all natural phenomena and conditions, inasmuch as he is himself the cause of all things. Thus it is well said in the Orphic Hymns,

> Zeus of the flashing bolt was the first to be born and the latest,
> Zeus is the head and the middle; of Zeus were all things created;
> 401b1 Zeus is the stay of the earth and the stay of the star-spangled heaven;
> Zeus is male and female of sex, the bride everlasting;
> Zeus is the breath of all and the rush of unwearying fire;
> Zeus is the root of the sea, and the sun and the moon in the heavens;
> Zeus of the flashing bolt is the king and the ruler of all men,
> Hiding them all away, and again to the glad light of heaven
> Bringing them back at his will, performing terrible marvels.

I think also that God and nothing else is meant when we speak of Necessity, since he is as it were an invincible cause; and Fate, because his action is continuous and he cannot be stayed in his course; and Destiny, because all things have their bounds, and nothing which exists is infinite; and Lot, from the fact that all things are allotted; and Nemesis, from the apportionment which is made to every individual; and Adrasteia, which is a cause ordained by nature which cannot be escaped; and Dispensation, so called because it exists for ever. What is said of the Fates and their spindle tends to the same conclusion; for they are three, appointed over different periods of time, and the thread on the spindle is part of it already spent, part reserved for the future, and part in the course of being spun. One of the Fates is appointed to deal with the past, namely, Atropos, for nothing that is gone by can be changed; Lachesis is concerned with the future, for cessation in the course of nature awaits all things; Clotho presides over the present, accomplishing and spinning for each his own particular destiny.[16] This fable is well and duly composed. All these things are nought else but God, even as worthy Plato tells us:

'God, then, as the old story has it, holding the beginning and the end and the middle of all things that exist, proceeding by a straight path in the course of nature brings them to accomplishment; and with him ever follows Justice, the avenger of all that falls short of the Divine Law—let every man who is to become blessed and happy partake in this from the very first'.[17]

[16]The identifications in this paragraph are supported by etymologizing.
[17]*Laws* 715E and 730C.

ON THE SOUL

J. A. Smith

BOOK I

1 · Holding as we do that, while knowledge of any kind is a thing to be honoured and prized, one kind of it may, either by reason of its greater exactness or of a higher dignity and greater wonderfulness in its objects, be more honourable and precious than another, on both accounts we should naturally be led to place in the front rank the study of the soul. The knowledge of the soul admittedly contributes greatly to the advance of truth in general, and, above all, to our understanding of Nature, for the soul is in some sense the principle of animal life. Our aim is to grasp and understand, first its essential nature, and secondly its properties; of these some are thought to be affections proper to the soul itself, while others are considered to attach to the animal owing to the presence of soul.

To attain any knowledge about the soul is one of the most difficult things in the world. As the form of question which here presents itself, viz. the question 'What is it?', recurs in other fields, it might be supposed that there was some single method of inquiry applicable to all objects whose essential nature we are endeavouring to ascertain (as there *is* for incidental properties the single method of demonstration); in that case what we should have to seek for would be this unique method. But if there is no such single and general method for solving the question of essence, our task becomes still more difficult; in the case of each different subject we shall have to determine the appropriate process of investigation. If to this there be a clear answer, e.g. that the process is demonstration or division, or some other known method, many difficulties and hesitations still beset us—with what facts shall we begin the inquiry? For the facts which form the starting-points in different subjects must be different, as e.g. in the case of numbers and surfaces.

First, no doubt, it is necessary to determine in which of the *summa genera* soul lies, what it *is;* is it 'a this-somewhat', a substance, or is it a quale or a quantum, or some other of the remaining kinds of predicates which we have distinguished? Further, does soul belong to the class of potential existents, or is it not rather an actuality? Our answer to this question is of the greatest importance.

We must consider also whether soul is divisible or is without parts, and

TEXT: W. D. Ross, OCT, Oxford, 1956

whether it is everywhere homogeneous or not; and if not homogeneous, whether its various forms are different specifically or generically: up to the present time those who have discussed and investigated soul seem to have confined themselves to the human soul. We must be careful not to ignore the question whether soul can be defined in a single account, as is the case with animal, or whether we must not give a separate account for each sort of it, as we do for horse, dog, man, god (in the latter case the universal, animal—and so too every other common predicate—is either nothing or posterior). Further, if what exists is not a plurality of souls, but a plurality of parts of one soul, which ought we to investigate first, the whole soul or its parts? It is also a difficult problem to decide which of these parts are in nature distinct from one another. Again, which ought we to investigate first, these parts or their functions, mind or thinking, the faculty or the act of sensation, and so on? If the investigation of the functions precedes that of the parts, the further question suggests itself: ought we not before either to consider the correlative objects, e.g. of sense or thought? It seems not only useful for the discovery of the causes of the incidental properties of substances to be acquainted with the essential nature of those substances (as in mathematics it is useful for the understanding of the property of the equality of the interior angles of a triangle to two right angles to know the essential nature of the straight and the curved or of the line and the plane) but also conversely, for the knowledge of the essential nature of a substance is largely promoted by an acquaintance with its properties: for, when we are able to give an account conformable to experience of all or most of the properties of a substance, we shall be in the most favourable position to say something worth saying about the essential nature of that subject; in all demonstration a definition of the essence is required as a starting-point, so that definitions which do not enable us
403a1 to discover the incidental properties, or which fail to facilitate even a conjecture about them, must obviously, one and all, be dialectical and futile.

A further problem presented by the affections of soul is this: are they all affections of the complex of body and soul, or is there any one among them peculiar to the soul by itself? To determine this is indispensable but difficult. If we consider the majority of them, there seems to be no case in which the soul can act or be acted upon without involving the body; e.g. anger, courage, appetite, and sensation generally. Thinking seems the most probable exception; but if this too proves to be a form of imagination or to be impossible without imagination, it too requires a body as a condition of its existence. If there is any way of acting or being acted upon proper to soul, soul will be capable of separate existence; if there is none, its separate existence is impossible. In the latter case, it will be like what is straight, which has many properties arising from the straightness in it, e.g. that of touching a bronze sphere at a point, though straightness divorced from the other constituents of the straight thing cannot touch it in this way; it cannot be so divorced at all, since it is always found in a body. It seems that all the affections of soul involve a body—passion, gentleness, fear, pity, courage, joy, loving, and hating; in all these there is a concurrent affection of the body. In support of this we may point to the fact that, while sometimes on the occasion of violent and striking occurrences there is no excitement or fear felt, on others faint and feeble stimulations produce these emotions, viz. when the body is already in a state of tension resembling its condition when we are angry. Here is a still clearer case: in the absence of any external cause of terror we find ourselves experiencing the feelings of a man in terror. From all this it is obvious that the affections of soul are enmattered accounts.

Consequently their definitions ought to correspond, e.g. anger should be defined as a certain mode of movement of such and such a body (or part or faculty of a body) by this or that cause and for this or that end. That is precisely why the study of the soul—either every soul or souls of this sort—must fall within the science of nature. Hence a physicist would define an affection of soul differently from a dialectician; the latter would define e.g. anger as the appetite for returning pain for pain, or something like that, while the former would define it as a boiling of the blood or warm substance surrounding the heart. The one assigns the material conditions, the other the form or account; for what he states is the account of the fact, though for its actual existence there must be embodiment of it in a material such as is described by the other. Thus the essence of a house is assigned in such an account as 'a shelter against destruction by wind, rain, and heat'; the physicist would describe it as 'stones, bricks, and timbers'; but there is a third possible description which would say that it was that form in that material with that purpose or end. Which, then, among these is entitled to be regarded as the genuine physicist? The one who confines himself to the material, or the one who restricts himself to the account alone? Is it not rather the one who combines both? If this is so, how are we to characterize the other two? Must we not say that there is no type of thinker who concerns himself with those qualities or attributes of the material which are in fact inseparable from the material, and without attempting even in thought to separate them? The physicist is he who concerns himself with all the properties active and passive of bodies or materials thus or thus defined; attributes not considered as being of this character he leaves to others, in certain cases it may be to a specialist, e.g. a carpenter or a physician, in others (*a*) where they are inseparable in fact, but are separable from any particular kind of body by an effort of abstraction, to the mathematician, (*b*) where they are separate, to the First Philosopher. But we must return from this digression, and repeat that the affections of soul, insofar as they are such as passion and fear, are inseparable from the natural matter of animals in this way and not in the same way as a line or surface.

2 · For our study of soul it is necessary, while formulating the problems of which in our further advance we are to find the solutions, to call into council the views of those of our predecessors who have declared any opinion on this subject, in order that we may profit by whatever is sound in their suggestions and avoid their errors.

The starting-point of our inquiry is an exposition of those characteristics which have chiefly been held to belong to soul in its very nature. Two characteristic marks have above all others been recognized as distinguishing that which has soul in it from that which has not—movement and sensation. It may be said that these two are what our predecessors have fixed upon as characteristic of soul.

Some say that what originates movement is both pre-eminently and primarily soul; believing that what is not itself moved cannot originate movement in another, they arrived at the view that soul belongs to the class of things in movement. This is what led Democritus to say that soul is a sort of fire or hot substance; his 'forms' or 404a1 atoms are infinite in number; those which are spherical he calls fire and soul, and compares them to the motes in the air which we see in shafts of light coming through windows; the mixture of seeds of all sorts he calls the elements of the whole of nature (Leucippus gives a similar account); the spherical atoms are identified with soul because atoms of that shape are most adapted to permeate everywhere, and to set all the others moving by being themselves in movement. This implies the view that soul is identical with what produces movement in animals. That is why, further, they regard respiration as the characteristic mark of life; as the environment compresses the bodies of animals, and tends to extrude those atoms which impart movement to them, because they themselves are never at rest, there must be a reinforcement of these by similar atoms coming in from without in the act of respiration; for they prevent the extrusion of those which are already within by counteracting the compressing and consolidating force of the environment; and animals continue to live only so long as they are able to maintain this resistance.

The doctrine of the Pythagoreans seems to rest upon the same ideas; some of them declared the motes in air, others what moved them, to be soul. These motes were referred to because they are seen always in movement, even in a complete calm.

The same tendency is shown by those who define soul as that which moves itself; all these seem to hold the view that movement is what is closest to the nature of soul, and that while all else is moved by soul, it alone moves itself. This belief arises from their never seeing anything originating movement which is not first itself moved.

Similarly also Anaxagoras (and whoever agrees with him in saying that thought set the whole in movement) declares the moving cause of things to be soul. His position must, however, be distinguished from that of Democritus. Democritus roundly identifies soul and mind, for he identifies what appears with what is true—that is why he commends Homer for the phrase 'Hector lay with thought distraught';[1] he does not employ mind as a special faculty dealing with truth, but 404b1 identifies soul and thought. What Anaxagoras says about them is less clear; in many places he tells us that the cause of beauty and order is thought, elsewhere that it is soul; it is found, he says, in all animals, great and small, high and low, but thought (in the sense of intelligence) appears not to belong alike to all animals, and indeed not even to all human beings.

All those, then, who had special regard to the fact that what has soul in it is moved, adopted the view that soul is to be identified with what is eminently originative of movement. All, on the other hand, who looked to the fact that what has soul in it knows or perceives what is, identify soul with the principle or principles of Nature, according as they admit several such principles or one only. Thus Empedocles declares that it is formed out of all his elements, each of them also

[1] *Iliad* XXIII 698.

being soul; his words are:

> For 'tis by Earth we see Earth, by Water Water,
> By Ether Ether divine, by Fire destructive Fire,
> By Love Love, and Hate by cruel Hate.[2]

In the same way Plato in the *Timaeus*[3] fashions the soul out of his elements; for like, he holds, is known by like, and things are formed out of the principles or elements. Similarly also in the lectures 'On Philosophy' it was set forth that the Animal-itself is compounded of the Idea itself of the One together with the primary length, breadth, and depth, everything else being similarly constituted. Again he puts his view in yet other terms: Mind is the monad, science or knowledge the dyad (because it goes undeviatingly from one point to another), opinion the number of the plane, sensation the number of the solid; the numbers are by him expressly identified with the Forms themselves or principles, and are formed out of the elements; now things are apprehended either by mind or science or opinion or sensation, and these same numbers are the Forms of things.

Some thinkers, accepting both premisses, viz. that the soul is both originative of movement and cognitive, have compounded it of both and declared the soul to be a self-moving number.

As to the nature and number of the first principles opinions differ. The difference is greatest between those who regard them as corporeal and those who regard them as incorporeal, and from both dissent those who make a blend and draw their principles from both sources. The number of principles is also in dispute; some admit one only, others assert several. There is a consequent diversity in their several accounts of soul; they assume, naturally enough, that what is in its own nature originative of movement must be among what is primordial. That has led some to regard it as fire, for fire is the subtlest of the elements and nearest to incorporeality; further, in the primary sense, fire both is moved and originates movement in all the others.

Democritus has expressed himself more ingeniously than the rest on the grounds for ascribing each of these two characters to soul; soul and thought are, he says, one and the same thing, and this thing must be one of the primary and indivisible bodies, and its power of originating movement must be due to its fineness of grain and the shape of its atoms; he says that of all the shapes the spherical is the most mobile, and that this is the shape of the particles of both fire and thought.

Anaxagoras, as we said above, seems to distinguish between soul and thought, but in practice he treats them as a single substance, except that it is thought that he specially posits as the principle of all things; at any rate what he says is that thought alone of all that is is simple, unmixed, and pure. He assigns both characteristics, knowing and origination of movement, to the same principle when he says that it was thought that set the whole in movement.

Thales, too, to judge from what is recorded about him seems to have held soul

[2] Frag. 109 Diels-Kranz.
[3] 35Aff.

to be a motive force, since he said that the magnet has a soul in it because it moves the iron.

Diogenes (and others) held the soul to be air because he believed air to be finest in grain and a first principle; therein lay the grounds of the soul's powers of knowing and originating movement. As the primordial principle from which all other things are derived, it is cognitive; as finest in grain, it has the power to originate movement.

Heraclitus too says that the first principle—the 'warm exhalation' of which, according to him, everything else is composed—is soul; further, that this exhalation is most incorporeal and in ceaseless flux; that what is in movement requires that what knows it should be in movement; and that all that is depends on movement (herein agreeing with the majority).

Alcmaeon also seems to have held a similar view about soul; he says that it is immortal because it resembles the immortals, and that this immortality belongs to it in virtue of its ceaseless movement; for all the divine things, moon, sun, the planets, and the whole heavens, are in perpetual movement.

Of more superficial writers, some, e.g. Hippo, have pronounced it to be water; they seem to have argued from the fact that the seed of all animals is fluid, for Hippo tries to refute those who say that the soul is blood, on the ground that the seed, which is the primordial soul, is not blood.

Another group (Critias, for example) did hold it to be blood; they take perception to be the most characteristic attribute of soul, and hold that perceptiveness is due to the nature of blood.

Each of the elements has thus found its partisan, except earth—earth has found no supporter unless we count as such those who have declared soul to be, or to be compounded of, *all* the elements. All, then, it may be said, characterize the soul by three marks, Movement, Sensation, Incorporeality, and each of these is traced back to the first principles. That is why (with one exception) all those who define the soul by its power of knowing make it either an element or constructed out of the elements. The language they all use is similar; like, they say, is known by like; as the soul knows everything, they construct it out of all the principles. Hence all those who admit but one cause or element, make the soul also one (e.g. fire or air), while those who admit a multiplicity of principles make the soul also multiple. The exception is Anaxagoras; he alone says that thought is impassible and has nothing in common with anything else. But, if this is so, how or in virtue of what cause can it know? That Anaxagoras has not explained, nor can any answer be inferred from his words. All who acknowledge pairs of opposites among their principles, construct the soul also out of these contraries, while those who admit as principles only one contrary of each pair, e.g. either hot or cold, likewise make the soul some one of these. That is why they allow themselves to be guided by the names; those who identify soul with the hot argue that *ζῆν* (to live) is derived from *ζεῖν* (to boil), while those who identify it with the cold say that soul (*ψυχή*) is so called from the process of respiration and refrigeration (*κατάψυξις*).

Such are the traditional opinions concerning soul, together with the grounds on which they are maintained.

3 · We must begin our examination with movement; for, doubtless, not only is it false that the essence of soul is correctly described by those who say that it is what moves (or is capable of moving) itself, but it is an impossibility that movement should be even an attribute of it.

We have already[4] pointed out that there is no necessity that what originates movement should itself be moved. There are two senses in which anything may be moved—either indirectly, owing to something other than itself, or directly, owing to itself. Things are indirectly moved which are moved as being contained in something which is moved, e.g. sailors, for they are moved in a different sense from that in which the ship is moved; the ship is directly moved, they are indirectly moved, because they are in a moving vessel. This is clear if we consider their limbs; the movement proper to the legs (and so to man) is walking, and in this case the sailors are not walking. Recognizing the double sense of 'being moved', what we have to consider now is whether the soul is directly moved and participates in such direct movement.

There are four species of movement—locomotion, alteration, diminution, growth; consequently if the soul is moved, it must be moved with one or several or all of these species of movement. Now if its movement is not incidental, there must be a movement natural to it, and, if so, as all the species enumerated involve place, place too must be natural to it. But if the essence of soul be to move itself, its being moved cannot be incidental to it, as it is to what is white or three cubits long; they too can be moved, but only incidentally—what is moved is that of which white and three cubits long are the attributes, the body in which they inhere; hence *they* have no place: but if the soul naturally partakes in movement, it follows that it must have a place.

Further, if there be a movement natural to the soul, there must be a counter-movement unnatural to it, and conversely. The same applies to rest as well as to movement; for the *terminus ad quem* of a thing's natural movement is the place of its natural rest, and similarly the *terminus ad quem* of its enforced movement is the place of its enforced rest. But what meaning can be attached to enforced movements or rests of the soul, it is difficult even to imagine.

Further, if the natural movement of the soul be upward, the soul must be fire; if downward, it must be earth; for upward and downward movements are the characteristics of these bodies. The same reasoning applies to the intermediate movements, *termini*, and bodies. Further, since the soul is observed to originate movement in the body, it is reasonable to suppose that it transmits to the body the movements by which it itself is moved, and so, reversing the order, we may infer from the movements of the body back to similar movements of the soul. Now the body is moved by locomotion. Hence it would follow that the soul too must change either its place as a whole or the relative places of its parts. This carries with it the possibility that the soul might even quit its body and re-enter it, and with this would be involved the possibility of a resurrection of animals from the dead. But, it may be contended, the soul can be moved indirectly by something else; for an animal can be

[4]See *Physics* VIII 5.

pushed out of its course. Yes, but that to whose *essence* belongs the power of being moved by itself, cannot be moved by something else except incidentally, just as what is good by or in itself cannot owe its goodness to something external to it or to some end to which it is a means.

If the soul *is* moved, the most probable view is that what moves it is sensible things.

We must note also that, if the soul moves itself, it must be the mover itself that is moved, so that it follows that if movement is in every case a displacement of that which is in movement, in that respect in which it is said to be moved, the movement of the soul must be a departure from its essential nature, at least if its self-movement is essential to it, not incidental.

Some go so far as to hold that the movements which the soul imparts to the body in which it is are the same in kind as those with which it itself is moved. An example of this is Democritus, who uses language like that of the comic dramatist Philippus, who accounts for the movements that Daedalus imparted to his wooden Aphrodite by saying that he poured quicksilver into it; similarly Democritus says that the spherical atoms owing to their own ceaseless movements draw the whole body after them and so produce its movements. We must urge the question whether it is these very same atoms which produce rest also—how they could do so, it is difficult and even impossible to say. And, in general, we may object that it is not in this way that the soul appears to originate movement in animals—it is through intention or process of thinking.

It is in the same fashion that the *Timaeus* tries to give a physical account of how the soul moves its body; the soul, it is there said, is in movement, and so owing to their mutual implication moves the body also. After compounding the soul-substance out of the elements and dividing it in accordance with the harmonic numbers, in order that it may possess a connate sensibility for 'harmony' and that the whole may move in movements well attuned, the Demiurge bent the straight line into a circle; this single circle he divided into two circles united at two common points; one of these he subdivided into seven circles. All this implies that the movements of the soul are identified with the local movements of the heavens.

Now, in the first place, it is a mistake to say that the soul is a magnitude. It is evident that Plato means the soul of the whole to be like the sort of soul which is called thought—not like the sensitive or the desiderative soul, for the movements of neither of these are circular. Now thought is one and continuous in the sense in which the process of thinking is so, and thinking is identical with thoughts—these have a serial unity like that of number, not a unity like that of a magnitude. Hence thought cannot have that kind of continuity either; thought is either without parts or is continuous in some other way than that which characterizes a magnitude. How, indeed, if it were a magnitude, could thought possibly think? Will it think with any one indifferently of its parts? In this case, the 'part' must be understood either in the sense of a magnitude or in the sense of a point (if a point *can* be called a part of a magnitude). If we accept the latter alternative, the points being infinite in number, obviously thought can never exhaustively traverse them; if the former, thought must think the same thing over and over again, indeed an infinite number of times (whereas it is manifestly possible to think a thing once only). If contact of any part whatsoever of itself with the object is all that is required, why need thought move in a circle, or indeed possess magnitude at all? On the other hand, if contact with the whole circle is necessary, what meaning can be given to the contact of the parts? Further, how could what has no parts think of what has parts, or what has parts think of what has none? We must identify the circle referred to with thought; for it is thought whose movement is thinking, and it is the circle whose movement is revolution, so that if thinking is a movement of revolution, the circle which has this characteristic movement must be thought.[5]

If the circular movement is eternal, there must be something which thought is always thinking—what can this be? For all practical processes of thinking have limits—they all go on for the sake of something else, and all theoretical processes come to a close in the same way as accounts do. For every account is a definition or a demonstration: demonstration has both a starting-point and may be said to end in a conclusion or inferred result (even if the process never reaches completion, at any rate it never returns upon itself again to its starting-point, it goes on assuming a fresh middle term or extreme, and moves straight forward, but circular movement returns to its starting-point); and definitions are all limited.

Further, if the same revolution is repeated, mind must repeatedly think of the same object.

Further, thinking has more resemblance to a coming to rest or arrest than to a movement; the same may be said of inferring.

It might also be urged that what is difficult and enforced is incompatible with blessedness; if the movement of the soul is not[6] of its essence, movement of the soul must be contrary to its nature. It must also be painful for the soul to be inextricably bound up with the body; furthermore, if, as is frequently said and widely accepted, it is better for thought not to be embodied, the union must be for it undesirable.

Further, the cause of the revolution of the heavens is left obscure. It is not the essence of soul which is the cause of this circular movement—that movement is only incidental to soul—nor is the body its cause. Again, it is not even asserted that it is better that soul should be so moved; and yet the reason for which God caused the soul to move in a circle can only have been that movement was better for it than rest, and movement of this kind better than any other. But since this sort of consideration is more appropriate to another field of speculation, let us dismiss it for the present.

The view we have just been examining, in company with most theories about the soul, involves the following absurdity: they all join the soul to a body, or place it in a body, without adding any specification of the reason of their union, or of the bodily conditions required for it. Yet such explanation can scarcely be omitted; for some community of nature is presupposed by the fact that the one acts and the other is acted upon, the one moves and the other is moved; but it is not the case that *any* two things are related to one another in these ways. All, however, that these thinkers do is to describe the specific characteristics of the soul; they do not try to determine anything about the body which is to contain it, as if it were possible, as in the

[5] Omitting νόησις.
[6] Retaining μή, with the MSS.

Pythagorean myths, that any soul could be clothed in any body—an absurd view, for each body seems to have a form and shape of its own. It is as absurd as to say that the art of carpentry could embody itself in flutes; each art must use its tools, each soul its body.

4 · There is yet another opinion about soul, which has commended itself to many as no less probable than any of those we have hitherto mentioned, and has rendered public account of itself in the court of popular discussion. Its supporters say that the soul is a kind of harmony; for harmony is a blend or composition of contraries, and the body is compounded out of contraries. Harmony, however, is a certain proportion or composition of the constituents blended, and soul can be neither the one nor the other of these. Further, the power of originating movement cannot belong to a harmony, while all concur in regarding this pretty well as a principal attribute of soul. It is more appropriate to call health (or generally one of the good states of the body) a harmony than to predicate it of the soul. The absurdity becomes most apparent when we try to attribute the active and passive affections of the soul to a harmony—it is difficult to harmonize them. Further, in using the word 'harmony' we have one or other of two cases in mind: the most proper sense is in relation to magnitudes which have motion and position, where harmony means their being compounded and harmonized in such a manner as to prevent the introduction of anything homogeneous; and the derived sense is that in which it means the ratio between the constituents so blended; in neither of these senses is it plausible to predicate it of soul. That soul is a harmony in the sense of the composition of the parts of the body is a view easily refutable; for there are many and various compoundings of the parts; of what is thought or the sensitive or the appetitive faculty the composition? And what *is* the composition which constitutes each of them? It is equally absurd to identify the soul with the ratio of the mixture; for the mixture of the elements which makes flesh has a different ratio from that which makes bone. The consequence of this view will therefore be that distributed throughout the whole body there will be many souls, since every one of the bodily parts is a mixture of the elements, and the ratio of mixture is in each case a harmony, i.e. a soul.

From Empedocles at any rate we might demand an answer to the following question—for he says that each of the parts of the body is what it is in virtue of a ratio between the elements: is the soul identical with this ratio, or is it not rather something over and above this which is formed in the parts? Is love the cause of any and every mixture, or only of those that are in the right ratio? Is love this ratio itself, or is love something over and above this? Such are the problems raised by this account. But, on the other hand, if the soul is different from the mixture, why does it disappear at one and the same moment with that relation between the elements which constitutes flesh or the other parts of the animal body? Further, if the soul is not identical with the ratio of mixture, and it is consequently not the case that each of the parts has a soul, what is that which perishes when the soul quits the body?

That the soul cannot either be a harmony, or be moved in a circle, is clear from what we have said. Yet that it can be moved incidentally is, as we said above, possible, and even that it can move itself, i.e. in the sense that *the vehicle* in which it is can be moved, and moved by it; in no other sense can the soul be moved in space.

More legitimate doubts might remain as to its movement in view of the following facts. We speak of the soul as being pained or pleased, being bold or fearful, being angry, perceiving, thinking. All these are regarded as modes of movement, and hence it might be inferred that the soul is moved. This, however, does not necessarily follow. We may admit to the full that being pained or pleased, or thinking, are movements (each of them a being moved), and that the movement is originated by the soul. For example we may regard anger or fear as such and such movements of the heart, and thinking as such and such another movement of that organ, or of some other; these modifications may arise either from changes of place in certain parts or from qualitative alterations (the special nature of the parts and the special modes of their changes being for our present purpose irrelevant). Yet[7] to say that it is the soul which is angry is as if we were to say that it is the soul that weaves or builds houses. It is doubtless better to avoid saying that the soul pities or learns or thinks, and rather to say that it is the man who does this with his soul. What we mean is not that the movement is in the soul, but that sometimes it terminates in the soul and sometimes starts from it, sensation e.g. coming from without, and reminiscence starting from the soul and terminating with the movements or states of rest in the sense organs.

But thought seems to be an independent substance implanted within us and to be incapable of being destroyed. If it could be destroyed at all, it would be under the blunting influence of old age. What really happens is, however, exactly parallel to what happens in the case of the sense organs; if the old man could recover the proper kind of eye, he would see just as well as the young man. The incapacity of old age is due to an affection not of the soul but of its vehicle, as occurs in drunkenness or disease. Thus it is that thinking and reflecting decline through the decay of some other inward part and are themselves impassible. Thinking, loving, and hating are affections not of thought, but of that which has thought, so far as it has it. That is why, when this vehicle decays, memory and love cease; they were activities not of thought, but of the composite which has perished; thought is, no doubt, something more divine and impassible. That the soul cannot be moved is therefore clear from what we have said, and if it cannot be moved at all, manifestly it cannot be moved by itself.

Of all the opinions we have enumerated, by far the most unreasonable is that which declares the soul to be a self-moving number; it involves in the first place all the impossibilities which follow from regarding the soul as moved, and in the second special absurdities which follow from calling it a number. How are we to imagine a unit being moved? By what agency? What sort of movement can be attributed to what is without parts or internal differences? If the unit is both originative of movement and itself capable of being moved, it must contain difference.

[7]Reading δέ for δή.

Further, since they say a moving line generates a surface and a moving point a line, the movements of the units must be lines (for a point is a unit having position, and the number of the soul is, of course, somewhere and has position).

Again, if from a number a number or a unit is subtracted, the remainder is another number; but plants and many animals when divided continue to live, and each segment is thought to retain the same kind of soul.

It must be all the same whether we speak of units or corpuscles; for if the spherical atoms of Democritus became points, nothing being retained but their being a quantum, there must remain in each a moving and a moved part, just as there is in what is continuous; what happens has nothing to do with the size of the atoms, it depends solely upon their being a quantum. That is why there must be something to originate movement in the units. If in the animal what originates movement is the soul, so also must it be in the case of the number, so that not the mover and the moved, but the mover only, will be the soul. But how is it possible for one of the units to fulfil this function? There must be *some* difference between such a unit and all the other units, and what difference can there be between one unit-point and another except a difference of position? Thus if, on the one hand, these units within the body are different from the points, the units will be in the same place; for each unit will occupy a point. And yet, if there can be two in the same place, why cannot there be an infinite number? For if things can occupy an indivisible place, they must themselves be indivisible. If, on the other hand, the points of the body are the number which is the soul, or if the number of the points in the body is the soul, why have not all bodies souls? For all bodies contain an *infinity* of points.

Further, how is it possible for these points to be isolated or separated from their bodies, seeing that lines cannot be resolved into points?

5 · The result is, as we have said, that this view, while on the one side identical with that of those who maintain that soul is a subtle kind of body, is on the
409b1 other entangled in the absurdity peculiar to Democritus' way of describing the manner in which movement is originated by soul. For if the soul is present throughout the whole percipient body, there must, if the soul be a kind of body, be two bodies in the same place; and for those who call it a number, there must be many points at one point, or every body must have a soul, unless the soul be a different sort of number—other, that is, than the points existing in a body. Another consequence that follows is that the animal must be moved by its number precisely in the way that Democritus explained its being moved. For what difference does it make whether we speak of small spheres or of large units, or, quite simply, of units in movement? One way or another, the movements of the animal must be due to their movements. Hence those who combine movement and number in the same subject lay themselves open to these and many other similar absurdities. It is impossible not only that these characters should give the definition of soul—it is impossible that they should even be incidental to it. The point is clear if the attempt be made to start from this account and explain from it the affections and actions of

the soul, e.g. reasoning, sensation, pleasure, pain, &c. For, to repeat what we have said earlier, it is not easy even to make a guess on that basis.

Such are the three ways in which soul has traditionally been defined: one group of thinkers declared it to be that which is most originative of movement because it moves itself, another group to be the subtlest and most incorporeal of all kinds of body. We have now sufficiently set forth the difficulties and inconsistencies to which these theories are exposed. It remains now to examine the doctrine that soul is composed of the elements.

The reason assigned for this doctrine is that thus the soul may perceive and come to know everything that is; but the theory necessarily involves itself in many impossibilities. Its upholders assume that like is known by like, as though they were assuming that the soul is identical with the objects. But the elements are not the only things; there are many others, or, more exactly, an infinite number of others, formed out of the elements. Let us admit that the soul knows and perceives the elements out of which each of these composites is made up; but by what means will it know or perceive the composite whole, e.g. what god, man, flesh, bone (or any other compound) is? For each *is,* not merely the elements of which it is composed, 410a1
but those elements combined in a determinate mode or ratio, as Empedocles himself says of bone,

> The kindly Earth in its broad-bosomed moulds
> Won of clear Water two parts out of eight
> And four of Fire; and so white bones were formed.[8]

Nothing, therefore, will be gained by the presence of the elements in the soul, unless there be also present there the ratios and the composition. Each element will indeed know its like, but there will be no knowledge of bone or man, unless they too are present in it. The impossibility of this needs no pointing out; for who would suggest that a stone or a man is in the soul? The same applies to the good and the not-good, and so on.

Further, things are said to be in many ways: 'be' signifies of a 'this' or substance, or a quantum, or a quale, or any other of the kinds of predicates we have distinguished. Does the soul consist of all of these or not? It does not appear that all have common elements. Is the soul formed out of those elements alone which enter into substances? If so, how will it be able to know each of the other kinds of thing? Will it be said that each kind of thing has elements or principles of its own, and that the soul is formed out of these? In that case, the soul must be a quantum *and* a quale *and* a substance. But all that can be made out of the elements of a quantum is a quantum, not a substance. These (and others like them) are the consequences of the view that the soul is composed of all the elements.

It is absurd, also, to say both that like is not capable of being affected by like, and that like is perceived and known by like; for perceiving, and also both thinking and knowing, are, on their own assumption, ways of being affected or moved.

[8] Frag. 96 Diels-Kranz.

That there are many puzzles and difficulties raised by saying, as Empedocles does, that each set of things is known by means of its corporeal elements and by reference to something is shown by what we have just said which is like them; for all the parts of the animal body which consist wholly of earth such as bones, sinews, and hair seem to be wholly insensitive and consequently not perceptive even of objects like themselves, as they ought to have been.

Further, each of the principles will have far more ignorance than knowledge; for though each of them will know one thing, there will be many of which it will be ignorant—viz. all the others. Empedocles at any rate must conclude that his god is the least intelligent of all beings; for of him alone is it true that there is one element, Strife, which he does not know, while there is nothing which mortal beings do not know; for there is nothing which does not enter into their composition.

In general, why has not everything a soul, since everything either is an element, or is formed out of one or several or all of the elements? Each must certainly know one or several or all.

The problem might also be raised, What is that which unifies the elements? The elements correspond, it would appear, to the matter; what unites them, whatever it is, is the supremely important factor. But it is impossible that there should be something superior to, and dominant over, the soul (and *a fortiori* over thought); it is reasonable to hold that thought is by nature most primordial and dominant, while their statement is that it is the elements which are first of all that is.

All, both those who assert that the soul, because of its knowledge and perception of what is, is compounded out of the elements, and those who assert that it is of all things the most originative of movement, fail to take into consideration all kinds of soul. In fact not all beings that perceive can originate movement; there appear to be certain animals which are stationary, and yet local movement is the only one, so it seems, which the soul originates in animals. And the same objection holds against all those who construct thought and the perceptive faculty out of the elements; for it appears that plants live, and yet are not endowed with locomotion or[9] perception, while a large number of animals are without discourse of reason. Even if these points were waived and thought admitted to be a part of the soul (and so too the perceptive faculty), still, even so, there would be kinds and parts of soul of which they had failed to give any account.

The same objection lies against the view expressed in the 'Orphic' poems: there it is said that the soul comes in from the whole when breathing takes place, being borne in upon the winds. Now this cannot take place in the case of plants, nor indeed in the case of certain animals, for not all breathe. This fact has escaped the notice of the holders of this view.

If we must construct the soul out of the elements, there is no necessity to suppose that all the elements enter into its construction; one element in each pair of contraries will suffice to enable it to discern both that element itself and its contrary. By means of the straight line we know both itself and the curved—the

[9] Ross follows Torstrik in excising the words 'locomotion or'.

carpenter's rule enables us to test both—but what is curved does not enable us to distinguish either itself or the straight.

Certain thinkers say that soul is intermingled in the whole universe, and it is perhaps for that reason that Thales came to the opinion that all things are full of gods. This presents some difficulties: why does the soul when it resides in air or fire not form an animal, while it does so when it resides in mixtures of the elements, and that although it is held to be of higher quality when contained in the former? (One might add the question, why the soul in air is maintained to be higher and more immortal than that in animals.) Both possible ways of replying to the former question lead to absurdity or paradox; for it is beyond paradox to say that fire or air is an animal, and it is absurd to refuse the name of animal to what has soul in it. The opinion that the elements have soul in them seems to have arisen from the doctrine that a whole must be homogeneous with its parts. If it is true that animals become animate by drawing into themselves a portion of what surrounds them, the partisans of this view are bound to say that the soul too is homogeneous with its parts. If the air sucked in is homogeneous, but soul heterogeneous, clearly while some part of soul will exist in the inbreathed air, some other part will not. The soul must either be homogeneous, or such that there are some parts of the whole in which it is not to be found.

From what has been said it is now clear that knowing as an attribute of soul cannot be explained by soul's being composed of the elements, and that it is neither sound nor true to speak of soul as moved. But since knowing, perceiving, opining, and further desiring, wishing, and generally all other modes of appetition, belong to soul, and the local movements of animals, and growth, maturity, and decay are produced by the soul, we must ask whether each of these is an attribute of the soul as a whole, i.e. whether it is with the whole soul we think, perceive, move ourselves, act or are acted upon, or whether each of them requires a different part of the soul? So too with regard to life. Does it depend on one of the parts of soul? Or is it dependent on more than one? Or on all? Or has it some quite other cause?

Some hold that the soul is divisible, and that we think with one part and desire with another. If, then, its nature admits of its being divided, what can it be that holds the parts together? Surely not the body; on the contrary it seems rather to be the soul that holds the body together; at any rate when the soul departs the body disintegrates and decays. If, then, there is something else which makes the soul one, this would have the best right to the name of soul, and we shall have to repeat for it the question: Is *it* one or multipartite? If it is one, why not at once admit that *the soul* is one? If it has parts, once more the question must be put: What holds *its* parts together, and so *ad infinitum*?

The question might also be raised about the parts of the soul: What is the separate rôle of each in relation to the body? For, if the whole soul holds together the whole body, we should expect each part of the soul to hold together a part of the body. But this seems an impossibility; it is difficult even to imagine what sort of bodily part thought will hold together, or how it will do this.

It is a fact of observation that plants and certain insects go on living when divided into segments; this means that each of the segments has a soul in it identical in species, though not numerically; for both of the segments for a time possess the power of sensation and local movement. That this does not last is not surprising, for they no longer possess the organs necessary for self-maintenance. But, all the same, in each of the parts there are present all the parts of soul, and the souls so present are homogeneous with one another and with the whole—the several parts of the soul being inseparable from one another, although the whole soul is[10] divisible. It seems that the principle found in plants is also a kind of soul; for this is the only principle which is common to both animals and plants; and this exists in isolation from the principle of sensation, though there is nothing which has the latter without the former.

BOOK II

412a1 1 · Let the foregoing suffice as our account of the views concerning the soul which have been handed on by our predecessors; let us now make as it were a completely fresh start, endeavouring to answer the question, What is soul? i.e. to formulate the most general possible account of it.

We say that substance is one kind of what is, and that in several senses: in the sense of matter or that which in itself is not a this, and in the sense of form or essence, which is that precisely in virtue of which a thing is called a this, and thirdly in the sense of that which is compounded of both. Now matter is potentiality, form actuality; and actuality is of two kinds, one as e.g. knowledge, the other as e.g. reflecting.

Among substances are by general consent reckoned bodies and especially natural bodies; for they are the principles of all other bodies. Of natural bodies some have life in them, others not; by life we mean self-nutrition and growth and decay. It follows that every natural body which has life in it is a substance in the sense of a composite.

Now given that there are bodies of such and such a kind, viz. having life, the soul cannot be a body; for the body is the subject or matter, not what is attributed to it. Hence the soul must be a substance in the sense of the form of a natural body having life potentially within it. But substance is actuality, and thus soul is the actuality of a body as above characterized. Now there are two kinds of actuality corresponding to knowledge and to reflecting. It is obvious that the soul is an actuality like knowledge; for both sleeping and waking presuppose the existence of soul, and of these waking corresponds to reflecting, sleeping to knowledge possessed but not employed, and knowledge of something is temporally prior.

That is why the soul is an actuality of the first kind of a natural body having life potentially in it. The body so described is a body which is organized. The parts

[10] Omitting οὐ.

of plants in spite of their extreme simplicity are organs; e.g. the leaf serves to shelter the pericarp, the pericarp to shelter the fruit, while the roots of plants are analogous to the mouth of animals, both serving for the absorption of food. If, then, we have to give a general formula applicable to all kinds of soul, we must describe it as an actuality of the first kind of a natural organized body. That is why we can dismiss as unnecessary the question whether the soul and the body are one: it is as though we were to ask whether the wax and its shape are one, or generally the matter of a thing and that of which it is the matter. Unity has many senses (as many as 'is' has), but the proper one is that of actuality.

We have now given a general answer to the question, What is soul? It is substance in the sense which corresponds to the account of a thing. That means that it is what it is to be for a body of the character just assigned. Suppose that a tool, e.g. an axe, were a *natural* body, then being an axe would have been its essence, and so its soul; if this disappeared from it, it would have ceased to be an axe, except in name. As it is, it is an axe; for it is not of a body of that sort that what it is to be, i.e. its account, is a soul, but of a natural body of a particular kind, viz. one having in itself the power of setting itself in movement and arresting itself. Next, apply this doctrine in the case of the parts of the living body. Suppose that the eye were an animal—sight would have been its soul, for sight is the substance of the eye which corresponds to the account, the eye being merely the matter of seeing; when seeing is removed the eye is no longer an eye, except in name—no more than the eye of a statue or of a painted figure. We must now extend our consideration from the parts to the whole living body; for what the part is to the part, that the whole faculty of sense is to the whole sensitive body as such.

We must not understand by that which is potentially capable of living what has lost the soul it had, but only what still retains it; but seeds and fruits are bodies which are potentially of that sort. Consequently, while waking is actuality in a sense corresponding to the cutting and the seeing, the soul is actuality in the sense corresponding to sight and the power in the tool; the body corresponds to what is in potentiality; as the pupil *plus* the power of sight constitutes the eye, so the soul *plus* the body constitutes the animal.

From this it is clear that the soul is inseparable from its body, or at any rate that certain parts of it are (if it has parts)—for the actuality of some of them is the actuality of the parts themselves. Yet some may be separable because they are not the actualities of any body at all. Further, we have no light on the problem whether the soul may not be the actuality of its body in the sense in which the sailor is the actuality of the ship.[11]

This must suffice as our sketch or outline of the nature of soul.

2 · Since what is clear and more familiar in account emerges from what in itself is confused but more observable by us, we must reconsider our results from this point of view. For it is not enough for a definitional account to express as most

[11] Omitting ἢ with the MSS.

now do the mere fact; it must include and exhibit the cause also. At present definitions are given in a form analogous to the conclusion of an argument; e.g. What is squaring? The construction of an equilateral rectangle equal to a given oblong rectangle. Such a definition is in form equivalent to a conclusion. One that tells us that squaring is the discovery of a mean proportional discloses the cause of what is defined.

We resume our inquiry from a fresh starting-point by calling attention to the fact that what has soul in it differs from what has not in that the former displays life. Now this word has more than one sense, and provided any one alone of these is found in a thing we say that thing is living—viz. thinking or perception or local movement and rest, or movement in the sense of nutrition, decay and growth. Hence we think of plants also as living, for they are observed to possess in themselves an originative power through which they increase or decrease in all spatial directions; they do not grow up but not down—they grow alike in both, indeed in all, directions; and that holds for everything which is constantly nourished and continues to live, so long as it can absorb nutriment.

This power of self-nutrition can be separated from the other powers mentioned, but not they from it—in mortal beings at least. The fact is obvious in plants; for it is the only psychic power they possess.

413^{b}1 This is the originative power the possession of which leads us to speak of things as *living* at all, but it is the possession of sensation that leads us for the first time to speak of living things as *animals;* for even those beings which possess no power of local movement but do possess the power of sensation we call animals and not merely living things.

The primary form of sense is touch, which belongs to all animals. Just as the power of self-nutrition can be separated from touch and sensation generally, so touch can be separated from all other forms of sense. (By the power of self-nutrition we mean that part of the soul which is common to plants and animals: all animals whatsoever are observed to have the sense of touch.) What the explanation of these two facts is, we must discuss later. At present we must confine ourselves to saying that soul is the source of these phenomena and is characterized by them, viz. by the powers of self-nutrition, sensation, thinking, and movement.

Is each of these a soul or a part of a soul? And if a part, a part merely distinguishable by definition or a part distinct in local situation as well? In the case of certain of these powers, the answers to these questions are easy, in the case of others we are puzzled what to say. Just as in the case of plants which when divided are observed to continue to live though separated from one another (thus showing that in *their* case the soul of each individual plant was actually one, potentially many), so we notice a similar result in other varieties of soul, i.e. in insects which have been cut in two; each of the segments possesses both sensation and local movement; and if sensation, necessarily also imagination and appetition; for, where there is sensation, there is also pleasure and pain, and, where these, necessarily also desire.

We have no evidence as yet about thought or the power of reflexion; it seems to be a different kind of soul, differing as what is eternal from what is perishable; it alone is capable of being separated. All the other parts of soul, it is evident from what we have said, are, in spite of certain statements to the contrary, incapable of separate existence though, of course, distinguishable by definition. If opining is distinct from perceiving, to be capable of opining and to be capable of perceiving must be distinct, and so with all the other forms of living above enumerated. Further, some animals possess all these parts of soul, some certain of them only, others one only (this is what enables us to classify animals); the cause must be considered later. A similar arrangement is found also within the field of the senses; some classes of animals have all the senses, some only certain of them, others only one, the most indispensable, touch.

Since the expression 'that whereby we live and perceive' has two meanings, just like the expression 'that whereby we know'—that may mean either knowledge or the soul, for we can speak of knowing *by* either, and similarly that whereby we are in health may be either health or the body or some part of the body; and since of these knowledge or health is a form, essence, or account, or if we so express it an activity of a recipient matter—knowledge of what is capable of knowing, health of what is capable of being made healthy (for the activity of that which is capable of originating change seems to take place in what is changed or altered); further, since it is the soul by which primarily we live, perceive, and think:—it follows that the soul must be an account and essence, not matter or a subject. For, as we said, the word substance has three meanings—form, matter, and the complex of both—and of these matter is potentiality, form actuality. Since then the complex here is the living thing, the body cannot be the actuality of the soul; it is the soul which is the actuality of a certain kind of body. Hence the rightness of the view that the soul cannot be without a body, while it cannot *be* a body; it is not a body but something relative to a body. That is why it is *in* a body, and a body of a definite kind. It was a mistake, therefore, to do as former thinkers did, merely to fit it into a body without adding a definite specification of the kind or character of that body, although evidently one chance thing will not receive another. It comes about as reason requires: the actuality of any given thing can only be realized in what is already potentially that thing, i.e. in a matter of its own appropriate to it. From all this it is plain that soul is an actuality or account of something that possesses a potentiality of being such.

3 · Of the psychic powers above enumerated some kinds of living things, as we have said, possess all, some less than all, others one only. Those we have mentioned are the nutritive, the appetitive, the sensory, the locomotive, and the power of thinking. Plants have none but the first, the nutritive, while another order of living things has this *plus* the sensory. If any order of living things has the sensory, it must also have the appetitive; for appetite is the genus of which desire, passion, and wish are the species; now all animals have one sense at least, viz. touch, and whatever has a sense has the capacity for pleasure and pain and therefore has pleasant and painful objects present to it, and wherever these are present, there is

desire, for desire is appetition of what is pleasant. Further, all animals have the sense for food (for touch is the sense for food; the food of all living things consists of what is dry, moist, hot, cold, and these are the qualities apprehended by touch) all other sensible qualities are apprehended by touch only indirectly. Sounds, colours, and odours contribute nothing to nutriment; flavours fall within the field of tangible qualities. Hunger and thirst are forms of desire, hunger a desire for what is dry and hot, thirst a desire for what is cold and moist; flavour is a sort of seasoning added to both. We must later clear up these points, but at present it may be enough to say that all animals that possess the sense of touch have also appetition. The case of imagination is obscure; we must examine it later. Certain kinds of animals possess in addition the power of locomotion, and still others, i.e. man and possibly another order like man or superior to him, the power of thinking and thought. It is now evident that a single definition can be given of soul only in the same sense as one can be given of figure. For, as in that case there is no figure apart from triangle and those that follow in order, so here there is no soul apart from the forms of soul just enumerated. It is true that a common definition can be given for figure which will fit all figures without expressing the peculiar nature of any figure. So here in the case of soul and its specific forms. Hence it is absurd in this and similar cases to look for a common definition which will not express the peculiar nature of anything that is and will not apply to the appropriate indivisible species, while at the same time omitting to look for an account which will. The cases of figure and soul are exactly parallel; for the particulars subsumed under the common name in both cases—figures and living beings—constitute a series, each successive term of which potentially contains its predecessor, e.g. the square the triangle, the sensory power the self-nutritive. Hence we must ask in the case of each order of living things, What is its soul, i.e. What is the soul of plant, man, beast? Why the terms are related in this serial way must form the subject of examination. For the power of perception is never found apart from the power of self-nutrition, while—in plants—the latter is found isolated from the former. Again, no sense is found apart from that of touch, while touch *is* found by itself; many animals have neither sight, hearing, nor smell. Again, among living things that possess sense some have the power of locomotion, some not. Lastly, certain living beings—a small minority—possess calculation and thought, for (among mortal beings) those which possess calculation have all the other powers above mentioned, while the converse does not hold—indeed some live by imagination alone, while others have not even imagination. Reflective thought presents a different problem.

It is evident that the way to give the most adequate definition of soul is to seek in the case of *each* of its forms for the most appropriate definition.

4 · It is necessary for the student of these forms of soul first to find a definition of each, expressive of what it is, and then to investigate its derivative properties, &c. But if we are to express what each is, viz. what the thinking power is, or the perceptive, or the nutritive, we must go farther back and first give an account of thinking or perceiving; for activities and actions are prior in definition to potentialities. If so, and if, still prior to them, we should have reflected on their

correlative objects, then for the same reason we must first determine about them, i.e. about food and the objects of perception and thought.

It follows that first of all we must treat of nutrition and reproduction, for the nutritive soul is found along with all the others and is the most primitive and widely distributed power of soul, being indeed that one in virtue of which all are said to have life. The acts in which it manifests itself are reproduction and the use of food, because for any living thing that has reached its normal development and which is unmutilated, and whose mode of generation is not spontaneous, the most natural act is the production of another like itself, an animal producing an animal, a plant a plant, in order that, as far as its nature allows, it may partake in the eternal and divine. That is the goal towards which all things strive, that for the sake of which they do whatsoever their nature renders possible. The phrase 'for the sake of which' is ambiguous; it may mean either the end to achieve which, or the being in whose interest, the act is done. Since then no living thing is able to partake in what is eternal and divine by uninterrupted continuance (for nothing perishable can for ever remain one and the same), it tries to achieve that end in the only way possible to it, and success is possible in varying degrees; so it remains not indeed as the self-same individual but continues its existence in something like itself—not numerically but specifically one.

The soul is the cause or source of the living body. The terms cause and source have many senses. But the soul is the cause of its body alike in all three senses which we explicitly recognize. It is the source of movement, it is the end, it is the essence of the whole living body.

That it is the last, is clear; for in everything the essence is identical with the cause of its being, and here, in the case of living things, their being is to live, and of their being and their living the soul in them is the cause or source. Further, the actuality of whatever is potential is identical with its account.

It is manifest that the soul is also the final cause. For nature, like thought, always does whatever it does for the sake of something, which something is its end. To that something corresponds in the case of animals the soul and in this it follows the order of nature; all natural bodies are organs of the soul. This is true of those that enter into the constitution of plants as well as of those which enter into that of animals. This shows that that for the sake of which they are is soul. That for the sake of which has two senses, viz. the end to achieve which, and the being in whose interest, anything is or is done.

The soul is also the cause of the living body as the original source of local movement. The power of locomotion is not found, however, in all living things. But change of quality and change of quantity are also due to the soul. Sensation is held to be a qualitative alteration, and nothing except what has soul in it is capable of sensation. The same holds of growth and decay; nothing grows or decays naturally except what feeds itself, and nothing feeds itself except what has a share of life in it.

Empedocles is wrong in adding that growth in plants is to be explained, the downward rooting by the natural tendency of earth to travel downwards, and the upward branching by the similar natural tendency of fire to travel upwards. For he misinterprets up and down; up and down are not for all things what they are for the whole world: if we are to distinguish and identify organs according to their functions, the roots of plants are analogous to the head in animals. Further, we must ask what is the force that holds together the earth and the fire which tend to travel in contrary directions; if there is no counteracting force, they will be torn asunder; if there is, this must be the soul and the cause of nutrition and growth. By some the element of fire is held to be the cause of nutrition and growth, for it alone of the bodies or[12] elements is observed to feed and increase itself. Hence the suggestion that in both plants and animals it is it which is the operative force. A concurrent cause in a sense it certainly is, but not the principal cause; that is rather the soul; for while the growth of fire goes on without limit so long as there is a supply of fuel, in the case of all complex wholes formed in the course of nature there is a limit or ratio which determines their size and increase, and limit and ratio are marks of soul but not of fire, and belong to the side of account rather than that of matter.

Nutrition and reproduction are due to one and the same psychic power. It is necessary first to give precision to our treatment of food, for it is by this function of absorbing food that this psychic power is distinguished from all the others. The current view is that what serves as food to a living thing is what is contrary to it—not that in every pair of contraries each is food to the other: to be food a contrary must not only be transformable into the other and vice versa, it must also in so doing increase the bulk of the other. Many a contrary is transformed into its other and vice versa, where neither is even a quantum e.g. an invalid into a healthy subject. It is clear that not even those contraries are food to one another in precisely the same sense; water may be said to feed fire, but not fire water. Where the members of the pair are elementary bodies only one of the contraries, it would appear, can be said to feed the other. But there is a difficulty here. One set of thinkers assert that like is fed, as well as increased in amount, by like. Another set, as we have said, maintain the very reverse, viz. that what feeds and what is fed are contrary to one another; like, they argue, is incapable of being affected by like; but food is changed in the process of digestion, and change is always *to* what is opposite or to what is intermediate. Further, food is acted upon by what is nourished by it, not the other way around, as timber is worked by a carpenter and not conversely; there is a change in the carpenter but it is merely a change from not-working to working. In answering this problem it makes all the difference whether we mean by 'the food' the 'finished' or the 'raw' product. If we use the word food of both, viz. of the undigested and the digested matter, we can justify both the rival accounts of it; taking food in the sense of undigested matter, it is the contrary of what is fed by it, taking it as digested it is like what is fed by it. Consequently it is clear that in a certain sense we may say that both parties are right, both wrong.

Since nothing except what is alive can be fed, what is fed is the besouled body and just because it has soul in it. Hence food is essentially related to what has soul in it. Food has a power which is other than the power to increase the bulk of what is fed by it; so far forth as what has soul in it is a quantum, food may increase its quantity,

[12]Ross excises 'bodies or'.

but it is only so far as what has soul in it is a 'this-somewhat' or substance that food acts *as* food; in that case it maintains the being of what is fed, and that continues to be what it is so long as the process of nutrition continues. Further, it is the agent in generation, i.e. not the generation of the individual fed but the reproduction of another like it; the substance of the individual fed is already in existence; nothing generates itself, but only maintains itself.

Hence the psychic power which we are now studying may be described as that which tends to maintain whatever has this power in it of continuing such as it was, and food helps it to do its work. That is why, if deprived of food, it must cease to be.

The process of nutrition involves three factors, what is fed, that wherewith it is fed, and what does the feeding; of these what feeds is the first soul, what is fed is the body which has that soul in it, and that with which it is fed is the food. But since it is right to call things after the ends they realize, and the end of this soul is to generate another being like that in which it is, the first soul ought to be named the reproductive soul. The expression 'wherewith it is fed' is ambiguous just as is the expression 'wherewith the ship is steered'; that may mean either the hand or the rudder, i.e. either what is moved and sets in movement, or what is merely moved. All food must be capable of being digested, and what produces digestion is warmth; that is why everything that has soul in it possesses warmth.

We have now given an outline account of the nature of food; further details must be given in the appropriate place.

5 · Having made these distinctions let us now speak of sensation in the widest sense. Sensation depends, as we have said, on a process of movement or affection from without, for it is held to be some sort of change of quality. Now some thinkers assert that like is affected only by like; in what sense this is possible and in what sense impossible, we have explained in our general discussion of acting and being acted upon.[13]

Here arises a problem: why do we not perceive the senses themselves, or why without the stimulation of external objects do they not produce sensation, seeing that they contain in themselves fire, earth, and all the other elements, of which—either in themselves or in respect of their incidental attributes—there is perception? It is clear that what is sensitive is so only potentially, not actually. The power of sense is parallel to what is combustible, for that never ignites itself spontaneously, but requires an agent which has the power of starting ignition; otherwise it could have set itself on fire, and would not have needed actual fire to set it ablaze.

We use the word 'perceive' in two ways, for we say that what has the power to hear or see, 'sees' or 'hears', even though it is at the moment asleep, and also that what is actually seeing or hearing, 'sees' or 'hears'. Hence 'sense' too must have two meanings, sense potential, and sense actual. Similarly 'to be a sentient' means either to have a certain power or to manifest a certain activity. To begin with let us speak

[13]See *Gen Corr* I 7.

as if there were no difference between being moved or affected, and being active, for movement is a kind of activity—an imperfect kind, as has elsewhere been explained. Everything that is acted upon or moved is acted upon by an agent which is actually at work. Hence it is that in one sense, as has already been stated, what acts and what is acted upon are like, in another unlike; for the unlike is affected, and when it has been affected it is like.

But we must now distinguish different senses in which things can be said to be potential or actual; at the moment we are speaking[14] as if each of these phrases had only one sense. We can speak of something as a knower either as when we say that man is a knower, meaning that man falls within the class of beings that know or have knowledge, or as when we are speaking of a man who possesses a knowledge of grammar; each of these has a potentiality, but not in the same way: the one because his kind or matter is such and such, the other because he can reflect when he wants to, if nothing external prevents him. And there is the man who is already reflecting—he is a knower in actuality and in the most proper sense is knowing, e.g. this A. Both the former are potential knowers, who realize their respective potentialities, the one by change of quality, i.e. repeated transitions from one state to its opposite under instruction, the other in another way by the transition from the inactive possession of sense[15] or grammar to their active exercise.

Also the expression 'to be acted upon' has more than one meaning; it may mean either the extinction of one of two contraries by the other, or the maintenance of what is potential by the agency of what is actual and already like what is acted upon, as actual to potential. For what possesses knowledge becomes an actual knower by a transition which is either not an alteration of it at all (being in reality a development into its true self or actuality) or at least an alteration in a quite different sense.

Hence it is wrong to speak of a wise man as being 'altered' when he uses his wisdom, just as it would be absurd to speak of a builder as being altered when he is using his skill in building a house.

What in the case of thinking or understanding leads from potentiality to actuality ought not to be called teaching but something else. That which starting with the power to know learns or acquires knowledge through the agency of one who actually knows and has the power of teaching either ought not to be said 'to be acted upon' at all—or else we must recognize two senses of alteration, viz. the change to conditions of privation, and the change to a thing's dispositions and to its nature.

In the case of what is to possess sense, the first transition is due to the action of the male parent and takes place before birth so that at birth the living thing is, in respect of sensation, at the stage which corresponds to the possession of knowledge. Actual sensation corresponds to the stage of the exercise of knowledge. But between the two cases compared there is a difference; the objects that excite the sensory powers to activity, the seen, the heard, &c., are outside. The ground of this difference is that what actual sensation apprehends is individuals, while what

[14]Retaining λέγομεν.
[15]Retaining αἴσθησιν: Ross prints ἀριθμητικήν, 'arithmetic'.

knowledge apprehends is universals, and these are in a sense within the soul itself. That is why a man can think when he wants to but his sensation does not depend upon himself—a sensible object must be there. A similar statement must be made about our knowledge of what is sensible—on the same ground, viz. that the sensible objects are individual and external.

A later more appropriate occasion may be found thoroughly to clear up all this. At present it must be enough to recognize the distinctions already drawn; a thing may be said to be potential in either of two senses, either in the sense in which we might say of a boy that he may become a general or in the sense in which we might say the same of an adult, and there are two corresponding senses of the term 'a potential sentient'. There are no separate names for the two stages of potentiality; we have pointed out that they are different and how they are different. We cannot help using the incorrect terms 'being acted upon or altered' of the two transitions involved. As we have said, what has the power of sensation is potentially like what the perceived object is actually; that is, while at the beginning of the process of its being acted upon the two interacting factors are dissimilar, at the end the one acted upon is assimilated to the other and is identical in quality with it.

6 · In dealing with each of the senses we shall have first to speak of the objects which are perceptible by each. The term 'object of sense' covers three kinds of objects, two kinds of which we call perceptible in themselves, while the remaining one is only incidentally perceptible. Of the first two kinds one consists of what is special to a single sense, the other of what is common to any and all of the senses. I call by the name of special object of this or that sense that which cannot be perceived by any other sense than that one and in respect of which no error is possible; in this sense colour is the special object of sight, sound of hearing, flavour of taste. Touch, indeed, discriminates more than one set of different qualities. Each sense has one kind of object which it discerns, and never errs in reporting that what is before it is colour or sound (though it may err as to what it is that is coloured or where that is, or what it is that is sounding or where that is). Such objects are what we call the special objects of this or that sense.

Common sensibles are movement, rest, number, figure, magnitude; these are not special to any one sense, but are common to all. There are at any rate certain kinds of movement which are perceptible both by touch and by sight.

We speak of an incidental object of sense where e.g. the white object which we see is the son of Diares; here because being the son of Diares is incidental to the white which is perceived, we speak of the son of Diares as being incidentally perceived. That is why it in no way as such affects the senses. Of the things perceptible in themselves, the special objects are properly called perceptible and it is to them that in the nature of things the structure of each several sense is adapted.

7 · The object of sight is the visible, and what is visible is colour and a certain kind of object which can be described in words but which has no single name; what we mean by the second will be abundantly clear as we proceed. Whatever is visible

is colour and colour is what lies upon what is in itself visible; 'in itself' here means not that visibility is involved in the definition of what thus underlies colour, but that that substratum contains in itself the cause of visibility. Every colour has in it the
418b1 power to set in movement what is actually transparent; that power constitutes its very nature. That is why it is not visible except with the help of light; it is only in light that the colour of a thing is seen. Hence our first task is to explain what light is.

Now there clearly is something which is transparent, and by 'transparent' I mean what is visible, and yet not visible in itself, but rather owing its visibility to the colour *of something else;* of this character are air, water, and many solid bodies. Neither air nor water is transparent because it is air or water; they are transparent because each of them has contained in it a certain substance which is the same in both and is also found in the eternal upper body. Of this substance light is the activity—the activity of what is transparent *qua* transparent; where this power is present, there is also the potentiality of the contrary, viz. darkness. Light is as it were the proper colour of what is transparent, and exists whenever the potentially transparent is excited to actuality by the influence of fire or something resembling 'the uppermost body'; for fire too contains something which is one and the same with the substance in question.

We have now explained what the transparent is and what light is; light is neither fire nor any kind whatsoever of body nor an efflux from any kind of body (if it were, it would again itself be a kind of body)—it is the presence of fire or something resembling fire in what is transparent. It is certainly not a body, for two bodies cannot be present in the same place. The opposite of light is darkness; darkness is the absence from what is transparent of the corresponding positive state above characterized; clearly therefore, light is just the presence of that.

Empedocles (and with him all others who used the same forms of expression) was wrong in speaking of light as 'travelling' or being at a given moment between the earth and its envelope, its movement being unobservable by us; that view is contrary both to the clear evidence of argument and to the observed facts; if the distance traversed were short, the movement might have been unobservable, but where the distance is from extreme East to extreme West, the strain upon our powers of belief is too great.

What is capable of taking on colour is what in itself is colourless, as what can take on sound is what is soundless; what is colourless includes what is transparent and what is invisible or scarcely visible, i.e. what is dark. The latter is the same as what is transparent, when it is potentially, not of course when it is actually transparent; it is the same substance which is now darkness, now light.

419a1 Not everything that is visible depends upon light for its visibility. This is only true of the 'proper' colour of things. Some objects of sight which in light are invisible, in darkness stimulate the sense; that is, things that appear fiery or shining. This class of objects has no simple common name, but instances of it are fungi, horns, heads, scales, and eyes of fish. In none of these is what is seen their own proper colour. Why we see these at all is another question. At present what is obvious is that what is seen in light is always colour. That is why without the help of light colour remains invisible. Its being colour at all means precisely its having in it the power to set in movement what is actually transparent, and the actuality of what is transparent is just light.

The following makes the necessity of a medium clear. If what has colour is placed in immediate contact with the eye, it cannot be seen. Colour sets in movement what is transparent, e.g. the air, and that, extending continuously from the object of the organ, sets the latter in movement. Democritus misrepresents the facts when he expresses the opinion that if the interspace were empty one could distinctly see an ant on the vault of the sky; that is an impossibility. Seeing is due to an affection or change of what has the perceptive faculty, and it cannot be affected by the seen colour itself; it remains that it must be affected by what comes between. Hence it is indispensable that there be *something* in between—if there were nothing, so far from seeing with greater distinctness, we should see nothing at all.

We have now explained the cause why colour cannot be seen otherwise than in light. Fire on the other hand is seen both in darkness and in light; this double possibility follows necessarily from our theory, for it is just fire that makes what is potentially transparent actually transparent.

The same account holds also of sound and smell; if the object of either of these senses is in immediate contact with the organ no sensation is produced. In both cases the object sets in movement only what lies between, and this in turn sets the organ in movement: if what sounds or smells is brought into immediate contact with the organ, no sensation will be produced. The same, in spite of all appearances, applies also to touch and taste; why there is this apparent difference will be clear later. What comes between in the case of sounds is air; the corresponding medium in the case of smell has no name. But, corresponding to what is transparent in the case of colour, there is a quality found both in air and water, which serves as a medium for what has smell; for animals that live in water seem to possess the sense of smell. Men and all other land animals that breathe, perceive smells only when they 419b1
breathe air in. The explanation of this too will be given later.

8 · Now let us, to begin with, make certain distinctions about sound and hearing.

Sound may mean either of two things—actual and potential sound. There are certain things which, as we say, have no sound, e.g. sponges or wool, others which have, e.g. bronze and in general all things which are smooth and solid—the latter are said to have a sound because they can make a sound, i.e. can generate actual sound between themselves and the organ of hearing.

Actual sound is always of something in relation to something and in something; for it is generated by an impact. Hence it is impossible for one body only to generate a sound—there must be a body impinging and a body impinged upon; what sounds does so by striking against something else, and this is impossible without a movement from place to place.

As we have said, not all bodies can by impact on one another produce sound; impact on wool makes no sound, while the impact on bronze or any body which is smooth and hollow does. Bronze gives out a sound when struck because it is smooth;

bodies which are hollow owing to reflection repeat the original impact over and over again, the body originally set in movement being unable to escape from the concavity.

Further, sound is heard both in air and in water, though less distinctly in the latter. Yet neither air nor water is the principal cause of sound. What is required for the production of sound is an impact of two solids against one another and against the air. The latter condition is satisfied when the air impinged upon does not retreat before the blow, i.e. is not dissipated by it.

That is why it must be struck with a sudden sharp blow, if it is to sound—the movement of the whip must outrun the dispersion of the air, just as one[16] might get in a stroke at a heap or whirl of sand as it was travelling rapidly past.

An echo occurs, when, a mass of air having been unified, bounded, and prevented from dissipation by the containing walls of a vessel, the air rebounds from this mass of air like a ball from a wall. It is probable that in all generation of sound echo takes place, though it is frequently only indistinctly heard. What happens here must be analogous to what happens in the case of light; light is always reflected—otherwise it would not be diffused and outside what was directly illuminated by the sun there would be blank darkness; but this reflected light is not always strong enough, as it is when it is reflected from water, bronze, and other smooth bodies, to cast a shadow, which is the distinguishing mark by which we recognize light.

It is rightly said that an empty space plays the chief part in the production of hearing, for people think that the air is empty, and the air is what causes hearing, when it is set in movement as one continuous mass; but owing to its friability it emits no sound, unless what is impinged upon is smooth. But then it becomes a single mass at the same time because of the surface; for the surface of the smooth object is single.

What has the power of producing sound is what has the power of setting in movement a single mass of air which is continuous up to the organ of hearing. The organ of hearing is physically united with air, and because it is in air, the air inside is moved concurrently with the air outside. Hence animals do not hear with all parts of their bodies, nor do all parts admit of the entrance of air; for even the part which can be moved and can sound has not air everywhere in it. Air in itself is, owing to its friability, quite soundless; only when its dissipation is prevented is its movement sound. The air in the ear is built into a chamber just to prevent this dissipating movement, in order that the animal may accurately apprehend all varieties of the movements of the air outside. That is why we hear also in water, viz. because the water cannot get into the air chamber or even, owing to the spirals, into the outer ear. If this does happen, hearing ceases, as it also does if the tympanic membrane is damaged, just as sight ceases if the membrane covering the pupil is damaged. It is also a sign of whether we hear or not that the ear does or does not reverberate like a horn; the air inside the ear has always a movement of its own, but the sound we hear is always the sounding of something else, not of the organ itself. That is why we say

[16]Retaining τις.

that we hear with what is empty and echoes, viz. because what we hear with is a chamber which contains a bounded mass of air.

Which is it that sounds, the striking body or the struck? Is not the answer that it is both, but each in a different way? Sound is a movement of what can rebound from a smooth surface when struck against it. As we have explained not everything sounds when it strikes or is struck, e.g. if one needle is struck against another, neither emits any sound. In order, therefore, that sound may be generated, what is struck must be smooth, to enable the air to rebound and be shaken off from it in one piece.

The distinctions between different sounding bodies show themselves only in actual sound; as without the help of light colours remain invisible, so without the help of actual sound the distinctions between sharp and flat sounds remain inaudible. Sharp and flat are here metaphors, transferred from their proper sphere, viz. that of touch, where they mean respectively what moves the sense much in a short time, and what moves the sense little in a long time. Not that what is sharp really moves fast, and what is flat, slowly, but that the difference in the qualities of the one and the other movement is due to their respective speeds. There seems to be a sort of parallelism between what is sharp or flat to hearing and what is sharp or blunt to touch; what is sharp as it were stabs, while what is blunt pushes, the one producing its effect in a short, the other in a long time, so that the one is quick, the other slow.

Let the foregoing suffice as an analysis of sound. Voice is a kind of sound characteristic of what has soul in it; nothing that is without soul utters voice, it being only by a metaphor that we speak of the voice of the flute or the lyre or generally of what (being without soul) possesses the power of producing a succession of notes which differ in length and pitch and timbre. The metaphor is based on the fact that all these differences are found also in voice. Many animals are voiceless, e.g. all non-sanguineous animals and among sanguineous animals fish. This is just what we should expect, since voice is a certain movement of air. The fish, like those in the Achelous, which are said to have voice, really make the sounds with their gills or some similar organ. Voice is the sound made by an animal, and that with a special organ. As we saw, everything that makes a sound does so by the impact of something against something else, across a space filled with air; hence it is only to be expected that no animals utter voice except those which take in air. Once air is inbreathed, Nature uses it for two different purposes, as the tongue is used both for tasting and for articulating; in that case of the two functions tasting is necessary for the animal's existence (hence it is found more widely distributed), while articulate speech serves its possessor's well-being; similarly in the former case Nature employs the breath both as an indispensable means to the regulation of the inner temperature of the living body and also as the matter of articulate voice, in the interests of its possessor's well-being. Why its former use is indispensable must be discussed elsewhere.

The organ of respiration is the windpipe, and the organ to which this is related as means to end is the lungs. The latter is the part of the body by which the temperature of land animals is raised above that of all others. But what primarily requires the air drawn in by respiration is not only this but the region surrounding the heart. That is why when animals breathe the air must penetrate inwards.

Voice then is the impact of the inbreathed air against the windpipe, and the agent that produces the impact is the soul resident in these parts of the body. Not every sound, as we said, made by an animal is voice (even with the tongue we may merely make a sound which is not voice, or without the tongue as in coughing); what produces the impact must have soul in it[17] and must be accompanied by an act of imagination, for voice is a sound with a meaning, and is not the result of any impact of the breath as in coughing; in voice the breath in the windpipe is used as an instrument to knock with against the walls of the windpipe. This is confirmed by our inability to speak when we are breathing either out or in—we can only do so by holding our breath; we make the movements with the breath so checked. It is clear also why fish are voiceless; they have no windpipe. And they have no windpipe because they do not breathe or take in air. Why they do not is a question belonging to another inquiry.

9 · Smell and its object are much less easy to determine than what we have hitherto discussed; the distinguishing characteristic of smell is less obvious than those of sound or colour. The ground of this is that our power of smell is less discriminating and in general inferior to that of many species of animals; men have a poor sense of smell and our apprehension of its objects is bound up with pleasure and pain, which shows that in us the organ is inaccurate. It is probable that there is a parallel failure in the perception of colour by animals that have hard eyes: probably they discriminate differences of colour only by the presence or absence of what excites fear, and that it is thus that human beings distinguish smells. It seems that there is an analogy between smell and taste, and that the species of tastes run parallel to those of smells—the only difference being that our sense of taste is more discriminating because it is a sort of touch, which reaches in man the maximum of discriminative accuracy. While in respect of all the other senses we fall below many species of animals, in respect of touch we far excel all other species in exactness of discrimination. That is why man is the most intelligent of all animals. This is confirmed by the fact that it is to differences in the organ of touch and to nothing else that the differences between man and man in respect of natural endowment are due; men whose flesh is hard are ill-endowed with intellect, men whose flesh is soft, well-endowed.

As flavours may be divided into sweet and bitter, so with smells. In some things the flavour and the smell have the same quality, e.g. both are sweet, in others they diverge. Similarly a smell may be pungent, astringent, acid, or succulent. But, as we said, because smells are much less easy to discriminate than flavours, the names of these varieties are applied to smells in virtue of similarity; for example sweet belongs to saffron or honey, pungent to thyme, and so on.

[17]Retaining *ἔμψυχον*.

In the same sense in which hearing has for its object both the audible and the inaudible, sight both the visible and the invisible, smell has for its object both the odorous and the inodorous. Inodorous may be either what has no smell at all, or what has a small or feeble smell. The same holds of the tasteless.

Smelling too takes place through a medium, i.e. through air or water—for water-animals too (both sanguineous and non-sanguineous) seem to smell just as much as land-animals; at any rate some of them make directly for their food from a distance if it has any scent. That is why the following facts constitute a problem for us. All animals smell in the same way, but man smells only when he inhales; if he exhales or holds his breath, he ceases to smell, no difference being made whether the odorous object is distant or near, or even placed inside the nostril; it is common to all not to perceive what is in immediate contact with the organ of sense, but our failure to apprehend what is odorous without the help of inhalation is peculiar to man (the fact is obvious on making the experiment). Now since bloodless animals do not breathe, they should have some other sense apart from those mentioned. But this is impossible, since it is scent that is perceived; a sense that apprehends what is odorous and what has a good or bad odour cannot be anything but smell. Further, they are observed to be deleteriously effected by the same strong odours as man is, e.g. bitumen, sulphur, and the like. These animals must be able to smell without breathing. The probable explanation is that in man the organ of smell has a certain superiority over that in all other animals just as his eyes have over those of hard-eyed animals. Man's eyes have in the eyelids a kind of shelter or envelope, which must be shifted or drawn back in order that we may see, while hard-eyed animals have nothing of the kind, but at once see whatever presents itself in the transparent medium. Similarly in certain species of animals the organ of smell is like the eye of hard-eyed animals, uncurtained, while in others which take in air it 422a1
probably has a curtain over it, which is drawn back in inhalation, owing to the dilating of the veins or pores. That explains also why animals that breathe cannot smell under water; to smell they must first inhale, and that they cannot do under water.

Smells are of what is dry as flavours of what is moist. Consequently the organ of smell is potentially dry.

10 · What can be tasted is always something that can be touched, and just for that reason it cannot be perceived through an interposed foreign body, for no more is it so with touch. Further, the flavoured and tasteable body is suspended in a liquid matter, and this is tangible. Hence, if we lived in water, we should perceive a sweet object introduced into the water, but the water would not be the medium through which we perceived; our perception would be due to the solution of the sweet substance in the water, just as if it were mixed with some drink. There is no parallel here to the perception of colour, which is due neither to any blending nor to any efflux. In the case of taste, there is no medium; but as the object of sight is colour, so the object of taste is flavour. But nothing excites a perception of flavour without the help of liquid; what acts upon the sense of taste must be either actually or potentially liquid like what is saline; it must be both itself easily dissolved, and capable of dissolving along with itself the tongue. Just as sight apprehends both what is visible and what is invisible (for darkness is invisible and yet is discriminated by sight; so is, in a different way, what is over-brilliant), and as hearing apprehends both sound and silence, of which the one is audible and the other inaudible, and also over loud sound as sight does what is bright (for as a faint sound is inaudible, so in a sense is a loud or violent sound; and as one thing is called invisible absolutely (as in other cases of impossibility), another if it is adapted by nature to have the property but has not it or has it only in a very low degree, as when we say that something is footless or stoneless—so too taste has as its object both what can be tasted and the tasteless—the latter in the sense of what has little flavour or a bad flavour or one destructive of taste. The primary difference seems to be that between what is drinkable and what is undrinkable—both are tasteable, but the latter is bad and tends to destroy taste, while the former is natural. What is drinkable is a common object of both touch and taste.

422b1 Since what can be tasted is liquid, the organ for its perception cannot be either actually liquid or incapable of becoming liquid. Tasting is being affected by what can be tasted as such; hence the organ of taste must be liquefied, and so to start with must be non-liquid but capable of liquefaction without loss of its distinctive nature. This is confirmed by the fact that the tongue cannot taste either when it is too dry or when it is too moist; in the latter case there is contact with the pre-existent moisture, as when after a foretaste of some strong flavour we try to taste another flavour; it is in this way that sick persons find everything they taste bitter, viz. because, when they taste, their tongues are overflowing with bitter moisture.

The species of flavour are, as in the case of colour, simple, i.e. the two contraries, the sweet and the bitter, secondary, viz. the succulent and the saline; between these come the pungent, the harsh, the astringent, and the acid; these pretty well exhaust the varieties of flavour. It follows that what has the power of tasting is what is potentially of that kind, and that what is tasteable is what has the power of making it actually what it itself already is.

11 · Whatever can be said of what is tangible, can be said of touch, and vice versa; if touch is not a single sense but a group of senses, there must be several kinds of what is tangible. It is a problem whether touch is a single sense or a group of senses. It is also a problem, what is the organ of touch; is it or is it not the flesh (including what in certain animals is analogous to flesh)? On the second view, flesh is the medium of touch, the real organ being situated farther inward. Every sense seems to be concerned with a single pair of contraries, white and black for sight, sharp and flat for hearing, bitter and sweet for taste; but in the field of what is tangible we find several such pairs, hot cold, dry moist, hard soft, &c. This problem finds a solution, when it is recalled that in the case of the other senses more than one pair of contraries are to be met with, e.g. in sound not only sharp and flat but loud and soft, smooth and rough, &c.; there are similar contrasts in the field of colour. Nevertheless we are unable clearly to detect in the case of touch what the single subject is which corresponds to sound in the case of hearing.

To the question whether the organ of touch lies inward or not (i.e. whether we need look any farther than the flesh), no indication can be drawn from the fact that 423a1
if the object comes into contact with the flesh it is at once perceived. For even under present conditions if the experiment is made of making a sort of membrane and stretching it tight over the flesh, as soon as this web is touched the sensation is reported in the same manner as before, yet it is clear that the organ is not in this membrane. If the membrane could be *grown* on to the flesh, the report would travel still quicker. That is why the flesh plays in touch very much the same part as would be played by an air-envelope growing round our body; had we such an envelope we should have supposed that it was by a single organ that we perceived sounds, colours, and smells, and we should have taken sight, hearing, and smell to be a single sense. But as it is, because that through which the different movements are transmitted is not naturally attached to our bodies, the difference of the various sense-organs is evident. But in the case of touch the obscurity remains.

For no living body could be constructed of air or water; it must be something solid. Consequently it must be composed of earth along with these, which is just what flesh and its analogue tend to be. Hence the body must be the medium for the faculty of touch, naturally attached to us, through which the several perceptions are transmitted. That they are several is clear when we consider touching with the tongue; we apprehend at the tongue all tangible qualities as well as flavour. Suppose all the rest of our flesh was sensitive to flavour, we should have identified the sense of taste and the sense of touch; but in fact they are two, for they do not correspond.

The following problem might be raised. Let us assume that every body has depth, i.e. has three dimensions, and that if two bodies have a third body between them they cannot be in contact with one another; let us remember that what is liquid is not independent of body and must be or contain water, and that if two bodies touch one another under water, their touching surfaces cannot be dry, but must have water between, viz. the water which wets their bounding surfaces; from all this it follows that in water two bodies cannot be in contact with one another. The same holds of two bodies in air—air being to bodies in air precisely what water is to bodies in water—but the facts are not so evident to our observation, because we live in air, just as animals that live in water would not notice that the things which touch one another in water have wet surfaces. The problem, then, is: does the perception of 423b1
all objects of sense take place in the same way, or does it not, e.g. taste and touch requiring contact (as they are commonly thought to do), while all other senses perceive over a distance? The distinction is unsound; we perceive what is hard or soft, as well as the objects of hearing, sight, and smell, through a medium, only that the latter are perceived over a greater distance than the former; that is why the facts escape our notice. For we do perceive everything through a medium; but in these cases the fact escapes us. Yet, to repeat what we said before, if the medium for touch were a membrane separating us from the object without our observing its existence, we should be relatively to it in the same condition as we are now to air or water in which we are immersed; in their case we fancy we can touch objects, nothing coming in between us and them. But there remains this difference between

what can be touched and what can be seen or can sound; in the latter two cases we perceive because the medium produces a certain effect upon us, whereas in the perception of objects of touch we are affected not *by* but *along with* the medium; it is as if a man were struck through his shield, where the shock is not first given to the shield and passed on to the man, but the concussion of both is simultaneous.

In general, flesh and the tongue are related to the organs of touch and taste, as air and water are to those of sight, hearing, and smell. Hence in neither the one case nor the other can there be any perception of an object if it is placed immediately upon the organ, e.g. if a white object is placed on the surface of the eye. This again shows that what has the power of perceiving the tangible is seated inside. Only so would there be a complete analogy with all the other senses. In their case if you place the object on the organ it is not perceived, here if you place it on the flesh it is perceived; therefore flesh is the medium of touch.

What can be touched are distinctive qualities of body *as* body; by such differences I mean those which characterize the elements, viz. hot cold, dry moist, of which we have spoken earlier in our treatise on the elements.[18] The organ for the perception of these is that of touch—that part of the body in which primarily the sense of touch resides. This is that part which is potentially such as its object is actually: for all sense-perception is a process of being so affected; so that that which makes something such as it itself actually is makes the other such because the other is already potentially such. That is why we do not perceive what is equally hot and cold or hard and soft, but only excesses, the sense itself being a sort of mean between the opposites that characterize the objects of perception. It is to this that it owes its power of discerning the objects in that field. What is in the middle is fitted to discern; relatively to either extreme it can put itself in the place of the other. As what is to perceive white and black must, to begin with, be actually neither but potentially either (and so with all the other sense-organs), so the organ of touch must be neither hot nor cold.

Further, as in a sense sight had for its object both what was visible and what was invisible (and there was a parallel truth about all the other senses discussed), so touch has for its object both what is tangible and what is intangible. Here by intangible is meant what like air possesses some quality of tangible things in a very slight degree and also what possesses it in an excessive degree, as destructive things do.

We have now given an outline account of each of the several senses.

12 · Generally, about all perception, we can say that a sense is what has the power of receiving into itself the sensible forms of things without the matter, in the way in which a piece of wax takes on the impress of a signet-ring without the iron or gold; what produces the impression is a signet of bronze or gold, but not *qua* bronze or gold: in a similar way the sense is affected by what is coloured or flavoured or sounding not insofar as each is what it is, but insofar as it is of such and such a sort and according to its form.

[18]See *Gen Corr* II 2–3.

A primary sense-organ is that in which such a power is seated. The sense and its organ are the same in fact, but their essence is not the same. What perceives is, of course, a spatial magnitude, but we must not admit that either the having the power to perceive or the sense itself is a magnitude; what they are is a certain form or power in a magnitude. This enables us to explain why excesses in objects of sense destroy the organs of sense; if the movement set up by an object is too strong for the organ, the form which is its sensory power is disturbed; it is precisely as concord and tone are destroyed by too violently twanging the strings of a lyre. This explains also why plants cannot perceive, in spite of their having a portion of soul in them and being affected by tangible objects themselves; for their temperature can be lowered or raised. The explanation is that they have no mean, and so no principle in them capable of taking on the forms of sensible objects but are affected together with their matter. The problem might be raised: Can what cannot smell be said to be affected by smells or what cannot see by colours, and so on? Now a smell is just what can be smelt, and if it produces any effect it can only be so as to make something smell it, and it might be argued that what cannot smell cannot be affected by smells and further that what can smell can be affected by it only in so far as it has in it the power to smell (similarly with the proper objects of all the other senses). Indeed that this is so seems clear as follows. Light or darkness, sounds and smells leave bodies quite unaffected; what does affect bodies is not these but the bodies which are their vehicles, e.g. what splits the trunk of a tree is the air which accompanies thunder. But bodies are affected by what is tangible and by flavours. If not, by what are things that are without soul affected, i.e. altered in quality? Must we not, then, admit that the objects of the other senses also may affect them? Is not the true account this, that all bodies are capable of being affected by smells and sounds, but that some on being acted upon, having no boundaries of their own, disintegrate, as in the instance of air, which does become odorous, showing that some effect is produced on it by what is odorous? What is smelling more than such an affection by what is odorous? Is it that air, when affected quickly, becomes perceptible, but that smelling is actually perceiving?

BOOK III

1 · That there is no sense in addition to the five—sight, hearing, smell, taste, touch—may be established by the following considerations:—

We in fact have sensation of everything of which touch can give us sensation (for all the qualities of the tangible *qua* tangible are perceived by us through touch); and absence of a sense necessarily involves absence of a sense-organ; and all objects that we perceive by immediate contact with them are perceptible by touch, which sense we actually possess, while all objects that we perceive through media, i.e. without immediate contact, are perceptible by or through the simple elements, e.g. air and water. Now this is so arranged that if more than one kind of sensible object is perceivable through a single medium, the possessor of a sense-organ homogeneous with that medium has the power of perceiving both kinds of objects (for example, if the sense-organ is made of air, and air is a medium both for sound and for colour); and if more than one medium can transmit the same kind of sensible objects, as e.g. water as well as air can transmit colour, both being transparent, then the possessor of either alone will be able to perceive the kind of objects transmissible through both. And of the simple elements two only, air and water, go to form sense-organs (for the pupil is made of water, the organ of hearing is made of air, and the organ of smell of one or other of these two, while fire is found either in none or in all—warmth being an essential condition of all sensibility—and earth either in none or, if anywhere, specially mingled with the components of the organ of touch; hence it would remain that there can be no sense-organ formed of anything except water and air); and these sense-organs are actually found in certain animals. Thus all the possible senses are possessed by those animals that are not imperfect or mutilated (for even the mole is observed to have eyes beneath its skin); so that, if there is no fifth element and no property other than those which belong to the four elements of our world, no sense can be wanting to such animals.

Further, there cannot be a special sense-organ for the common sensibles either, i.e. the objects which we perceive incidentally through this or that special sense, e.g. movement, rest, figure, magnitude, number, unity; for all these we perceive by movement, e.g. magnitude by movement, and therefore also figure (for figure is a species of magnitude), what is at rest by the absence of movement: number is perceived by the negation of continuity, and by the special sensibles; for each sense perceives one class of sensible objects. So that it is clearly impossible that there should be a special sense for any one of the common sensibles, e.g. movement; for, if that were so, our perception of it would be exactly parallel to our present perception of what is sweet by vision. That is so because we have a sense for each of the two qualities, in virtue of which when they happen to meet in one sensible object we are aware of both contemporaneously. If it were not like this our perception of the common qualities would always be incidental, i.e. as is the perception of Cleon's son, where we perceive him not as Cleon's son but as white, and the white thing happens to be Cleon's son.

But in the case of the common sensibles there is already in us a common sensibility which enables us to perceive them non-incidentally; there is therefore no special sense required for their perception: if there were, our perception of them would have been exactly like what has been above described.

The senses perceive each other's special objects incidentally; not because the percipient sense is this or that special sense, but because all form a unity: this incidental perception takes place whenever sense is directed at one and the same moment to two disparate qualities in one and the same object, e.g. to the bitterness and the yellowness of bile; the assertion of the identity of both cannot be the act of either of the senses; hence the illusion of sense, e.g. the belief that if a thing is yellow it is bile.

It might be asked why we have more senses than one. Is it to prevent a failure to apprehend the common sensibles, e.g. movement, magnitude, and number, which go along with the special sensibles? Had we no sense but sight, and that sense no object but white, they would have tended to escape our notice and everything would have merged for us into an indistinguishable identity because of the concomitance of colour and magnitude. As it is, the fact that the common sensibles are given in the objects of more than one sense reveals their distinction from each and all of the special sensibles.

2 · Since it is through sense that we are aware that we are seeing or hearing, it must be either by sight that we are aware of seeing, or by some sense other than sight. But the sense that gives us this new sensation must perceive both sight and its object, viz. colour: so that either there will be two senses both percipient of the same sensible object, or the sense must be percipient of itself. Further, even if the sense which perceives sight were different from sight, we must either fall into an infinite regress, or we must somewhere assume a sense which is aware of itself. If so, we ought to do this in the first case.

This presents a difficulty: if to perceive by sight is just to see, and what is seen is colour (or the coloured), then if we are to see that which sees,[19] that which sees[20] originally must be coloured. It is clear therefore that 'to perceive by sight' has more than one meaning; for even when we are not seeing, it is by sight that we discriminate darkness from light, though not in the same way as we distinguish one colour from another. Further, in a sense even that which sees is coloured; for in each case the sense-organ is capable of receiving the sensible object without its matter. That is why even when the sensible objects are gone the sensings and imaginings continue to exist in the sense-organs.

The activity of the sensible object and that of the sense is one and the same activity, and yet the distinction between their being remains. Take as illustration actual sound and actual hearing: a man may have hearing and yet not be hearing, and that which has a sound is not always sounding. But when that which can hear is actively hearing and that which can sound is sounding, then the actual hearing and the actual sound come about at the same time (these one might call respectively hearkening and sounding).

If it is true that the movement, i.e. the acting, and the being acted upon,[21] is to be found in that which is acted upon, both the sound and the hearing so far as it is actual must be found in that which has the faculty of hearing; for it is in the passive factor that the actuality of the active or motive factor is realized; that is why that which causes movement may be at rest. Now the actuality of that which can sound is just sound or sounding, and the actuality of that which can hear is hearing or hearkening; 'sound' and 'hearing' are both ambiguous. The same account applies to the other senses and their objects. For as the acting-and-being-acted-upon is to be found in the passive, not in the active factor, so also the actuality of the sensible object and that of the sensitive subject are both realized in the latter. But while in some cases each has a distinct name, e.g. sounding and hearkening, in some one or other is nameless, e.g. the actuality of sight is called seeing, but the actuality of

[19]Retaining τὸ ὁρῶν.
[20]Retaining τὸ ὁρῶν.
[21]Ross excises 'and the being acted upon'.

colour has no name: the actuality of the faculty of taste is called tasting, but the actuality of flavour has no name. Since the actualities of the sensible object and of the sensitive faculty are one actuality in spite of the difference between their modes of being, actual hearing and actual sounding appear and disappear from existence at one and the same moment, and so actual savour and actual tasting, &c., while as potentialities one of them may exist without the other. The earlier students of nature were mistaken in their view that without sight there was no white or black, without taste no savour. This statement of theirs is partly true, partly false: 'sense' and 'the sensible object' are ambiguous terms, i.e. may denote either potentialities or actualities: the statement is true of the latter, false of the former. This ambiguity they wholly failed to notice.

If voice is a concord, and if the voice and the hearing of it are in one sense one and the same, and if concord is a ratio, hearing as well as what is heard must be a ratio. That is why the excess of either the sharp or the flat destroys the hearing. (So also in the case of savours excess destroys the sense of taste, and in the case of colours excessive brightness or darkness destroys the sight, and in the case of smell excess of strength whether in the direction of sweetness or bitterness is destructive.) This shows that the sense is a ratio.

That is also why the objects of sense are pleasant when e.g. acid or sweet or salt, being pure and unmixed, are brought into the proper ratio; then they are pleasant: and in general what is blended—a concord—is more pleasant than the sharp or the flat alone; or, to touch, that which is capable of being either warmed or chilled:[22] the sense and the ratio are identical; while excess is painful or destructive.

Each sense then is relative to its particular group of sensible qualities: it is found in a sense-organ as such and discriminates the differences which exist within that group; e.g. sight discriminates white and black, taste sweet and bitter, and so in all cases. Since we also discriminate white from sweet, and indeed each sensible quality from every other, with what[23] do we perceive that they are different? It must be by sense; for what is before us is sensible objects. (Hence it is also obvious that the flesh cannot be the ultimate sense-organ: if it were, the discriminating power could not do its work without immediate contact with the object.)

Therefore discrimination between white and sweet cannot be effected by two agencies which remain separate; both the qualities discriminated must be present to something that is one and single. On any other supposition even if I perceived sweet and you perceived white, the difference between them would be apparent. What says that two things are different must be one; for sweet is different from white. Therefore what asserts this difference must be self-identical, and as what asserts, so also what thinks or perceives. That it is not possible by means of two agencies which remain separate to discriminate two objects which are separate, is therefore obvious; and that it is not possible to do this in separate moments of time may be seen if we look at it as follows. For as what asserts the difference between the good

[22] Ross, following Dittenberger, excises the sentence 'or, to touch, . . . chilled'.
[23] Reading τίνι for τινί.

and the bad is one and the same, so also the time at which it asserts the one to be different and the other to be different is not accidental to the assertion (as it is for instance when I now assert a difference but do not assert that there is now a difference); it asserts thus—both now and that the objects are different now; the objects therefore must be present at one and the same moment. Both the discriminating power and the time of its exercise must be one and undivided.

But, it may be objected, it is impossible that what is self-identical should be moved at one and the same time with contrary movements in so far as it is undivided, and in an undivided moment of time. For if what is sweet be the quality perceived, it moves the sense or thought in this determinate way, while what is bitter 427a1
moves it in a contrary way, and what is white in a different way. Is it the case then that what discriminates, though both numerically one and indivisible, is at the same time divided in its being? In one sense, it is what is divided that perceives two separate objects at once, but in another sense it does so *qua* undivided; for it is divisible in its being, but spatially and numerically undivided.

But is not this impossible? For while it is true that what is self-identical and undivided may be both contraries at once *potentially,* it cannot be self-identical in its being—it must lose its unity by being put into activity. It is not possible to be at once white and black, and therefore it must also be impossible for a thing to be affected at one and the same moment by the forms of both, assuming it to be the case that sensation and thinking are properly so described.

Just as what is called a point is, as being at once one and two, properly said to be divisible,[24] so here, that which discriminates is *qua* undivided one, and active in a single moment of time, while *qua* divisible it twice over uses the same dot at one and the same time. So far then as it takes the limit as two, it discriminates two separate objects[25] with what in a sense is separated; while so far as it takes it as one, it does so with what is one[26] and occupies in its activity a single moment of time.

About the principle in virtue of which we say that animals are percipient, let this discussion suffice.

3 · There are two distinctive peculiarities by reference to which we characterize the soul—(1) local movement and (2) thinking, understanding, and perceiving. Thinking and understanding are regarded as akin to a form of perceiving; for in the one as well as the other the soul discriminates and is cognizant of something which is. Indeed the ancients go so far as to identify thinking and perceiving; e.g. Empedocles says[27] 'For 'tis in respect of what is present that man's wit is increased', and again[28] 'Whence it befalls them from time to time to think diverse thoughts', and Homer's phrase[29] 'For suchlike is man's mind' means the same. They all look upon thinking as a bodily process like perceiving, and hold that like is understood as

[24]Ross adds: 'and indivisible'.
[25]Ross excises 'two separate objects'.
[26]Reading ἑνί, ἑνί.
[27]Frag. 106 Diels-Kranz. [28]Frag. 108 Diels-Kranz.
[29]*Odyssey* XVIII 136.

well as perceived by like, as I explained at the beginning of our discussion. Yet they ought at the same time to have accounted for error also; for it is more intimately connected with animal existence and the soul continues longer in the state of error. They cannot escape the dilemma: either whatever seems is true (and there are some who accept this) or error is contact with the unlike: for that is the opposite of the knowing of like by like.

But it seems that error as well as knowledge in respect to contraries is one and the same.

That perceiving and understanding are not identical is therefore obvious; for the former is universal in the animal world, the latter is found in only a small division of it. Further, thinking is also distinct from perceiving—I mean that in which we find rightness and wrongness—rightness in understanding, knowledge, true opinion, wrongness in their opposites; for perception of the special objects of sense is always free from error, and is found in all animals, while it is possible to think falsely as well as truly, and thought is found only where there is discourse of reason. For imagination is different from either perceiving or discursive thinking, though it is not found without sensation, or judgement without it. That this activity is not the same kind of thinking[30] as judgement is obvious. For imagining lies within our own power whenever we wish (e.g. we can call up a picture, as in the practice of mnemonics by the use of mental images), but in forming opinions we are not free: we cannot escape the alternative of falsehood or truth. Further, when we think something to be fearful or threatening, emotion is immediately produced, and so too with what is encouraging; but when we merely imagine we remain as unaffected as persons who are looking at a painting of some dreadful or encouraging scene. Again within the field of judgement itself we find varieties—knowledge, opinion, understanding, and their opposites; of the differences between these I must speak elsewhere.

Thinking is different from perceiving and is held to be in part imagination, in part judgement: we must therefore first mark off the sphere of imagination and then speak of judgement. If then imagination is that in virtue of which an image arises for us, excluding metaphorical uses of the term, is it a single faculty or disposition relative to images, in virtue of which we discriminate and are either in error or not? The faculties in virtue of which we do this are sense, opinion, knowledge, thought.

That imagination is not sense is clear from the following considerations: Sense is either a faculty or an activity, e.g. sight or seeing: imagination takes place in the absence of both, as e.g. in dreams. Again, sense is always present, imagination not. If actual imagination and actual sensation were the same, imagination would be found in all the brutes: this is held not to be the case; e.g. it is not found in ants or bees or grubs. Again, sensations are always true, imaginations are for the most part false. Once more, we do not, when sense functions precisely with regard to its object, say that we imagine it to be a man, but rather when there is some failure of accuracy in its exercise—then it is either true or false.[31] And, as we were saying before,

[30]Retaining *νόησις*.
[31]Retaining *τότε ἤ*.

visions appear to us even when our eyes are shut. Neither is imagination any of the things that are never in error: e.g. knowledge or intelligence; for imagination may be false.

It remains therefore to see if it is opinion, for opinion may be either true or false.

But opinion involves belief (for without belief in what we opine we cannot have an opinion), and in the brutes though we often find imagination we never find belief. Further, every opinion is accompanied by belief, belief by conviction, and conviction by discourse of reason, while there are some of the brutes in which we find imagination, without discourse of reason.[32] It is clear then that imagination cannot, again, be opinion *plus* sensation, or opinion mediated by sensation, or a blend of opinion and sensation; this is impossible both for these reasons and because the content of the supposed opinion cannot be different from that of the sensation (I mean that imagination must be the blending of the perception of white with the opinion that it is white: it could scarcely be a blend of the opinion that it is good with the perception that it is white): to imagine is therefore (on this view) identical with 428b1 the thinking of exactly the same as what one perceives non-incidentally. But what we imagine is sometimes false though our contemporaneous judgement about it is true; e.g. we imagine the sun to be a foot in diameter though we are convinced that it is larger than the inhabited part of the earth. Thus either while the fact has not changed and the observer has neither forgotten nor lost belief in the true opinion which he had, that opinion has disappeared, or if he retains it then his opinion is at once true and false. A true opinion, however, becomes false only when the fact alters without being noticed.

Imagination is therefore neither any one of the states enumerated, nor compounded out of them.

But since when one thing has been set in motion another thing may be moved by it, and imagination is held to be a movement and to be impossible without sensation, i.e. to occur in beings that are percipient and to have for its content what can be perceived, and since movement may be produced by actual sensation and that movement is necessarily similar in character to the sensation itself, this movement cannot exist apart from sensation or in creatures that do not perceive, and its possessor does and undergoes many things in virtue of it, and it is true and false.

The reason is as follows. Perception of the special objects of sense is never in error or admits the least possible amount of falsehood. Next comes perception that what is incidental to the objects of perception *is* incidental to them: in this case certainly we may be deceived; for while the perception that there is white before us cannot be false, the perception that what is white is this or that may be false. Third comes the perception of the common attributes which accompany the incidental objects to which the special sensibles attach (I mean e.g. of movement and magnitude); it is in respect of these that the greatest amount of sense-illusion is possible.

[32]Ross, following Biehl, excises 'Further . . . reason', as a doublet of lines 19–22.

The motion which is due to the activity of sense in these three modes of its exercise will differ; the first kind of derived motion is free from error while the sensation is present; the others may be erroneous whether it is present or absent, especially when the object of perception is far off. If then imagination presents no other features than those enumerated and is what we have described, then imagination must be a movement resulting from an actual exercise of a power of sense.

As sight is the most highly developed sense, the name *φαντασία* (imagination) has been formed from *φάος* (light) because it is not possible to see without light. And because imaginations remain in the organs of sense and resemble sensations, animals in their actions are largely guided by them, some (i.e. the brutes) because of the non-existence in them of thought, others (i.e. men) because of the temporary eclipse in them of thought by feeling or disease or sleep.

About imagination, what it is and why it exists, let so much suffice.

4 · Turning now to the part of the soul with which the soul knows and (whether this is separable from the others in definition only, or spatially as well) we have to inquire what differentiates this part, and how thinking can take place.

If thinking is like perceiving, it must be either a process in which the soul is acted upon by what is capable of being thought, or a process different from but analogous to that. The thinking part of the soul must therefore be, while impassible, capable of receiving the form of an object; that is, must be potentially identical in character with its object without being the object. Thought must be related to what is thinkable, as sense is to what is sensible.

Therefore, since everything is a possible object of thought, mind in order, as Anaxagoras says, to dominate, that is, to know, must be pure from all admixture; for the co-presence of what is alien to its nature is a hindrance and a block: it follows that it can have no nature of its own, other than that of having a certain capacity. Thus that in the soul which is called thought (by thought I mean that whereby the soul thinks and judges) is, before it thinks, not actually any real thing. For this reason it cannot reasonably be regarded as blended with the body: if so, it would acquire some quality, e.g. warmth or cold, or even have an organ like the sensitive faculty: as it is, it has none. It was a good idea to call the soul 'the place of forms', though this description holds only of the thinking soul, and even this is the forms only potentially, not actually.

Observation of the sense-organs and their employment reveals a distinction between the impassibility of the sensitive faculty and that of the faculty of thought. After strong stimulation of a sense we are less able to exercise it than before, as e.g. in the case of a loud sound we cannot hear easily immediately after, or in the case of a bright colour or a powerful odour we cannot see or smell, but in the case of thought thinking about an object that is highly thinkable renders it more and not less able afterwards to think of objects that are less thinkable: the reason is that while the faculty of sensation is dependent upon the body, thought is separable from it.

When thought has become each thing in the way in which a man who actually knows is said to do so (this happens when he is now able to exercise the power on his own initiative), its condition is still one of potentiality, but in a different sense from the potentiality which preceded the acquisition of knowledge by learning or discovery; and thought is then able to think of itself.[33]

Since we can distinguish between a magnitude and what it is to be a magnitude, and between water and what it is to be water, and so in many other cases (though not in all; for in certain cases the thing and its form are identical), flesh and what it is to be flesh are discriminated either by different faculties, or by the same faculty in two different states; for flesh necessarily involves matter and is like what is snub-nosed, a *this* in a *this*. Now it is by means of the sensitive faculty that we discriminate the hot and the cold, i.e. the factors which combined in a certain ratio constitute flesh: the essential character of flesh is apprehended by something different either wholly separate from the sensitive faculty or related to it as a bent line to the same line when it has been straightened out.

Again in the case of abstract objects what is straight is analogous to what is snub-nosed; for it necessarily implies a continuum: its constitutive essence is different, if we may distinguish between straightness and what is straight: let us take it to be two-ness. It must be apprehended, therefore, by a different power or by the same power in a different state. To sum up, in so far as the realities it knows are capable of being separated from their matter, so it is also with the powers of thought.

The problem might be suggested: if thinking is a passive affection, then if thought is simple and impassible and has nothing in common with anything else, as Anaxagoras says, how can it come to think at all? For interaction between two factors is held to require a precedent community of nature between the factors. Again it might be asked, is thought a possible object of thought to itself? For if thought is thinkable *per se* and what is thinkable is in kind one and the same, then either thought will belong to everything, or it will contain some element common to it with all other realities which makes them all thinkable.

Have not we already disposed of the difficulty about interaction involving a common element, when we said that thought is in a sense potentially whatever is thinkable, though actually it is nothing until it has thought? What it thinks must be[34] in it just as characters may be said to be on a writing-table on which as yet nothing actually stands written: this is exactly what happens with thought.

Thought is itself thinkable in exactly the same way as its objects are. For in the case of objects which involve no matter, what thinks and what is thought are identical; for speculative knowledge and its object are identical. (Why thought is not always thinking we must consider later.) In the case of those which contain matter each of the objects of thought is only potentially present. It follows that while they will not have thought in them (for thought is a potentiality of them only in so far as they are capable of being disengaged from matter) thought may yet be thinkable.

[33]Retaining δὲ αὐτόν.

[34]Retaining δεῖ.

5 · Since in every class of things, as in nature as a whole, we find two factors involved, a matter which is potentially all the particulars included in the class, a cause which is productive in the sense that it makes them all (the latter standing to the former, as e.g. an art to its material), these distinct elements must likewise be found within the soul.

And in fact thought, as we have described it, is what it is by virtue of becoming all things, while there is another which is what it is by virtue of making all things: this is a sort of positive state like light; for in a sense light makes potential colours into actual colours.

Thought in this sense of it is separable, impassible, unmixed, since it is in its essential nature activity (for always the active is superior to the passive factor, the originating force to the matter).

Actual knowledge is identical with its object: in the individual, potential knowledge is in time prior to actual knowledge, but absolutely it is not prior even in time. It does not sometimes think and sometimes not think. When separated it is alone just what it is, and this alone is immortal and eternal (we do not remember because, while this is impassible, passive thought is perishable); and without this nothing thinks.

6 · The thinking of indivisibles is found in those cases where falsehood is impossible: where the alternative of true or false applies, there we always find a sort of combining of objects of thought in a quasi-unity. As Empedocles said that 'where heads of many a creature sprouted without necks'[35] they afterwards by Love's power were combined, so here too objects of thought which were separate are combined, e.g. 'incommensurate' and 'diagonal': if the combination be of objects past or future the combination of thought includes in its content the date. For falsehood always involves a combining; for even if you assert that what is white is not white you have combined not-white.[36] It is possible also to call all these cases division. However that may be, there is not only the true or false assertion that Cleon is white but also the true or false assertion that he *was* or *will be* white. In each and every case that which unifies is thought.

Since the word 'indivisible' has two senses, i.e. may mean either 'not capable of being divided' or 'not actually divided', there is nothing to prevent thought from thinking of what is undivided, e.g. when it thinks of a length (which is actually undivided) and that in an undivided time; for the time is divided or undivided in the same manner as the line. It is not possible, then, to tell what part of the line it was thinking of in each half of the time: the object has no actual parts until it has been divided; if in thought you think of each half separately, then by the same act you divided the time also, the half-lines becoming as it were new wholes of length. But if you think of it as a whole consisting of these two parts, then also you think of it in a time which corresponds to both parts together. (But what is not quantitatively but qualitatively simple is thought of in a simple time and by a simple act of the soul.)[37]

[35]Frag. 57 Diels-Kranz.

[36]Ross adds: 'and white'.

[37]Ross, following Bywater, places the bracketed sentence after 'spatial' in line 20.

But that which thought thinks of and the time in which it thinks are in this case divisible only incidentally and not as such. For in them too there is something indivisible (though, it may be, not separable) which gives unity to the time and the whole of length; and this is found equally in every continuum whether temporal or spatial.

Points and similar instances of things that divide, themselves being indivisible, are realized in consciousness in the same manner as privations.

A similar account may be given of all other cases, e.g. how evil or black is cognized; they are cognized, in a sense, by means of their contraries. That which cognizes must be its objects potentially, and they must be in it. But if there is anything that has no contrary,[38] then it knows itself and is actually and possesses independent existence.

Assertion is the saying of something concerning something, as too is denial, and is in every case either true or false: this is not always the case with thought: the thinking of the definition in the sense of what is is for something to be is never in error nor is it the assertion of something concerning something; but, just as while the seeing of the special object of sight can never be in error, seeing whether the white object is a man or not may be mistaken, so too in the case of objects which are without matter.

7 · Actual knowledge is identical with its object: potential knowledge in the 431a1 individual is in time prior to actual knowledge but absolutely it has no priority even in time; for all things that come into being arise from what actually is. In the case of sense clearly the sensitive faculty already was potentially what the object makes it to be actually; the faculty is not affected or altered. This must therefore be a different kind of movement; for movement is an activity of what is imperfect, activity in the unqualified sense, i.e. that of what has been perfected, is different.

To perceive then is like bare asserting or thinking; but when the object is pleasant or painful, the soul makes a sort of affirmation or negation, and pursues or avoids the object. To feel pleasure or pain is to act with the sensitive mean towards what is good or bad as such. Both avoidance and appetite when actual are identical with this: the faculty of appetite and avoidance are not different, either from one another or from the faculty of sense-perception; but their being *is* different.

To the thinking soul images serve as if they were contents of perception (and when it asserts or denies them to be good or bad it avoids or pursues them). That is why the soul never thinks without an image. The process is like that in which the air modifies the pupil in this or that way and the pupil transmits the modification to some third thing (and similarly in hearing), while the ultimate point of arrival is one, a single mean, with different manners of being.

With what part of itself the soul discriminates sweet from hot I have explained before and must now describe again as follows: That with which it does so is a sort of unity, but in the way a boundary is; and these things being one by analogy and numerically, are each to each as the qualities discerned are to one another (for what difference does it make whether we raise the problem of discrimination between

[38]Omitting τῶν αἰτίων.

disparates or between contraries, e.g. white and black?). Let then *C* be to *D* as *A*, white is to *B*, black: it follows *alternando* that *C* : *A* :: *D* : *B*. If then *C* and *A* belong to one subject, the case will be the same with them as with *D* and *B*; *D* and *B* form a single identity with different modes of being; so too will the former pair. The same reasoning holds if *A* be sweet and *B* white.

The faculty of thinking then thinks the forms in the images, and as in the former case what is to be pursued or avoided is marked out for it, so where there is no sensation and it is engaged upon the images it is moved to pursuit or avoidance. E.g. perceiving by sense that the beacon is fire, it recognizes in virtue of the general faculty of sense that it signifies an enemy, because it sees it moving; but sometimes by means of the images or thoughts which are within the soul, just as if it were seeing, it calculates and deliberates what is to come by reference to what is present; and when it makes a pronouncement, as in the case of sensation it pronounces the object to be pleasant or painful, in this case it avoids or pursues; and so generally in cases of action.[39]

That too which involves no action, i.e. that which is true or false, is in the same province with what is good or bad: yet they differ in this, that the one is absolute and the other relative to someone.

The so-called abstract objects the mind thinks just as, in the case of the snub, one might think of it *qua* snub not separately, but if anyone actually thought of it *qua* hollow[40] he would think of it without the flesh in which it is embodied: it is thus that the mind when it is thinking the objects of mathematics thinks of them as separate though they are not separate. In every case the mind which is actively thinking is the objects which it thinks. Whether it is possible for it while not existing separate from spatial conditions to think anything that is separate, or not, we must consider later.

8 · Let us now summarize our results about soul, and repeat that the soul is in a way all existing things; for existing things are either sensible or thinkable, and knowledge is in a way what is knowable, and sensation is in a way what is sensible: in *what* way we must inquire.

Knowledge and sensation are divided to correspond with the realities, potential knowledge and sensation answering to potentialities, actual knowledge and sensation to actualities. Within the soul the faculties of knowledge and sensation are *potentially* these objects, the one what is knowable, the other what is sensible. They must be either the things themselves or their forms. The former alternative is of course impossible: it is not the stone which is present in the soul but its form.

It follows that the soul is analogous to the hand; for as the hand is a tool of tools, so thought is the form of forms and sense the form of sensible things.

Since it seems that there is nothing outside and separate in existence from sensible spatial magnitudes, the objects of thought are in the sensible forms, viz. both the abstract objects and all the states and affections of sensible things. Hence

[39] Retaining ἐν πράξει.

[40] Reading, with most MSS, οὐ κεχωρισμένως, ᾗ δὲ κοῖλον εἴ τις.

no one can learn or understand anything in the absence of sense, and when the mind is actively aware of anything it is necessarily aware of it along with an image; for images are like sensuous contents except in that they contain no matter.

Imagination is different from assertion and denial; for what is true or false involves a synthesis of thoughts. In what will the primary thoughts differ from images? Must we not say that neither these nor even our other thoughts are images, though they necessarily involve them?

9 · The soul of animals is characterized by two faculties, the faculty of discrimination which is the work of thought and sense, and the faculty of originating local movement. Sense and thought we have now sufficiently examined. Let us next consider what it is in the soul which originates movement. Is it a single part of the soul separate either spatially or in definition? Or is it the soul as a whole? If it is a part, is that part different from those usually distinguished or already mentioned by us, or is it one of them? The problem at once presents itself, in what sense we are to speak of parts of the soul, or how many we should distinguish. For in a sense there is an infinity of parts: it is not enough to distinguish, with some thinkers, the calculative, the passionate, and the desiderative, or with others the rational and the irrational; for if we take the dividing lines followed by these thinkers we shall find parts far more distinctly separated from one another than these, namely those we have just mentioned: the nutritive, which belongs both to plants and to all animals, and the sensitive, which cannot easily be classed as either irrational or rational; further the imaginative, which is, in its being, different from all, while it is very hard to say with which of the others it is the same or not the same, supposing we determine to posit separate parts in the soul; and lastly the appetitive, which would seem to be distinct both in definition and in power from all hitherto enumerated.

It is absurd to break up the last-mentioned faculty: for wish is found in the calculative part and desire and passion in the irrational; and if the soul is tripartite appetite will be found in all three parts. Turning our attention to the present object of discussion, let us ask what that is which originates local movement of the animal.

The movement of growth and decay, being found in all living things, must be attributed to the faculty of reproduction and nutrition, which is common to all: breathing in and out, sleep and waking, we must consider later: these too present much difficulty: at present we must consider local movement, asking what it is that originates forward movement in the animal.

That it is not nutritive faculty is obvious; for this kind of movement is always for an end and is accompanied either by imagination or[41] by appetite; for no animal moves except by compulsion unless it has an impulse towards or away from an object. Further, if it were the nutritive faculty, even plants would have been capable of originating such movement and would have possessed the organs necessary to carry it out. Similarly it cannot be the sensitive faculty either; for there are many

[41] Retaining ἤ.

animals which have sensibility but remain fast and immovable throughout their lives.

If then Nature never makes anything without a purpose and never leaves out what is necessary (except in the case of mutilated or imperfect growths; and that here we have neither mutilation nor imperfection may be argued from the facts that such animals can reproduce their species and rise to completeness of nature and decay to an end), it follows that, had they been capable of originating forward movement, they would have possessed the organs necessary for that purpose. Further, neither can the calculative faculty or what is called thought be the cause of such movement; for mind as speculative never thinks what is practicable, it never says anything about an object to be avoided or pursued, while this movement is always in something which is avoiding or pursuing an object. No, not even when it is aware of such an object does it thereby enjoin pursuit or avoidance of it; e.g. the mind often thinks of something terrifying or pleasant without enjoining the emotion of fear. It is the heart that is moved (or in the case of a pleasant object some other part). Further, even when thought does command and bids us pursue or avoid something, sometimes no movement is produced; we act in accordance with desire, as in the case of moral weakness. And, generally, we observe that the possessor of medical knowledge is not necessarily healing, which shows that something else is required to produce action in accordance with knowledge; the knowledge alone is not the cause. Lastly, appetite too is incompetent to account fully for movement; for those who successfully resist temptation have appetite and desire and yet follow thought and refuse to enact that for which they have appetite.

10 · These two at all events appear to be sources of movement: appetite and thought (if one may venture to regard imagination as a kind of thinking; for many men follow their imaginations contrary to knowledge, and in all animals other than man there is no thinking or calculation but only imagination).

Both of these then are capable of originating local movement, thought and appetite: thought, that is, which calculates means to an end, i.e. practical thought (it differs from speculative thought in the character of its end); while appetite is in every form of it relative to an end; for that which is the object of appetite is the stimulant of practical thought; and that which is last in the process of thinking is the beginning of the action. It follows that there is a justification for regarding these two as the sources of movement, i.e. appetite and practical thought; for the object of appetite starts a movement and as a result of that thought gives rise to movement, the object of appetite being to it a source of stimulation. So too when imagination originates movement, it necessarily involves appetite.

That which moves therefore is a single faculty and the faculty of appetite; for if there had been two sources of movement—thought and appetite—they would have produced movement in virtue of some common character. As it is, thought is never found producing movement without appetite (for wish is a form of appetite; and when movement is produced according to calculation it is also according to wish), but appetite can originate movement *contrary* to calculation, for desire is a form of appetite. Now thought is always right, but appetite and imagination may be either right or wrong. That is why, though in any case it is the object of appetite which originates movement, this object may be either the real or the apparent good. To produce movement the object must be more than this: it must be good that can be brought into being by action; and only what can be otherwise than as it is can thus be brought into being. That then such a power in the soul as has been described, i.e. that called appetite, originates movement is clear. Those who distinguish parts in the soul, if they distinguish and divide in accordance with differences of power, find themselves with a very large number of parts, a nutritive, a sensitive, an intellective, a deliberative, and now an appetitive part; for these are more different from one another than the faculties of desire and passion.

Since appetites run counter to one another, which happens when a principle of reason and a desire are contrary and is possible only in beings with a sense of time (for while thought bids us hold back because of what is future, desire is influenced by what is just at hand: a pleasant object which is just at hand presents itself as both pleasant and good, without condition in either case, because of want of foresight into what is farther away in time), it follows that while that which originates movement must be specifically one, viz. the faculty of appetite as such (or rather farthest back of all the object of that faculty; for it is it that itself remaining unmoved originates the movement by being apprehended in thought or imagination), the things that originate movement are numerically many.

All movement involves three factors, (1) that which originates the movement, (2) that by means of which it originates it, and (3) that which is moved. The expression 'that which originates the movement' is ambiguous: it may mean either something which itself is unmoved or that which at once moves and is moved. Here that which moves without itself being moved is the realizable good, that which at once moves and is moved is the faculty of appetite (for that which is moved is moved insofar as it desires, and appetite in the sense of actual appetite *is* a kind of movement), while that which is in motion is the animal. The instrument which appetite employs to produce movement is bodily: hence the examination of it falls within the province of the functions common to body and soul. To state the matter summarily at present, that which is the instrument in the production of movement is to be found where a beginning and an end coincide as e.g. in a ball and socket joint; for there the convex and the concave sides are respectively an end and a beginning (that is why while the one remains at rest, the other is moved): they are separate in definition but not separable spatially. For everything is moved by pushing and pulling. Hence just as in the case of a wheel, so here there must be a point which remains at rest, and from that point the movement must originate.

To sum up, then, and repeat what I have said, inasmuch as an animal is capable of appetite it is capable of self-movement; it is not capable of appetite without possessing imagination; and all imagination is either calculative or sensitive. In the latter all animals partake.

11 · We must consider also in the case of imperfect animals, sc. those which have no sense but touch, what it is that in them originates movement. Can they have imagination or not? or desire? Clearly they have feelings of pleasure and pain, and

if they have these they must have desire. But how can they have imagination? Must not we say that, as their movements are indefinite, they have imagination and desire, but indefinitely?

Sensitive imagination, as we have said, is found in all animals, deliberative imagination only in those that are calculative: for whether this or that shall be enacted is already a task requiring calculation; and there must be a single standard to measure by, for that is pursued which is greater. It follows that what acts in this way must be able to make a unity out of several images.

This is the reason why imagination is held not to involve opinion, in that it does not involve opinion based on inference, though opinion involves imagination.[42] Hence appetite contains no deliberative element. Sometimes it overpowers wish and sets it in movement; at times wish acts thus upon appetite, like a ball,[43] appetite overcoming appetite, i.e. in the condition of moral weakness (though by nature the higher faculty is always more authoritative and gives rise to movement). Thus three modes of movement are possible.

The faculty of knowing is never moved but remains at rest. Since the one premiss or judgement is universal and the other deals with the particular (for the first tells us that such and such a kind of man should do such and such a kind of act, and the second that this is an act of the kind meant, and I a person of the type intended), it is the latter opinion that really originates movement, not the universal; or rather it is both, but the one does so while it remains in a state more like rest, while the other partakes in movement.

12 · The nutritive soul then must be possessed by everything that is alive and has a soul, from its birth to its death. For what has been born must grow, reach maturity, and decay—all of which are impossible without nutrition. Therefore the nutritive faculty must be found in everything that grows and decays.

But sensation need not be found in all things that live. For it is impossible for touch to belong either to those whose body is uncompounded or to those which are incapable of taking in the forms without their matter.

But animals must be endowed with sensation, since Nature does nothing in vain. For all things that exist by Nature are means to an end, or will be concomitants of means to an end. Every body capable of forward movement would,
434b1 if unendowed with sensation, perish and fail to reach its end, which is the aim of Nature; for how could it obtain nutriment? Stationary living things, it is true, have as their nutriment that from which they have arisen; but it is not possible that a body which is not stationary but produced by generation should have a soul and a discerning mind without also having sensation. (Nor yet even if it were not produced by generation.) Why should it not have sensation? It would have to be better either for the soul or for the body; but in fact it is neither—for the absence of sensation will not enable the one to think better or the other to exist better. Therefore no body which is not stationary has soul without sensation.

[42]Ross, following Bywater, excises the last clause.
[43]Retaining the MSS text: *κινεῖ τὴν βούλησιν, ὅτε δ' ἐκείνη ταύτην ὥσπερ σφαίρα.*

But if a body *has* sensation, it must be either simple or compound. And simple it cannot be; for then it could not have touch, which is indispensable. This is clear from what follows. An animal is a body with soul in it: every body is tangible, i.e. perceptible by touch; hence necessarily, if an animal is to survive, its body must have tactual sensation. All the other senses, e.g. smell, sight, hearing, apprehend through media; but where there is immediate contact the animal, if it has no sensation, will be unable to avoid some things and take others, and so will find it impossible to survive. That is why taste also is a sort of touch; it is relative to nutriment, which is just tangible body; whereas sound, colour, and odour are not nutritious, and further neither grow nor decay. Hence it is that taste also must be a sort of touch, because it is the sense for what is tangible and nutritious.

Both these senses, then, are indispensable to the animal, and it is clear that without touch it is impossible for an animal to be. All the other senses subserve well-being and for that very reason belong not to any and every kind of animal, but only to some, e.g. those capable of forward movement must have them; for, if they are to survive, they must perceive not only by immediate contact but also at a distance from the object. This will be possible if they can perceive through a medium, the medium being affected and moved by the perceptible object, and the animal by the medium. Just as that which produces local movement causes a change extending to a certain point, and that which gave an impulse causes another to produce a new impulse so that the movement traverses a medium—the first mover impelling without being impelled, the last moved being impelled without impelling, while the medium (or media, for there are many) is both—so is it also in the case of alteration, except that the agent produces it without the patient's changing its place. Thus if an object is dipped into wax, the movement goes on until submersion has taken place, and in stone it goes no distance at all, while in water the disturbance goes far beyond the object dipped: in air the disturbance is propagated farthest of all, the air acting and being acted upon, so long as it maintains an unbroken unity. That is why in the case of reflection it is better, instead of saying that the sight issues from the eye and is reflected, to say that the air, so long as it remains one, is affected by the shape and colour. On a smooth surface the air possesses unity; hence it is that it in turn sets the sight in motion, just as if the impression on the wax were transmitted as far as the wax extends.

13 · It is clear that the body of an animal cannot be simple, i.e. consist of one element such as fire or air. For without touch it is impossible to have any other sense; for every body that has soul in it must, as we have said, be capable of touch. All the other elements with the exception of earth can constitute organs of sense, but all of them bring about perception only through something else, viz. through the media. Touch takes place by direct contact with its objects, whence also its name. All the other organs of sense, no doubt, perceive by contact, only the contact is mediate: touch alone perceives by immediate contact. Consequently no animal body can consist of these other elements.

Nor can it consist solely of earth. For touch is as it were a mean between all tangible qualities, and its organ is capable of receiving not only all the specific qualities which characterize earth, but also the hot and the cold and all other tangible qualities whatsoever. That is why we have no sensation by means of bones, hair, &c., because they consist of earth. So too plants, because they consist of earth, have no sensation. Without touch there can be no other sense, and the organ of touch cannot consist of earth or of any other single element.

It is evident, therefore, that the loss of this one sense alone must bring about the death of an animal. For as on the one hand nothing which is not an animal can have this sense, so on the other it is the only one which is indispensably necessary to what is an animal. This explains, further, why excesses of the other sensible objects, i.e. excess of colour, sound, and smell, destroys not the animal but only the organs of the sense (except incidentally, as when the sound is accompanied by an impact or shock, or where through the objects of sight or of smell certain other things are set in motion, which destroy by contact—flavour also destroys only in so far as it is at the same time capable of contact), whereas excess in tangible qualities, e.g. heat, cold, or hardness, destroys the animal itself. As in the case of every sensible quality excess destroys the organ, so here what is tangible destroys touch, which is the essential mark of being an animal; for it has been shown that without touch it is impossible for an animal to be. That is why excess in intensity of tangible qualities destroys not merely the organ, but the animal itself, because this is the only sense which it must have.

All the other senses are necessary to animals, as we have said, not for their being, but for their well-being. Such, e.g., is sight, which, since it lives in air or water, or generally in what is transparent, it must have in order to see, and taste because of what is pleasant or painful to it, in order that it may perceive these qualities in its nutriment and so may desire to be set in motion, and hearing that it may have communication made to it, and a tongue that it may communicate with its fellows.[44]

[44]Ross, following Torstrik, excises the last clause.

SENSE AND SENSIBILIA

J. I. Beare

1 · Having now considered the soul, by itself, and its several faculties, we 436^{a}1 must next make a survey of animals and all living things, in order to ascertain what functions are peculiar, and what functions are common, to them. What has been already determined respecting the soul must be assumed throughout. The remaining parts of our subject must be now dealt with, and we may begin with those that come first.

The most important attributes of animals, whether common to all or peculiar to some, are, manifestly, attributes of soul and body in conjunction, e.g., *sensation, memory, passion, appetite* and *desire* in general, and, in addition, *pleasure* and *pain*. For these may, in fact, be said to belong to all animals. But there are, besides these, certain other attributes, of which some are common to all living things, while others are peculiar to certain species of animals. The most important of these may be summed up in four pairs, viz. *waking* and *sleeping, youth* and *old age, inhalation* and *exhalation, life* and *death*. We must examine these, determining their respective natures, and the causes of their occurrence.

But it behoves the natural scientist to obtain also a clear view of the first principles of *health* and *disease,* inasmuch as neither health nor disease can exist in lifeless things. Indeed we may say of most physical inquirers, and of those physicians who study their art more philosophically, that while the former complete their works with a disquisition on medicine, the latter start from a consideration of nature. 436^{b}1

That all the attributes above enumerated belong to soul and body in conjunction, is obvious; for they all either imply sensation as a concomitant, or have it as their medium. Some are either affections or states of sensation, others, means of defending and safe-guarding it, while others, again, involve its destruction or privation. Now it is clear, alike by reasoning and without reasoning, that sensation is generated in the soul through the medium of the body.

We have already, in our treatise *On the Soul,* explained the nature of sensation and perceiving, and the reason why this affection belongs to animals. Sensation must, indeed, be attributed to all animals as such, for by its presence or absence we distinguish between what is and what is not an animal.

TEXT: W. D. Ross, *Aristotle: Parva Naturalia,* Clarendon Press, Oxford, 1955

But coming now to the special senses severally, we may say that touch and taste necessarily appertain to all animals, touch, for the reason given in *On the Soul,* and taste, because of nutrition. It is by taste that one distinguishes in food the pleasant from the unpleasant, so as to flee from the latter and pursue the former; and savour in general is an affection of the nutritive part.

The senses which operate through external media, viz. *smelling, hearing, seeing,* are found in all animals which possess the faculty of locomotion. To all that possess them they are a means of preservation in order that, guided by antecedent perception, they may both pursue their food, and shun things that are bad or destructive. But in animals which have also intelligence they serve for the attainment of a higher perfection. They bring in tidings of many distinctive qualities of things, from which knowledge of things both speculative and practical is generated in the soul.

Of the two last mentioned, seeing, regarded as a supply for the primary wants of life is in its own right the superior sense; but for developing thought hearing incidentally takes the precedence. The faculty of seeing, thanks to the fact that all bodies are coloured, brings tidings of multitudes of distinctive qualities of all sorts; whence it is through this sense especially that we perceive the common sensibles, viz. *figure, magnitude, motion, number;* while hearing announces only the distinctive qualities of sound, and, to some few animals, those also of voice. Incidentally, however, it is hearing that contributes most to the growth of intelligence. For rational discourse is a cause of instruction in virtue of its being audible, which it is, not in its own right, but incidentally; since it is composed of words, and each word is a symbol. Accordingly, of persons destitute from birth of either sense, the blind are more intelligent than the deaf and dumb.

2 · Of the distinctive powers of each of the faculties of sense enough has been said already.

But as to the nature of the sensory organs, or parts of the body in which each of the senses is naturally implanted, some inquire into them with reference to the elements of bodies. Not, however, finding it easy to coordinate five senses with four elements, they are at a loss respecting the fifth sense. They all hold the organ of sight to consist of fire, being prompted to this view by a certain affection of whose true cause they are ignorant. This is that, when the eye is pressed and moved, fire appears to flash from it. This naturally takes place in darkness, or when the eyelids are closed—for then, too, darkness is produced.

This raises another puzzle; for, unless a man can perceive[1] and see without being aware of it, the eye must see itself. But then why does the above affection not occur also when the eye is at rest? The true explanation of this affection, which will contain the answer to our question, and account for the current notion that the eye consists of fire, must be determined in the following way:—

Things which are smooth have the natural property of shining in darkness, without, however, producing light. Now, the part of the eye called the black, i.e. its

[1]Ross adds *μή* before *αἰσθανόμενον*.

central part, is smooth. The phenomenon of the flash occurs only when the eye is 437b1 moved, because one object then becomes as it were two. The rapidity of the movement has the effect of making that which sees and that which is seen seem different from one another. Hence the phenomenon does not occur unless the motion is rapid and takes place in darkness. For it is in the dark that that which is smooth, e.g. the heads of certain fishes, and the sepia of the cuttle-fish, naturally shines, and, when the movement of the eye is slow, it is impossible that that which sees and that which is seen should appear to be simultaneously two and one. The eye sees itself in the above phenomenon as it does so in reflexion.

If the visual organ were fire, which is the doctrine of Empedocles, a doctrine taught also in the *Timaeus*, and if vision were the result of light issuing from the eye as from a lantern, why should the eye not have had the power of seeing even in the dark? It is totally idle to say, as the *Timaeus* does, that the visual ray coming forth in the darkness is quenched. What is a quenching of light? That which, like a fire of coals or an ordinary flame, is hot and dry is, indeed, quenched by the moist or cold; but heat and dryness are not evidently attributes of light. And if they are attributes of it, but belong to it in a degree so slight as to be imperceptible to us, we should have expected that in the daytime the light of the sun should be quenched when rain falls, and that darkness should prevail in frosty weather. After all, flame and ignited bodies are subject to such extinction, but experience shows that nothing of this sort happens to the sunlight.

Empedocles at times seems to hold, as we said before, that vision occurs when light issues forth from the eye, e.g., in the following passage:—

> As when one who purposes going abroad prepares a lantern,
> A gleam of fire blazing through the stormy night,
> Adjusting thereto, to screen it from all sorts of winds, transparent sides,
> Which scatter the breath of the winds as they blow,
> While, out through them leaping, the fire, i.e. all the more subtle part of this,
> Shines along his threshold with incessant beams:
> So the primaeval fire, fenced within the membranes.
> And delicate tissues gave birth to a round-eyed daughter—
> Tissues bored through with wonderful channels—
> And these fended off the deep surrounding flood, 438a1
> While letting through the fire, i.e. all its more subtle part.

Sometimes he accounts for vision thus, but at other times he explains it by emanations from the visible objects.

Democritus, on the other hand, is right in his opinion that the eye is of water; not, however, when he goes on to explain seeing as mirroring. The mirroring that takes place in an eye is due to the fact that the eye is smooth, and it really has its seat not in the eye, but in that which sees. For the case is one of reflexion. But it would seem that in his time there was no scientific knowledge of the general subject of the formation of images and the phenomena of reflexion. It is strange, too, that it never occurred to him to ask why the eye alone sees, while none of the other things in which images are reflected do so.

True, then, the visual organ proper is composed of water, yet vision appertains to it not because it is water, but because it is transparent—a property common alike to water and to air. But water is more easily confined and more easily condensed than air; it is that the pupil, i.e. the eye proper, consists of water. That it does so is proved by facts of actual experience. The substance which flows from eyes when decomposing is seen to be water, and this in undeveloped embryos is remarkably cold and glistening. In sanguineous animals the white of the eye is fat and oily, in order that the moisture of the eye may be proof against freezing. Wherefore the eye is of all parts of the body the least sensitive to cold: no one ever feels cold in the part sheltered by the eyelids. The eyes of bloodless animals are covered with a hard scale which gives them similar protection.

It is, to state the matter generally, an irrational notion that the eye should see in virtue of something issuing from it; that the visual ray should extend itself all the way to the stars, or else go out merely to a certain point, and there coalesce, as some say, with rays which proceed from the object. It would be better to suppose this coalescence to take place in the fundament of the eye itself. But even this would be mere trifling. For what is meant by the coalescence of light with light? Or how is it
438b1 possible? Coalescence does not occur between any two things taken at random. And how could the light within the eye coalesce with that outside it? For the membrane comes between them.

That without light vision is impossible has been stated elsewhere; but, whether the medium between the eye and its objects is air or light, vision is caused by a process through this medium.

Accordingly, that the inner part of the eye consists of water is easily intelligible, water being transparent.

Now, as vision outwardly is impossible without light, so also it is impossible inwardly. There must, therefore, be some transparent medium within the eye, and, as this is not air, it must be water. The soul or its perceptive part is not situated at the external surface of the eye, but obviously somewhere within: whence the necessity of the interior of the eye being transparent, i.e. capable of admitting light. And that it is so is plain from actual occurrences. It is matter of experience that soldiers wounded in battle by a sword slash on the temple, so inflicted as to sever the passages of the eye, feel a sudden onset of darkness, as if a lamp had gone out; because what is called the pupil, i.e. the transparent, which is a sort of lamp, is then cut off.

Hence, if the facts be at all as here stated, it is clear that—if one should explain the nature of the sensory organs in this way, i.e., by correlating each of them with one of the elements,—we must conceive that the part of the eye which sees consists of water, that what is perceptive of sound consists of air, and that the sense of smell consists of fire. (For the organ of smell is potentially that which the sense of smell is actually; since the object of sense is what causes the actualization of each sense, so that it must beforehand have been potentially such and such. Now, odour is a smoke-like evaporation, and smoke-like evaporation arises from fire. This also helps us to understand why the olfactory organ has its proper seat in the environment of the brain; for cold matter is potentially hot. In the same way must the genesis of the eye be explained. Its structure is an offshoot from the brain, because the latter is the moistest and coldest of all the bodily parts.)

The organ of touch consists of earth, and the faculty of taste is a particular form of touch. This explains why the sensory organ of both touch and taste is closely 439a1
related to the heart. For the heart, as being the hottest of all the bodily parts, is the counterpoise of the brain.

This, then, is the way in which the characteristics of the bodily organs of sense must be determined.

3 · Of the sensibles corresponding to each sensory organ, viz. colour, sound, odour, savour, touch, we have treated in *On the Soul* in general terms, having there determined what their function is, and what is implied in their becoming actualized in relation to their respective organs. We must next consider what account we are to give of any one of them; what, for example, we should say *colour* is, or *sound,* or *odour,* or *savour;* and so also respecting *touch.* We begin with *colour.*

Now, each of them may be spoken of from two points of view, i.e., either as actual or as potential. We have in *On the Soul* explained in what sense the colour, or sound, regarded as actualized, is the same as, and in what sense it is different from, the correlative sensation, the actual seeing or hearing. The point of our present discussion is to determine what each sensible object must be in itself, in order to produce actual sensation.

We have already in *On the Soul* stated of light that it is the colour of the transparent incidentally; for whenever a fiery element is in a medium its presence there is light; while the privation of it is darkness. But what we call transparent is not something peculiar to air, or water, or any other of the bodies usually called transparent, but is a common nature and power, capable of no separate existence of its own, but residing in these, and subsisting likewise in all other bodies in a greater or less degree. As the bodies in which it subsists must have some extreme bounding surface, so too must this. Here, then, we may say that light is a nature inhering in the transparent when the latter is without determinate boundary. But it is manifest that, when the transparent is in determinate bodies, its bounding extreme must be something real; and that colour is just this something we are plainly taught by facts—colour being actually either at the limit, or being itself that limit, in bodies. (Hence it was that the Pythagoreans named the superficies of a body its hue.) For it is at the limit of the body, but it is not the limit of the body; but the same natural substance which is coloured *outside* must be thought to be so inside too.

Air and water, too are evidently coloured; for their brightness is of the nature 439b1
of colour. But the colour which air or sea presents, since the body in which it resides is not determinately bounded, is not the same when one approaches and views it close by as it is when one regards it from a distance; whereas in determinate bodies

the colour presented is definitely fixed, unless, indeed, when the atmospheric environment causes it to change. Hence it is clear that that in them which is susceptible of colour is in both cases the same. It is therefore the transparent, according to the degree to which it subsists in bodies (and it does so in all more or less), that causes them to partake of colour. But since the colour is at the extremity of the body, it must be at the extremity of the transparent in the body. Whence it follows that we may define colour as the limit of the transparent in determinately bounded body. For whether we consider the special class of bodies called transparent, as water and such others, or determinate bodies, which appear to possess a fixed colour of their own, it is at the exterior bounding surface that all alike exhibit their colour.

Now, that which when present in air produces light may be present also in the transparent; or again, it may not be present, but there may be a privation of it. Accordingly, as in the case of air the one condition is light, the other darkness, in the same way the colours white and black are generated in determinate bodies.

We must now treat of the other colours, reviewing the several ways in which they can come about.

It is conceivable that the white and the black should be juxtaposed in quantities so minute that either separately would be invisible, though the joint product would be visible; and that they should thus have the other colours for resultants. Their product could, at all events, appear neither white nor black; and, as it must have some colour, and can have neither of these, this colour must be of a mixed character—in fact, a species of colour different from either. Such, then, is a possible way of conceiving the existence of a plurality of colours besides the white and black; and we may suppose that many are the result of a ratio; for they may be juxtaposed in the ratio of 3 to 2, or of 3 to 4, or in ratios expressible by other numbers; while some may be juxtaposed according to no numerically expressible ratio, but according to some incommensurable relation of excess or defect; and, accordingly, we may regard all these colours as analogous to concords, and suppose that those involving numerical ratios, like the concords in music, may be those generally regarded as most agreeable; as, for example, purple, crimson, and some few such colours, their fewness being due to the same causes which render the concords few. The other compound colours may be those which are not based on numbers. Or it may be that, while all colours whatever are based on numbers, some are regular in this respect, others irregular; and that the latter, whenever they are not pure, owe this character to a corresponding impurity in their numerical ratios. This then is one way to explain the genesis of intermediate colours.

Another is that the black and white appear the one through the medium of the other, giving an effect like that sometimes produced by painters overlaying a less vivid upon a more vivid colour, as when they desire to represent an object appearing under water or enveloped in a haze, and like that produced by the sun, which in itself appears white, but takes a crimson hue when beheld through a fog or a cloud of smoke. On this hypothesis, too, a variety of colours may be conceived to arise in the same way as that already described; for between those at the surface and those underneath a definite ratio might sometimes exist; in other cases they might stand in no determinate ratio. To say with the ancients that colours are emanations, and that the visibility of object is due to such a cause, is absurd. For they must, in any case, explain sense-perception through touch; so that it were better to say at once that visual perception is due to a process set up by the perceived object in the medium between this object and the sensory organ; due, that is, to contact, not to emanations.

If we accept the hypothesis of juxtaposition, we must assume not only invisible magnitude, but also imperceptible time, in order that the arrival of the movements may be unperceived, and that the colour may appear to be one because they seem to be simultaneous. On the hypothesis of superposition, however, no such assumption is needed: the stimulatory process produced in the medium by the upper colour, when this is itself unaffected, will be different in kind from that produced by it when affected by the underlying colour. Hence it presents itself as a different colour, i.e. as one which is neither white nor black. So that, if it is impossible to suppose any magnitude to be invisible, and we must assume that there is some distance from which every magnitude is visible, this superposition theory too[2] might pass as a theory of colour-mixture. Indeed, in the previous case also there is no reason why, to persons at a distance from the juxtaposed blacks and whites, some one colour should not appear to present itself as a blend of both. For it will be shown, in a discussion to be undertaken later on, that there is no magnitude absolutely invisible.

There is a mixture of bodies, however, not merely such as some suppose, i.e. by 440b1
juxtaposition of their minimal parts, which, owing to sense, are imperceptible by us, but a mixture by which they are wholly blent together, as we have described it in the treatise on mixture, where we dealt with this subject generally in its most comprehensive aspect. For, on the supposition we are criticizing, the only totals capable of being mixed are those which are divisible into minimal parts as men, horses, or seeds. For of mankind as a whole the individual man is such a least part; of horses the individual horse. Hence by the juxtaposition of these we obtain a mixed total, consisting of both together; but we do not say that by such a process any individual man has been mixed with any individual horse. Not in this way, but by complete interpenetration must we conceive those things to be mixed which are not divisible into minima; and it is in the case of these that natural mixture exhibits itself in its most perfect form. We have explained already in our discourse on mixture how such mixture is possible. It is plain that when bodies are mixed their colours also are necessarily mixed at the same time; and that this is the real cause determining the existence of a plurality of colours—not superposition or juxtaposition. For when bodies are thus mixed, their resultant colour presents itself as one and the same at all distances alike; not varying as it is seen nearer or farther away.

Colours will thus, too be many in number on account of the fact that the ingredients may be combined with one another in a multitude of ratios; some will be based on determinate numerical ratios, while others again will have as their basis a

[2]Retaining καί.

relation of quantitative excess. And all else that was said in reference to the colours, considered as juxtaposed or superposed, may be said of them likewise when regarded as mixed.

Why colours, as well as savours and sounds, consist of species determinate and not infinite is a question which we shall discuss hereafter.

4 · We have now explained what colour is, and the reason why there are many colours; while before, in our work *On the Soul*, we explained the nature of sound and voice.[3] We have next to speak of odour and savour, both of which are almost the same physical affection, although they each have their being in different things. Savours, as a class, display their nature more clearly to us than odours, the cause of which is that the olfactory sense of man is inferior in acuteness to that of the animals, and is, when compared with our other senses, the least perfect of all. Man's sense of touch, on the contrary, excels that of all other animals in fineness, and taste is a modification of touch.

Now the natural substance water tends to be tasteless. But either we must suppose that water contains in itself the various kinds of savour, though in amounts so small as to be imperceptible, which is the doctrine of Empedocles; or the water must be a sort of matter, qualified, as it were, to produce germs of savours of all kinds, so that all kinds of savour are generated from the water, though different kinds from its different parts; or else the water is in itself quite undifferentiated in respect of savour, but some agent, such for example as one might conceive heat or the sun to be, is the efficient cause of savour.

Of these three hypotheses, the falsity of that held by Empedocles is only too evident. For we see that when pericarpal fruits are plucked and exposed in the sun,[4] or subjected to the action of fire, their savours are changed by the heat, which shows that their qualities are not due to their drawing anything from the water in the ground, but to a change which they undergo within the pericarp itself; and we see, moreover, that these juices, when extracted and allowed to lie, instead of sweet become by lapse of time harsh or bitter, or acquire savours of any and every sort; and that, again, by the process of boiling they are made to assume almost all kinds of new savours.

It is likewise impossible that water should be a material qualified to generate all kinds of savour germs; for we see different kinds of taste generated from the same water, having it as their nutriment.

It remains, therefore, to suppose that the water is changed by passively receiving some affection. Now, it is manifest that water does not contract the quality of sapidity from the agency of heat alone. For water is of all liquids the thinnest, thinner even than oil itself, though oil, owing to its viscosity, is more ductile than water, the latter being uncohesive in its particles; whence water is more difficult than oil to hold in the hand. But since perfectly pure water does not, when

[3]Ross, following Freudenthal, excises 'while . . . voice'.
[4]Ross, following Bitterauf, excises 'exposed . . . sun, or'.

subjected to the action of heat, show any tendency to acquire consistency, we must infer that some other agency than heat is the cause of sapidity. For all savours exhibit a comparative consistency. Heat is, however, a co-agent in the matter.

Now the savours found in pericarpal fruits evidently exist also in the earth. Hence many of the old natural philosophers assert that water has qualities like $441^{b}1$ those of the earth through which it flows, a fact especially manifest in the case of saline springs, for salt is a form of earth. Hence also when liquids are filtered through ashes, a bitter substance, the taste they yield is bitter. There are many wells, too, of which some are bitter, others acid, while others exhibit other tastes of all kinds.

As was to be anticipated, therefore, it is among plants that tastes occur in richest variety. For, like all things else, the moist is affected only by its contrary; and this contrary is the dry. Thus we see why the moist is affected by fire, which, as a natural substance, is dry. Heat is, however, the essential property of fire, as dryness is of earth, according to what has been said in our treatise on the elements. Fire and earth, therefore, taken absolutely as such, have no natural power to affect, or be affected; nor have any other pair of substances. Any two things can affect or be affected by, one another only so far as contrariety to the other resides in either of them.

As, therefore, persons washing colours or savours in a liquid cause the water in which they wash to acquire such a quality, so nature, too, by washing the dry and earthy in the moist, and by filtering the latter, that is, moving it on by the agency of heat through the dry and earthy, imparts to it a certain quality. This affection, wrought by the aforesaid dry in the moist, capable of transforming the sense of taste from potentiality to actuality, is savour. Savour brings into actual exercise the perceptive faculty which pre-existed only in potency. The activity of sense-perception in general is analogous, not to the process of acquiring knowledge, but to that of exercising knowledge already acquired.

That savours, either as a quality or as the privation of a quality, belong not to every form of the dry but to the nutrient, we shall see by considering that neither the dry without the moist, nor the moist without the dry, is nutrient. For no single element, but only composite substance, constitutes nutriment for animals. Now, among the perceptible elements of the food which animals assimilate, the tangible are the efficient causes of growth and decay; it is *qua* hot or cold that the food assimilated causes these; for the heat or cold is the direct cause of growth or decay. It is *qua* tastable, however, that the assimilated food supplies nutrition. For all $442^{a}1$ organisms are nourished by the sweet, either by itself or in combination with other savours. Of this we must speak with more precise detail in our work on generation: for the present we need touch upon it only so far as our subject here requires. Heat causes growth, and fits the food-stuff for alimentation; it attracts that which is light, while the salt and bitter it rejects because of their heaviness. In fact, whatever effects external heat produces in external bodies, the same are produced by their internal heat in animal and vegetable organisms. Hence it is that nourishment is effected by the sweet. The other savours are introduced into and blended in food on a principle analogous to that on which the saline or the acid is used artificially, i.e. for seasoning. These latter are used because they counteract the tendency of the sweet to be too nutrient, and to float on the stomach.

As the intermediate colours arise from the mixture of white and black, so the intermediate savours arise from the sweet and bitter; and these savours, too, severally involve either a definite ratio, or else an indefinite relation of degree, between their components, either having certain numbers at the basis of their mixture and motion, or else being mixed in proportions not arithmetically expressible. The tastes which give pleasure in their combination are those which have their components joined in a definite ratio.

The sweet taste alone is rich, while the saline is fairly identical with the bitter. Between the extremes of sweet and bitter come the harsh, the pungent, the astringent, and the acid. Savours and colours contain respectively about the same number of species. For there are seven species of each, if, as is reasonable, we regard grey as a variety of black (for the alternative is that yellow should be classed with white, as rich with sweet); while crimson, violet, leek-green, and deep blue, come between white and black, and from these all others are derived by mixture.

Again, as black is a privation of white in the transparent, so saline or bitter is a privation of sweet in the nutrient moist. This explains why the ash of all burnt things is bitter; for the potable moisture has been exuded from them.

Democritus and most of the natural philosophers who treat of sense-perception proceed quite irrationally, for they represent all objects of sense as objects of touch.
442b1 Yet, if this is really so, it clearly follows that each of the other senses is a mode of touch; but one can see at a glance that this is impossible.

Again, they treat the percepts common to all senses as special to one. For magnitude and figure, roughness and smoothness, and, moreover, the sharpness and bluntness found in solid bodies, are percepts common to all the senses, or if not to all, at least to sight and touch. This explains why it is that the senses are liable to err regarding them, while no such error arises respecting their special sensibles; e.g. the sense of seeing is not deceived as to colour, nor is that of hearing as to sound.

On the other hand, they reduce the special to common sensibles, as Democritus does with white and black; for he asserts that the latter is rough, and the former smooth, while he reduces savours to the atomic figures. Yet surely no one sense, or, if any, the sense of sight rather than any other, can discern the common sensibles. But if we suppose that the sense of taste is better able to do so, then—since to discern the smallest objects in each kind is what marks the acutest sense—taste should have been the sense which best perceived the common sensibles generally, and showed the most perfect power of discerning figures in general.

Again, all the sensibles involve contrariety; e.g. in colour white is contrary to black, and in savours bitter is contrary to sweet; but no one figure is reckoned as contrary to any other figure. Else, to which of the possible polygonal figures is the spherical figure contrary?

Again, since figures are infinite in number, savours also should be infinite; for why should one savour be perceived, and another not?

This completes our discussion of the object of taste, i.e. savour; for the other affections of savours are examined in their proper place in connection with the natural history of plants.

5 · Our conception of the nature of odours must be analogous to that of savours; inasmuch as the sapid moist effects in air and water alike, but in a different province of sense, precisely what the dry effects in the moist of water only. We customarily predicate transparency of both air and water in common; but it is not *qua* that either is a vehicle of odour, but *qua* possessed of a power of washing or rinsing the sapid dryness.

For the object of smell exists not in air only: it also exists in water. This is proved by the case of fishes and testacea, which are seen to possess the faculty of smell, although water contains no air (for whenever air is generated within water it rises to the surface), and these creatures do not breathe. Hence, if one were to assume that air and water are both moist, it would follow that odour is the natural substance consisting of the sapid dry diffused in the moist, and whatever is of this kind would be an object of smell.

That the property of odorousness is based upon the sapid may be seen by comparing the things which possess with those which do not possess odour. The elements, viz. fire, air, earth, water, are inodorous, because both the dry and the moist among them are without sapidity, unless some added ingredient produces it. This explains why sea-water possesses odour, for it contains savour and dryness. Salt, too, is more odorous than natron, as the oil which exudes from the former proves, for natron is allied to earth more nearly than salt. Again, a stone is inodorous, just because it is tasteless, while, on the contrary, wood is odorous, because it is sapid. The kinds of wood, too, which contain more water are less odorous than others. Moreover, to take the case of metals, gold is inodorous because it is without taste, but bronze and iron are odorous; and when the moisture has been burnt out of them, their slag is, in all cases, less odorous. Silver and tin are more odorous than the one class of metals, less so than the other, inasmuch as they are watery.

Some writers look upon exhalation, which is a compound of earth and air, as the essence of odour. Heraclitus implied his adherence to it when he declared that if all existing things were turned into smoke, the nose would be the organ to discern them with. All writers incline to refer odour to this cause, but some regard it as vapour, others as exhalation; while others, again, hold it to be either. Vapour is merely a form of moisture, but smoky exhalation is, as already remarked, composed of air and earth. The former when condensed turns into water; the latter, into a particular species of earth. Now, it is unlikely that odour is either of these. For vaporous exhalation consists of mere water; and smoky exhalation cannot occur in water at all, though, as has been before stated, aquatic creatures also have the sense of smell.

Again, the exhalation theory of odour is analogous to the theory of emanations. If, therefore, the latter is untenable, so, too, is the former.

It is clearly conceivable that the moist, whether in air (for air, too, is essentially moist) or in water, should imbibe the influence of, and have effects wrought in it by, the sapid dryness. Moreover, if the dry produces in moist media and air, an effect as of something washed out in them, it is manifest that odours must be something analogous to savours. Indeed, this analogy is, in some instances, a fact; for odours as well as savours are spoken of as pungent, sweet, harsh, astringent, rich; and one might regard fetid smells as analogous to bitter tastes; which explains why the former are as unpleasant to breathe as the latter are to drink. It is clear, therefore, that odour is in both water and air what savour is in water alone. This explains why coldness and freezing render savours dull, and abolish odours altogether; for cooling and freezing tend to annul the kinetic heat which helps to fabricate sapidity.

There are two species of the odorous. For the statement of certain writers that the odorous is not divisible into species is false; it is so divisible. We must here define the sense in which these species are to be admitted or denied.

One class of odours, then, is that which runs parallel, as has been observed, to savours: to odours of this class their pleasantness or unpleasantness belongs incidentally. For owing to the fact that savours are qualities of nutrient matter, the odours connected with these are agreeable as long as animals have an appetite for the food, but they are not agreeable to them when sated and no longer in want of it; nor are they agreeable, either, to those animals that do not like the food itself which yields the odours. Hence, as we observed, these odours are pleasant or unpleasant incidentally, and the same reasoning explains why it is that they are perceptible to all animals in common.

The other class of odours consists of those agreeable in their essential nature, e.g. those of flowers. For these do not in any degree stimulate animals to food, nor do they contribute in any way to appetite; their effect upon it, if any, is rather the opposite. For the verse of Strattis ridiculing Euripides—

Use not perfumery to flavour soup,

contains a truth.

444a1 Those who nowadays introduce such flavours into beverages deforce our sense of pleasure by habituating us to them, until, from two distinct kinds of sensations combined, pleasure arises as it might from one simple kind.

Of this species of odour man alone is sensible; the other, viz. that correlated with tastes, is, as has been said before, perceptible also to the other animals. And odours of the latter sort, since their pleasureableness depends upon taste, are divided into as many species as there are different tastes; but we cannot go on to say this of the former kind of odour, since its nature is agreeable or disagreeable *per se*. The reason why the perception of such odours is peculiar to man is found in the characteristic state of man's brain. For his brain is naturally cold, and the blood which it contains in its vessels is thin and pure but easily cooled (whence it happens that the exhalation arising from food, being cooled by the coldness of this region, produces unhealthy rheums); therefore it is that odours of such a species have been generated for human beings, as a safeguard to health. This is their sole function, and that they perform it is evident. For food, whether dry or moist, though pleasant to taste, is often unwholesome; whereas the odour arising from what is fragrant, that odour which is pleasant in its own right, is, so to say, always beneficial to persons in any state of bodily health whatever.

For this reason, too, the perception of odour is effected through respiration, not in all animals, but in man and certain other sanguineous animals, e.g. quadrupeds, and all that participate freely in the natural substance air; because when odours, on account of the lightness of the heat in them, mount to the brain, the health of this region is thereby promoted. For odour, as a power, is naturally heat-giving. Thus nature has employed respiration for two purposes: primarily for the relief thereby brought to the thorax, secondarily for the inhalation of odour. For while an animal is inhaling, odour moves in through its nostrils, as it were from a side-entrance.

But the perception of the second class of odours above described is confined to human beings, because man's brain is, in proportion to his whole bulk, larger and moister than the brain of any other animal. This is the reason of the further fact that man alone, so to speak, among animals perceives and takes pleasure in the odours of flowers and such things. For the heat and stimulation set up by these odours are commensurate with the excess of moisture and coldness in his cerebral region. On all the other animals which have lungs, nature has bestowed their due perception of one of the two kinds of odour through the act of respiration, guarding against the needless creation of two organs of sense; for in the fact that they breathe the other animals have already sufficient provision for their perception of the one species of odour only, as human beings have for their perception of both.

But that creatures which do not breathe have the olfactory sense is evident. For fishes, and all insects as a class, have, thanks to the species of odour correlated with nutrition, a keen olfactory sense of their proper food from a distance, even when they are very far away from it; such is the case with bees, and also with the class of small ants, which some denominate *knipes*. Among marine animals, too, the murex and many other similar animals have an acute perception of their food by its odour.

It is not equally certain what the organ is whereby they so perceive. This question, of the organ whereby they perceive odour, may well cause a difficulty, if we assume that smelling takes place in animals only while breathing (for that this is the fact is manifest in all the animals which do breathe), whereas none of those just mentioned breathes, and yet they have the sense of smell—unless, indeed, they have some other sense not included in the ordinary five. This supposition, is however, impossible. For any sense which perceives odour is a sense of smell, and this they do perceive, though probably not in the same way as creatures which breathe, but when the latter are breathing the current of breath removes something that is laid like a lid upon the organ proper (which explains why they do not perceive odours when not breathing); while in creatures which do not breathe this is always off: just as some animals have eyelids on their eyes, and when these are not raised they cannot see, whereas hard-eyed animals have no lids, and consequently do not need, besides eyes, an agency to raise the lids, but see on the basis of what is possible for them from the start.

Consistently with what has been said above, not one of the animals shows repugnance to the odour of things which are essentially ill-smelling, unless one of the latter is positively pernicious. They are destroyed, however, by these things, just as human beings get headaches from, and are often asphyxiated by, the fumes of charcoal; so the other animals perish from the strong fumes of brimstone and bituminous substances, and they avoid them because of that quality. For the disagreeable odour in itself they care nothing whatever (though the odours of many plants are essentially disagreeable), unless, indeed, it has some effect upon the taste of their food.

The senses making up an odd number, and an odd number having always a middle unit, the sense of smell occupies in itself as it were a middle position between the tactual senses, i.e. touch and taste, and those which perceive through a medium, i.e. sight and hearing. Hence the object of smell, too, is an affection of nutrient substances (which fall within the class of tangibles), and is also an affection of the audible and visible; whence it is that creatures have the sense of smell both in air and water. Accordingly, the object of smell is something common to both of these provinces, i.e. it appertains both to the tangible on the one hand, and on the other to the audible and transparent. Hence the propriety of the figure by which it has been described by us as an immersion or washing of dryness in the moist and fluid. Such then must be our account of the sense in which one is or is not entitled to speak of the odorous as having species.

The theory held by certain of the Pythagoreans, that some animals are nourished by odours alone, is unsound. For, in the first place, we see that food must be composite, since the bodies nourished by it are not simple. This explains why waste matter is secreted from food, either within the organisms, or, as in plants, outside them. But since even water by itself alone, that is, when unmixed, will not suffice for food—for anything which is to form a consistency must be corporeal—, it is still much less conceivable that air should be so corporealized. But, besides this, we see that all animals have a receptacle for food, from which, when it has entered, the body absorbs it. Now, the organ which perceives odour is in the head, and odour enters with the inhalation of the breath; so that it goes to the respiratory region. It is plain, therefore, that odour, *qua* odour, does not contribute to nutrition; that, however, it is serviceable to health is equally plain, as well by immediate perception as from the arguments above employed; so that odour is in relation to general health what savour is in the province of nutrition and in relation to the bodies nourished.

This then must conclude our discussion of the several organs of sense-perception.

6 · One might ask: if every body is infinitely divisible, are its sensible qualities—colour, savour, odour, sound, weight, cold or heat, heaviness or lightness, hardness or softness—also infinitely divisible? Or, is this impossible?

Each of them is productive of sense-perception, since, in fact, all derive their name from the very circumstance of their being able to stimulate this. Hence if their power is divisible, our perception of them should likewise be divisible to infinity, and every part of a body should be a perceptible magnitude. For it is impossible, e.g., to see a thing which is white but not of a certain magnitude.

Since if it were not so, we might conceive a body existing but having no colour, or weight, or any such quality; accordingly not perceptible at all. For these quantities are the objects of sense-perception. On this supposition, every perceptible object should be regarded as composed of non-perceptible parts. Yet it must be really composed of perceptible parts, since assuredly it does not consist of mathematical qualities. Again, by what faculty should we discern and cognize these? Is it by thought? But they are not objects of thought; nor does thought think of objects in space, except when it acts in conjunction with sense-perception. At the same time, if this be the case it seems to tell in favour of the atomistic hypothesis; for thus, indeed, the question might be solved. But it is impossible. Our views on the subject of atoms are to be found in our treatise on movement.

The solution of these questions will bring with it also the answer to the question why the species of colour, taste, sound, and other sensible qualities are limited. For in all classes of things lying between extremes the intermediates must be limited. But contraries are extremes, and every object of sense-perception involves contrariety; e.g. in colour, white and black; in savour, sweet and bitter, and in all the other sensibles also the contraries are extremes. Now, that which is continuous is divisible into an infinite number of unequal parts, but into a finite number of equal parts, while that which is not *per se* continuous is divisible into species which are finite in number. Since then, the several sensible qualities of things are to be reckoned as species, while continuity always subsists in these, we must take account of the difference between the potential and the actual. It is owing to this difference that we do not see its ten-thousandth part in a grain of millet, although sight has 446a1
embraced the whole grain within its scope; and it is owing to this, too, that the sound contained in a quarter-tone escapes notice, and yet one hears the whole strain, inasmuch as it is a continuum; but the interval between the extreme sounds escapes the ear. So, in the case of other objects of sense, extremely small constituents are unnoticed; because they are only potentially not actually visible, unless when they have been parted from the wholes. So the foot-length too exists potentially in the two-foot length, but actually only when it has been separated from the whole. But increments so small might well, if separated from their totals, be dissolved in their environments, like a drop of sapid moisture poured out into the sea. But even if this were not so still, since the increment of sense-perception is not perceptible in itself, nor capable of separate existence (since it exists only potentially in the more distinctly perceivable whole of sense-perception), so neither will it be possible to perceive its correlatively small object when separated in actuality. But yet this is to be considered as perceptible: for it is both potentially so already, and destined to be actually so when it has become part of an aggregate. Thus, therefore, we have shown that some magnitudes and their sensible qualities escape notice, and the reason why they do so, as well as the manner in which they are still perceptible or not perceptible in such cases. Accordingly then, when these are so great as to be perceptible actually, and not merely because they are in the whole, but even apart from it, it follows necessarily that their sensible qualities, whether colours or tastes or sounds, are limited in number.

One might ask:—do the objects of sense-perception, or the movements proceeding from them in whichever of the two ways sense-perception takes place), when these are actualized for perception, always arrive first at a middle point, as odour evidently does, and also sound? For he who is nearer perceives the odour sooner, and the sound of a stroke reaches us some time after it has been struck. Is it thus also with an object seen, and with light? Empedocles, for example, says that the light from the sun arrives first in the intervening space before it comes to the eye, or reaches the Earth. This might plausibly seem to be the case. For whatever is moved, is moved from one place to another; hence there must be a corresponding interval of time also in which it is moved from the one place to the other. But any given time is divisible; so that we should assume a time when the sun's ray was not as yet seen, but was still travelling in the middle space.

Now, even if one always hears and has heard—and, in general, perceives and has perceived—at the same time, and these acts do not come into being but occur without coming into being—yet, just as, though the stroke which causes the sound has been already struck, the sound is not yet at the ear (and that this last is a fact is further proved by the transformation which the letters undergo, implying that the local movement takes place in the space between; for the reason why we do not succeed in catching the sense of what is said is that the air in moving towards them has its form changed): is the same also true in the case of colour and light? For certainly it is not true that the beholder sees, and the object is seen, in virtue of some merely abstract relationship between them, such as that between equals. For if it were so, there would be no need that either should occupy some particular place; since to the equalization of things their being near to, or far from, one another makes no difference.

Now this may with good reason take place as regards sound and odour, for these, like air and water, are continuous, but the movement of both is divided into parts. This too is the ground of the fact that the object which the person first in order of proximity hears or smells is the same as that which each subsequent person perceives, while yet it is not the same.

Some, indeed, raise a question also on these very points; they declare it impossible that one person should hear, or see, or smell, the same object as another, urging the impossibility of several persons in different places hearing or smelling the same object; for the one same thing would thus be divided from itself. The answer is that, in perceiving the object which first set up the motion—e.g. a bell, or frankincense, or fire—all perceive an object numerically one and the same; while, of course, in the special object perceived they perceive an object numerically different for each, though specifically the same for all; and this, accordingly, explains how it is that many persons together see, or smell, or hear the same object. These things are not bodies, but an affection or process of some kind (otherwise this would not have been, as it is, a fact of experience), though, on the other hand, they each imply a body.

But with regard to light the case is different. For light is due to the presence of something, but it is not a movement. And in general, even in qualitative change the case is different from what it is in local movement. Local movements, of course, arrive first at a point midway before reaching their goal (and sound, it is currently believed, is a movement of something locally moved), but we cannot go on to assert this in like manner of things which undergo qualitative change. For this kind of 447a1 change may possibly take place in a thing all at once, without one half of it being changed before the other; e.g. it is possible that water should be frozen simultaneously in every part. But still, for all that, if the body which is heated or frozen is extensive, each part of it successively is affected by the part contiguous, while the part first changed in quality is so changed by the cause itself which originates the change, and thus the change throughout the whole need not[5] take place simultaneously and all at once. Tasting would have been as smelling now is, if we lived in a liquid medium, and perceived things at a distance, before touching them.

Naturally, then, the parts of media between a sensory organ and its object are not all affected at once—except in the case of light, for the reason above stated, and also in the case of seeing, for the same reason; for light is an efficient cause of seeing.

7 · Another question respecting sense-perception is as follows: assuming, as is natural, that of two movements the stronger always tends to extrude the weaker, is it possible or not that one should be able to perceive two objects simultaneously in the same individual time? The above assumption explains why persons do not perceive what is brought before their eyes, if they are at the time deep in thought, or in a fright, or listening to some loud noise. This assumption, then, must be made, and also the following: that it is easier to perceive each object of sense when in its simple form than when an ingredient in a mixture; easier, for example, to perceive wine when neat than when blended, and so also honey, and a colour, or to discern a note by itself alone, than in a chord; the reason being that component elements tend to efface one another. Such is the effect of all ingredients of which, when compounded, some one thing is formed.

If, then, the greater movement tends to expel the less, it necessarily follows that, when they concur, this greater should itself too be less distinctly perceptible than if it were alone, since the less by blending with it has removed some of its individuality, according to our assumption that simple objects are in all cases more perceptible.

Now, if the two stimuli are equal but heterogeneous, no perception of either will ensue; they will alike efface one another's characteristics. But in such a case the perception of either stimulus in its simple form is impossible. Hence either there will then be no sense-perception at all, or there will be a perception compounded of both and differing from either. The latter is what actually seems to result from ingredients blended together, whatever may be the compound in which they are so mixed.

Since, then, from some a resultant object is produced, while from others no such resultant is produced, and of the latter sort are those things which belong to different sense provinces (for only those things are capable of mixture whose

[5] Reading καὶ οὐκ ἀνάγκη.

447b1 extremes are contraries, and no one compound can be formed from, e.g., white and high, except incidentally, i.e. not as a concord is formed of high and low), there follows logically the impossibility of discerning such concurrent stimuli at the same time. For we must suppose that the stimuli, when equal, tend alike to efface one another, since no one stimulus results from them; while, if they are unequal, the stronger alone is distinctly perceptible.

Again, the soul would be more likely to perceive simultaneously, with one and the same sensory act, two things in the same sensory province, such as the low and the high in sound; for the sensory stimulation in this one province is more likely to be simultaneous than that involving two different provinces, as sight and hearing. But it is impossible to perceive two objects simultaneously in the same sensory act unless they have been mixed, for their amalgamation involves their becoming one, and the sensory act related to one object is itself one, and such act when one, is, of course, simultaneous with itself. Hence, when things are mixed we of necessity perceive them simultaneously: for we perceive them by a perception actually one. For an object numerically one means that which is perceived by a perception actually one, whereas an object specifically one means that which is perceived by a sensory act potentially one. If then the actualized perception is one, it will declare its data to be one object; they must, therefore, have been mixed. Accordingly, when they have not been mixed, the actualized perceptions which perceive them will be two; but in one and the same faculty the perception actualized at any single moment is necessarily one, only one stimulation or exertion of a single faculty being possible at a single instant, and in the case supposed here the faculty is one. Hence it is not possible to perceive the possibility of perceiving two distinct objects simultaneously with one and the same sense.

But if it be thus impossible to perceive simultaneously two objects in the same province of sense if they are really two, manifestly it is still less conceivable that we should perceive simultaneously objects in two different sensory provinces, as white and sweet. For it appears that when the soul predicates numerical unity it does so in virtue of nothing else than such simultaneous perception while it predicates specific unity in virtue of the discriminating faculty of sense together with the mode in which this operates. What I mean, for example, is this; the same sense no doubt discerns white and black, though they are specifically different from one another, and so, too, a faculty of sense self-identical, but different from the former, discerns sweet and bitter; but while both these faculties differ from one another in their modes of discerning either of their respective contraries, yet in perceiving the co-ordinates in each province they proceed in manners analogous to one another; for
448a1 instance, as taste perceives sweet, so sight perceives white; and as the latter perceives black, so the former perceives bitter.

Again, if movements of contraries are themselves contrary, and if contraries cannot subsist together in the same individual subject, and if contraries, e.g. sweet and bitter, come under one and the same sense-faculty, we must conclude that it is impossible to discern them simultaneously. It is likewise clearly impossible so to discern such homogeneous sensibles as are not contrary. For these are, classed some with white, others with black, and so it is, likewise, in the other provinces of sense; for example, of savours, some are classed with sweet, and others with bitter. Nor can one discern the components in compounds simultaneously (for these are ratios of contraries, as e.g. the octave or the fifth); unless, indeed, on condition of perceiving them as one. For thus, and not otherwise, the ratios of the extreme sounds are compounded into one ratio; since we should have together the ratio, on the one hand, of many to few or of odd to even, on the other, that of few to many or of even to odd.

If, then, the sensibles denominated co-ordinates though in different provinces of sense (e.g. I call sweet and white co-ordinates though in different provinces) stand yet more aloof, and differ more, from one another than do any sensibles in the same province; while sweet differs from white even more than black does from white, it is still less conceivable that one should discern them simultaneously than sensibles which are in the same province. Therefore, if simultaneous perception of the latter be impossible, that of the former is *a fortiori* impossible.

Some of the writers who treat of concords assert that the sounds combined in these do not reach us simultaneously, but only appear to do so, their real successiveness being unnoticed whenever the time it involves is imperceptible. Is this true or not? One might perhaps, following this up, go so far as to say that even the current opinion that one sees and hears simultaneously is due merely to the fact that the intervals of time escape observation. But this can scarcely be true, nor is it conceivable that any portion of time should be imperceptible, or that any should be unnoticeable; the truth being that it is possible to perceive every instant of time. For if it is impossible that a person should, while perceiving himself or anything else in a continuous time, be at any instant unaware of his own existence, and if there is in the time-continuum a time so small as to be absolutely imperceptible, then it is clear that a person would, during such time, be unaware of his own existence, as well as of his seeing and perceiving.

Again, if there is any magnitude, whether time or thing, absolutely imperceptible owing to its smallness, it follows that there would not be either a thing which one perceives, or a time in which one perceives it, unless in the sense that in some part of the given time he sees some part of the given thing. For if one sees a whole line, and perceives it during a time which forms one and the same continuum—in the sense that he does so in some portion of this time—let us suppose the part CB, representing a time in which he was perceiving nothing, to be cut off from the whole. Well, then, he perceives *in* a certain part or perceives *a part* of the line, after the fashion in which one sees the whole earth by seeing some given part of it, or walks in a year by walking in some given part of the year. But in the part CB he perceives nothing: therefore, he is said to perceive the whole object and during the whole time simply because he perceives in some part of AB. But the same argument holds also in the case of AC; for one always perceives only, in some part and perceives only some part; and it is impossible to perceive any whole.

Therefore, we must conclude that all magnitudes are perceptible, but their actual dimensions do not present themselves immediately. One sees the sun, or a four-cubit rod at a distance, as a magnitude, but their exact dimensions are not given in their visual presentation: indeed, at times an object of sight appears indivisible, but nothing that one sees is really indivisible. The reason for this has been previously explained. It is clear then, from the above arguments, that no portion of time is imperceptible.

But we must here return to the question proposed above for discussion, whether it is possible or impossible to perceive several objects simultaneously; by 'simultaneously' I mean perceiving the several objects in a time one and indivisible relatively to one another.

First, then, can one perceive different things simultaneously but with different parts of the soul—in a time which is indivisible and forms a continuous whole? Or is it that, first, in the case of a single sense (take, e.g., sight), if we assume it to perceive one colour with one part and another with another, it will have *several* parts the same in kind? For what it perceives is the same in genus.

Should any one urge that, as there are two eyes, so there may be in the soul something analogous, that of the eyes, doubtless, some one organ is formed, and hence their actualization in perception is one; but if this is so in the soul, then in so far as what is formed of both is one, the true perceiving subject also will be one, while if the two parts of soul remain separate, the analogy of the eyes will fail.

Furthermore, the senses will be each at the same time one and many, as if we should say that they were each a set of diverse sciences; for neither will an activity exist without its proper faculty, nor without activity will there be sensation.

But if the soul does not, in the way suggested, perceive in one and the same individual time sensibles of the same sense, *a fortiori* it is not thus that it perceives sensibles of different senses. For it is, as already stated, more conceivable that it should perceive a plurality of the former together in this way than a plurality of heterogeneous objects.

If then, as is the fact, the soul with one part perceives sweet, with another, white, either that which results from these is some one part, or else there is no such one resultant. But there must be such one, inasmuch as the general faculty of sense-perception is one. What one object, then, does that one faculty perceive? For assuredly no one object arises by composition of these. We must conclude, therefore, that there is, as has been stated before, some one faculty in the soul with which the latter perceives all its percepts, though it perceives each different genus of sensibles through a different organ.

May we not, then, conceive this faculty which perceives white and sweet to be one *qua* indivisible in its actualization, but different, when it has become divisible in its actualization?

Or is what occurs in the case of the soul possibly analogous to what holds true in that of the things themselves? For the same numerically one thing is white and sweet, and has many other qualities; for if the qualities are not separable from one another, their being is different in each case. In the same way, therefore, we must assume also, in the case of the soul, that the faculty of perception in general is in itself numerically one and the same, but different in its being: different, that is to say, in genus as regards some of its objects, in species as regards others. Hence too, we may conclude that one can perceive numerically different objects simultaneously with a faculty which is numerically one and the same, but not the same in its account.

That every sensible object is a magnitude, and that nothing which it is possible to perceive is indivisible, may be thus shown. The distance whence an object could not be seen is indeterminate, but that whence it is visible is determinate. We may say the same of the objects of smelling and hearing, and of all sensibles not discerned by actual contact. Now, there is, in the interval of distance, some extreme place, the last from which the object is invisible, and the first from which it is visible. This place, beyond which if the object be one cannot perceive it, while if the object be on the hither side one must perceive it, is itself necessarily indivisible. Therefore, if any sensible object be indivisible, such object, if set in the said extreme place whence imperceptibility ends and perceptibility begins, will have to be both visible and invisible at the same time; but this is impossible.

This concludes our survey of the characteristics of the organs of sense- 449b1
perception and their objects, whether regarded in general or in relation to each organ. Of the remaining subjects, we must first consider that of memory and remembering.

ON MEMORY

J. I. Beare

1 · We have to treat of memory and remembering, considering its nature, its cause, and the part of the soul to which this experience, as well as that of recollecting, belongs. For the persons who possess a retentive memory are not identical with those who excel in power of recollection; indeed, as a rule, slow people have a better memory, whereas those who are quick-witted and clever are better at recollecting.

We must first consider the objects of memory, a point on which mistakes are often made. Now to remember what is future is not possible—that is an object of opinion or expectation (and indeed there might be actually a science of expectation, like that of divination, in which some believe); nor is there memory of what is present, but only sense-perception. For by the latter we do not know what is future or past, but what is present only. But memory relates to what is past. No one would say that he remembers what is present, when it is present, e.g. a given white object at the moment when he sees it; nor would one say that he remembers an object of scientific contemplation at the moment when he is actually contemplating it, and has it full before his mind;—of the former he would say only that he perceives it, of the latter only that he knows it. But when one has knowledge or perception apart from the objects, he thus remembers as to the former, that he learned it, or thought it out for himself, as to the latter, that he heard, or saw, it or had some sensible experience of it. For whenever one exercises the faculty of remembering, he must say within himself that he formerly heard or perceived or thought of that.

Memory is, therefore, neither perception nor conception, but a state or affection of one of these, conditioned by lapse of time. As already observed, there is no such thing as memory of the present while present; for the present is object only of perception, and the future, of expectation, but the object of memory is the past. All memory, therefore, implies a time elapsed; consequently only those animals which perceive time remember, and the organ whereby they perceive time is also that whereby they remember.

The subject of imagination has been already considered in our work *On the*
450a1 *Soul*. Without an image thinking is impossible. For there is in such activity an affection identical with one in geometrical demonstrations. For in the latter case, though we do not make any use of the fact that the quantity in the triangle is

TEXT: W. D. Ross, *Aristotle: Parva Naturalia*, Clarendon Press, Oxford, 1955

determinate, we nevertheless draw it determinate in quantity. So likewise when one thinks, although the object may not be quantitative, one envisages it as quantitative, though he thinks of it in abstraction from quantity; while, on the other hand, if it is something by nature quantitative but indeterminate, one envisages it as if it had determinate quantity, though one thinks of it only as a quantity. Why we cannot think of anything without a continuum or think of non-temporal things without time, is another question. Now, one must cognize magnitude and motion by means of the same faculty by which one cognizes time. Thus it is clear that the cognition of these objects is effected by the primary faculty of perception, and memory even of intellectual objects involves an image and the image is an affection of the common sense. Thus memory belongs incidentally to the faculty of thought, and essentially it belongs to the primary faculty of sense-perception.

Hence not only human beings and the beings which possess opinion or intelligence, but also certain other animals, possess memory. If memory were a function of the thinking parts, it would not have been an attribute of many of the other animals, but probably, in that case, no mortal beings[1] would have had memory; since, even as the case stands, it is not an attribute of them all, just because all have not the faculty of perceiving time. Whenever one actually remembers having seen or heard or learned something, he perceives in addition as we have already observed that it happened before; and before and after are in time.

Accordingly, if asked, of which among the parts of the soul memory is a function, we reply: manifestly of that part to which imagination also appertains; and all objects of which there is imagination are in themselves objects of memory, while those which do not exist without imagination are objects of memory incidentally.

One might ask how it is possible that though the affection is present, and the fact absent, the latter—that which is not present—is remembered. It is clear that we must conceive that which is generated through sense-perception in the soul, and in the part of the body which is its seat,—viz. that affection the state whereof we call memory—to be some such thing as a picture.[2] The process of movement stamps in, as it were, a sort of impression of the percept, just as persons do who make an impression with a seal. This explains why, in those who are strongly moved owing to passion, or time of life, no memory is formed; just as no impression would be formed if the movement of the seal were to impinge on running water; while there are others in whom, owing to the receiving surface being frayed, as happens to old walls, or owing to the hardness of the receiving surface, the requisite impression is not implanted at all. Hence both very young and very old persons are defective in memory; they are in a state of flux, the former because of their growth, the latter, owing to their decay. Similarly, both those who are too quick and those who are too slow have bad memories. The former are too moist, the latter too hard, so that in the case of the former the image does not remain in the soul, while on the latter it is not imprinted at all.

[1]Retaining the MSS reading *θνητῶν*.
[2]Retaining *τὸ πάθος*.

But then, if this is what happens in the genesis of memory, when one remembers, is it this affection that he remembers, or is it the thing from which this was derived? If the former, it would follow that we remember nothing which is absent; if the latter, how it is possible that, though perceiving directly only the impression, we remember that absent thing which we do not perceive? Granted that there is in us something like an impression or picture, why should the perception of this be memory of something else, and not of this itself? For when one actually remembers, this impression is what he contemplates, and this is what he perceives. How then will he remember what is not present? One might as well suppose it possible also to see or hear that which is not present. Or can this in a way actually happen? A picture painted on a panel is at once a picture and a likeness: that is, while one and the same, it is both of these, although the being of both is not the same, and one may contemplate it either as a picture, or as a likeness. Just in the same way we have to conceive that the image within us is both something in itself and relative to something else. In so far as it is regarded in itself, it is only an object of contemplation, or an image; but when considered as relative to something else, e.g., as its likeness, it is also a reminder. Hence, whenever its movement is actual, if the soul perceives this in its own right, it appears to occur as a mere thought or image; but if the soul perceives it *qua* related to something else, then—just as when one contemplates the painting in the picture as being a likeness, and without having seen the actual Coriscus, contemplates it as a likeness of Coriscus, and in that case the experience involved in this contemplation of it is different from what one has when he contemplates it simply as a painted figure—of the objects in the soul, the one presents itself simply as a thought, but the other, just because, as in the painting, it is a likeness, presents itself as a reminder.

We can now understand why it is that sometimes, when we have such processes, based on some former act of perception, occurring in the soul, we do not know whether this really implies our having had perceptions corresponding to them, and we doubt whether the case is or is not one of memory. But occasionally it happens that we get a sudden idea and recollect that we heard or saw something formerly. This happens whenever, from contemplating a mental object in itself, one changes his point of view, and regards it as relative to something else.

The opposite also occurs, as happened in the cases of Antipheron of Oreus and others suffering from mental derangement; for they were accustomed to speak of their images as facts of their past experience, and as if remembering them. This takes place whenever one contemplates what is not a likeness as if it were a likeness.

Mnemonic exercises aim at preserving one's memory of something by repeatedly reminding him of it; which implies nothing else than the frequent contemplation of something as a likeness, and not in its own right.

As regards the question, therefore, what memory or remembering is, it has now been shown that it is the having of an image, related as a likeness to that of which it is an image; and as to the question of which of the faculties within us memory is a function, it has been shown that it is a function of the primary faculty of sense-perception, i.e. of that faculty whereby we perceive time.

2 · Next comes the subject of recollection, in dealing with which we must assume the truths elicited in our tentative discussions. For recollection is not the recovery or acquisition of memory; since at the instant when one at first learns or experiences, he does not thereby recover a memory, inasmuch as none has preceded, nor does he acquire one *ab initio*. It is only at the instant when the state or affection is implanted in the soul that memory exists, and therefore memory is not itself implanted concurrently with the implantation of the sensory experience. Further, when it has first been implanted in the indivisible and ultimate organ, there is then already established in the person affected the affection, or the knowledge (if one ought to apply the term 'knowledge' to the state or affection; and indeed one may well remember, in the incidental sense, some of the things which one knows; but to remember, strictly speaking, is an activity which will not occur until time has elapsed. For one remembers now what one saw or otherwise experienced formerly; one does not remember now what one experiences now.

Again, it is obviously possible, without any present act of recollection, to remember as a continued consequence of the original perception or other experience; whereas when one recovers some knowledge which he had before, or some perception, or some other experience, the state of which we above declared to be memory, it is then, and then only, that this recovery may amount to a recollection of any of the things aforesaid; and memory follows on recollection.

But even the assertion that recollection is the reinstatement of something which was there before requires qualification—it is right in one way, wrong in another. For the same person may twice learn, or twice discover the same fact. Accordingly, the act of recollecting ought to be distinguished from these acts; i.e. recollecting must imply in those who recollect the presence of some source over and above that from which they originally learn.

Acts of recollection are due to the fact that one movement has by nature another that succeeds it.

If this order be necessary, whenever a subject experiences the former of two movements thus connected, it will experience the latter; if, however, the order be not necessary, but customary, only for the most part will the subject experience the latter of the two movements. But it is a fact that there are some movements, by a single experience of which persons take the impress of custom more deeply than they do by experiencing others many times; hence upon seeing some things but once we remember them better than others which we may have seen frequently.

Whenever, therefore, we are recollecting, we are experiencing one of the antecedent movements until finally we experience the one after which customarily comes that which we seek. This explains why we hunt up the series, having started in thought from the present or some other, and from something either similar, or contrary, to what we seek, or else from that which is contiguous with it. That is how recollection takes place; for the movements involved in these starting-points are in some cases identical, in others, again, simultaneous, while in others they comprise a portion of them, so that the remnant which one experienced after that portion is comparatively small.

Thus, then, it is that persons seek to recollect, and thus, too, it is that they

recollect even without seeking to do so, viz. when the movement has supervened on some other. For, as a rule, it is when antecedent movements of the classes here described have first been excited, that the particular movement implied in recollection follows. We need not examine a series of which the beginning and end lie far apart, in order to see how we remember; one in which they lie near one another will serve equally well. For it is clear that the method is in each case the same. For by the effect of custom the movements tend to succeed one another in a certain order. Accordingly, therefore, when one wishes to recollect, that is what he will do: he will try to obtain a beginning of movement whose sequel shall be the movement which he desires to reawaken. This explains why attempts at recollection succeed soonest and best when they start from a beginning. For, in order of
452a1 succession, the movements are to one another as the objects. Accordingly, things arranged in a fixed order, like the successive demonstrations in geometry, are easy to remember, while badly arranged subjects are remembered with difficulty.

Recollecting differs also in this respect from relearning, that one who recollects will be able, somehow, to move, solely by his own effort, to the term next after the starting-point. When one cannot do this of himself, but only by external assistance, he no longer remembers. It often happens that, though a person cannot recollect at the moment, yet by seeking he can do so, and discovers what he seeks. This he succeeds in doing by setting up many movements, until finally he excites one of a kind which will have for its sequel the fact he wishes to recollect. For remembering is the existence of a movement capable of stimulating the mind to the desired movement, and this, as has been said, in such a way that the person should be moved from within himself, i.e. in consequence of movements wholly contained within himself.

But one must get hold of a starting-point. This explains why it is that persons are supposed to recollect sometimes by starting from 'places'. The cause is that they pass swiftly from one point to another, e.g. from milk to white, from white to mist, and thence to moist, from which one remembers Autumn if this be the season he is trying to recollect.

It seems in general that the middle point among all things is a good starting-point. For if one does not recollect before, he will do so when he has come to this, or, if not, nothing can help him; as, e.g. if one were to have in mind A B C D E F G H I. For, if he does not remember at I, he remembers at E; because from E movement in either direction is possible, to D or to F. But, if it is not for one of these that he is searching, he will remember when he has come to C, if he is searching for A or B. But if not, he will remember by going to G, and so in all cases. The cause of one's sometimes recollecting and sometimes not, though starting from the same point, is, that from the same starting-point a movement can be made in several directions, as, for instance, from C to B or to D. If, then, the mind has not moved in an old path[3], it tends to move to the more customary; for custom now assumes the role of nature. Hence the rapidity with which we recollect what we frequently think about. For as one thing follows another by nature, so too that happens by custom;[4]

[3]Reading μὴ διὰ παλαιοῦ.
[4]Reading συνηθείᾳ.

and frequency creates nature. And since in the realm of nature occurrences take place which are even contrary to nature, or fortuitous, the same happens *a fortiori* in the sphere swayed by custom, since in this sphere nature is not similarly established. Hence it is that the mind receives an impulse to move sometimes in the required direction, and at other times otherwise, particularly when something else somehow deflects the mind from the right direction and attracts it to itself. This last consideration explains too how it happens that, when we want to remember a name, if we know one somewhat like it, we blunder on to that.

Thus, then, recollection takes place.

But the point of capital importance is that one should know, determinately or indeterminately, the time-relation. There is,—let it be taken as a fact,—something by which one distinguishes a greater and a smaller time; and it is reasonable to think that one does this in a way analogous to that in which one discerns magnitudes. For it is not by the mind's reaching out towards them, as some say a visual ray from the eye does that one thinks of large things at a distance in space (for even if they are not there, one may similarly think of them); but one does so by a proportionate movement. For there are in the mind similar figures and movements. Therefore, when one thinks of the greater objects, in what will his thinking of those differ from his thinking of the smaller? For all the internal though smaller are as it were proportional. Now, as we may assume within a person something proportional to the forms, so too, we may doubtless assume something else proportional to their distances. It is as though, if one has the movement AB, BE, he constructs CD; for AC and CD are proportional. Why then does he construct CD rather than FG? Is it not because as AC is to AB, so is H to I? These movements therefore he has simultaneously. But if he wishes to think of FG, he thinks of BE in like manner as before; but now, instead of H, I, he thinks of K, L; for these are so related as is FA to BA.

When, therefore, the movement corresponding to the object and that corresponding to its time concur, then one actually remembers. If one supposes he does without really doing so, he supposes himself to remember. For one may be mistaken, and think that he remembers when he really does not. But it is not possible that when one actually remembers he should not suppose himself to remember, but should remember unconsciously. For that is what remembering is. If however, the movement corresponding to the object takes place without that corresponding to the time, or, if the latter takes place without the former, one does not remember.

The movement answering to the time is of two kinds. Sometimes in remembering a fact one has no determinate time-notion of it, no such notion as that, e.g., he did something or other on the day before yesterday; while in other cases he has a determinate notion of the time. Still, even though one does not remember with actual determination of the time, he genuinely remembers, none the less. People often say that they remember, but yet do not know when whenever they do not know determinately the exact length of time.

It has been already stated that those who have a good memory are not identical with those who are quick at recollecting. But the act of recollecting differs from that of remembering, not only in respect of time, but also in this, that many also of the other animals have memory, but, of all that we are acquainted with, none, we venture to say, except man, shares in the faculty of recollection. The cause of this is that recollection is, as it were, a mode of inference. For he who endeavours to recollect infers that he formerly saw or heard, or had some such experience, and the process is, as it were, a sort of investigation. But to investigate in this way belongs naturally to those animals alone which are also endowed with the faculty of deliberation; for deliberation is a form of inference.

That the affection is corporeal, i.e. that recollection is a searching for an image in a corporeal substrate, is proved by the fact that some persons, when, despite the most strenuous application of thought, they have been unable to recollect, feel discomfort, which even though they abandon the effort at recollection, persists in them none the less; and especially persons of melancholic temperament. For these are most powerfully moved by images. The reason why the effort of recollection is not under the control of their will is that, as those who throw a stone cannot stop it at their will when thrown, so he who tries to recollect and hunts sets up a process in a material part, in which resides the affection. Those who have moisture around that part which is the centre of sense-perception suffer most discomfort of this kind. For when once the moisture has been set in motion it is not easily brought to rest, until the idea which was sought for has again presented itself, and thus the movement has found a straight course. For a similar reason bursts of anger or fits of terror, when once they have excited such motions, are not at once allayed, even though the angry or terrified persons set up counter motions, but the passions continue to move them on, in the same direction as at first. The affection resembles also that in the case of words, tunes, or sayings, whenever one of them has become inveterate on the lips. People give them up and resolve to avoid them; yet again and again they find themselves humming the forbidden air, or using the prohibited word.

Those whose upper parts are abnormally large, as is the case with dwarfs, have
453b1 abnormally weak memory, as compared with their opposites, because of the great weight which they have resting upon the organ of perception, and because their movements are, from the very first, not able to keep true to a course, but are dispersed, and because, in the effort at recollection, these movements do not easily find a direct onward path. Infants and very old persons have bad memories, owing to the amount of movement going on within them; for the latter are in process of rapid decay, the former in process of vigorous growth; and we may add that children, until considerably advanced in years, are dwarf-like. Such then is our theory as regards memory and remembering—their nature, and the particular organ of the soul by which animals remember; also as regards recollection, its definition, and the manner and causes of its performance.

ON SLEEP

J. I. Beare

1 · With regard to sleep and waking, we must consider what they are; whether they are peculiar to soul or to body, or common to both; and if common, to what part of soul or body they appertain; further, from what cause they are attributes of animals, and whether all animals share in them both, or some partake of the one only, others of the other only, or some partake of neither and some of both.

Further, we must also inquire what dreams are, and from what cause sleepers sometimes dream, and sometimes do not; or whether the truth is that sleepers always dream but do not always remember; and if this occurs, what its explanation is.

Again, we must inquire whether it is possible or not to foresee the future, and if it be possible, in what manner; further, whether it extends only to things to be accomplished by the agency of men, or to those also of which the cause lies in supra-human agency, and which result from the workings of nature, or of spontaneity.

First, then, this much is clear, that waking and sleep appertain to the same part of an animal, inasmuch as they are opposites, and sleep is evidently a privation of waking. For contraries, in natural as well as in all other matters, are seen always to present themselves in the same subject, and to be affections of the same: examples are—health and sickness, beauty and ugliness, strength and weakness, sight and blindness, hearing and deafness. This is also clear from the following consider- 454a1
ations. The criterion by which we know the waking person to be awake is identical with that by which we know the sleeper to be asleep; for we assume that one who is exercising sense-perception is awake, and that every one who is awake perceives either some external movement or else some movement within himself. If waking, then, consists in nothing else than the exercise of sense-perception, the inference is clear, that that in virtue of which animals perceive, is that by which they wake, when they are awake, or sleep, when they are asleep.

But since the exercise of sense-perception does not belong to soul or body exclusively, then (since the subject of actuality is identical with that of potentiality, and what is called sense-perception, as actuality, is a movement of the soul through the body) it is clear that it is not an affection of soul exclusively, and that a soulless body has not the potentiality of perception.

TEXT: W. D. Ross, *Aristotle: Parva Naturalia*, Clarendon Press, Oxford, 1955

Now, whereas we have already elsewhere distinguished what are called the parts of the soul, and whereas the nutritive is, in all living bodies, capable of existing without the other parts, while none of the others can exist without the nutritive; it is clear that sleep and waking are not affections of such living things as partake only of growth and decay, e.g. not of plants, because these have not the faculty of sense-perception, whether or not this be capable of separate existence; in potentiality, indeed, and in being it *is* separable.

Likewise it is clear that there is no animal which is always awake or always asleep, but that both these affections belong to the same animals. For if there be an animal not endued with sense-perception, it is impossible that this should either sleep or wake; since both these are affections of the activity of the primary faculty of sense-perception. But it is equally impossible also that either of these two affections should perpetually attach itself to the same animal, e.g. that some species of animal should be always asleep or always awake; for[1] all organs which have a natural function must lose power when they work beyond the time for which they can work; for instance, the eyes tire of seeing, and must give it up; and so it is with the hand and every other member which has a function. Now, if sense-perception is the function of something, this also, if it continues beyond the time for which it can perceive continuously, will lose its power and will do its work no longer. Accordingly, if the waking period is determined by this fact, that in it sense-perception is free; if in the case of some contraries one of the two must be present, while in the case of others this is not necessary; if waking is the contrary of sleeping, and one of these two must be present to every animal: it must follow that the state of sleeping is necessary. Finally, if such affection is sleep, and this is a state of powerlessness arising from excess of waking, and excess of waking is in its origin sometimes morbid, sometimes not, so that the powerlessness or dissolution of activity will be so or not; it is necessary that every creature which wakes must also be capable of sleeping, since it is impossible that it should always be actualizing its powers.

So, also, it is impossible for any animal to continue always sleeping. For sleep is an affection of the perceptive part—a sort of bond or motionlessness—so that every creature that sleeps must have a perceptive part. Now, that which is capable of sense-perception in actuality has the faculty of sense-perception; but to actualize this faculty, in the proper and unqualified sense, is impossible while one is asleep. All sleep, therefore, must be susceptible of awakening. Accordingly, almost all other animals are clearly observed to partake in sleep, whether they are aquatic, aerial, or terrestrial, since fishes of all kinds, and molluscs, as well as all others which have eyes, have been seen sleeping. Hard-eyed creatures and insects manifestly assume the posture of sleep; but the sleep of all such creatures is of brief duration, so that often it might well baffle one's observation to decide whether they sleep or not. Of testaceous animals no direct sensible evidence is as yet forthcoming to determine whether they sleep, but if the above reasoning be convincing to any one, he will be persuaded that they do.

That, therefore, all animals sleep may be gathered from these considerations.

[1]Reading ἐπεί (Susemihl) for ἔτι.

For an animal is defined as such by its possessing sense-perception; and we assert that sleep is, in a certain way, or, as it were, a motionlessness bond, imposed on sense-perception, while its loosening or remission constitutes the being awake. But no plant can partake in either of these affections; for without sense-perception there is neither sleeping nor waking. But creatures which have sense-perception have likewise the feeling of pain and pleasure, while those which have these have appetite as well; but plants have none of these affections. A mark of this is that the nutritive part does its own work better when the animal is asleep than when it is awake. Nutrition and growth are then especially promoted, a fact which implies that creatures do not need sense-perception to assist these processes.

2 · We must now proceed to inquire into the cause why one sleeps and wakes, and into the particular nature of the sense-perception, or sense-perceptions, if there be several, on which these affections depend. Since, then, some animals possess all the modes of sense-perception, and some not all, not, for example, sight, while all possess touch and taste, except such animals as are imperfectly developed, a class of which we have already treated in our work on the soul; and since an animal when asleep is unable to exercise, in the simple sense, any sensory faculty whatever, it follows that in the state called sleep the same affection must extend to all the senses; because, if it attaches itself to one of them but not to another, then an animal while asleep may perceive with the latter; but this is impossible.

Now, since every sense has something special and also something common; special, as, e.g., seeing is to the sense of sight, hearing to the auditory sense, and so on with the other senses severally; while all are accompanied by a common power, in virtue whereof a person perceives that he sees or hears (for, assuredly, it is not by *sight* that one sees that he sees; and it is not by taste, or sight, or both together that one discerns, and that sweet things are different from white things, but by a part common to all the organs of sense; for there is one sensory function, and the controlling sensory organ is one, though differing as a faculty of perception in relation to each genus, e. g., sound or colour); and since this subsists in association chiefly with the faculty of touch (for this can exist apart from all the other organs of sense, but none of them can exist apart from it—a subject of which we have treated in our speculations concerning the soul); it is therefore evident that waking and sleeping are an affection of this. This explains why they belong to all animals; for touch alone belongs to all.

For if sleeping were caused by the senses having all undergone some affection, it would be strange that these senses, for which it is neither necessary nor in a manner possible to be active simultaneously, should necessarily all go idle and become motionless simultaneously. For the contrary, viz. that they should not rest simultaneously, would have been more reasonably anticipated. But, according to the explanation just given, all is quite clear regarding those also. For, when the sense organ which controls all the others, and to which all the others are tributary, has been in some way affected, it is necessary that these others should be all affected at the same time, whereas, if one of these becomes powerless, there is no necessity for it to do so.

It is indeed evident from many considerations that sleep does not consist in the mere fact that the senses do not function or that one does not employ them, nor even in the inability to exercise the sense-perceptions; for such is what happens in cases of swooning. A swoon means just such impotence of perception, and certain other cases of unconsciousness also are of this nature. Moreover, persons who have the blood-vessels in the neck compressed become insensible. But sleep supervenes when such incapacity of exercise has neither arisen in some chance organ of sense, nor from some chance cause, but when, as has been just stated, it has its seat in the primary organ with which one perceives objects in general. For when this has become powerless all the other sensory organs also must lack power to perceive; but when one of them has become powerless, it is not necessary for this also to lose its power.

We must next state the cause to which sleep is due, and its quality as an affection. Now, since there are several types of cause (for we say that that for the sake of which, and that whence the origin of motion comes, and the matter, and the account, are all causes), in the first place, then, as we assert that nature operates for the sake of an end, and that this end is a good; and that to every creature which is endowed by nature with the power to move, but cannot with pleasure to itself move always and continuously, rest is necessary and beneficial; and since, taught by truth itself, men apply to sleep this metaphorical term, calling it a rest: we conclude that its end is the conservation of animals. But the waking state is the goal, since the exercise of sense-perception or of thought is the goal for all beings to which either of these appertains; inasmuch as these are best, and the goal is what is best. Again, sleep belongs of necessity to each animal. I use the term 'necessity' in its conditional sense, meaning that if an animal is to exist and have its own proper nature, it must have certain endowments; and, if these are to belong to it, certain others likewise must belong to it.

The next question to be discussed is that of the kind of movement or action, taking place within their bodies, from which the affection of waking or sleeping arises in animals. Now, we must assume that the causes of this affection in all other animals are identical with, or analogous to, those which operate in sanguineous animals; and that the causes operating in sanguineous animals generally are identical with those operating in man. Hence we must consider them all on this basis. Now, it has been determined already in another work that sense-perception in 456a1 animals originates in the same part in which movement originates. This is one of three determinate places, viz. that which lies midway between the head and the abdomen. This in sanguineous animals is the region of the heart; for all sanguineous animals have a heart; and from this it is that both motion and the controlling sense-perception originate. Now, as regards movement, it is obvious that the origin of breathing and of the cooling process generally takes its rise there; and it is with a view to the conservation of the heat in this part that nature has provided respiration and the process of being cooled by moisture. Of this *per se* we shall treat hereafter. In bloodless animals, and insects, and such as do not respire, the connatural spirit is seen puffed up and subsiding in the part which is in them analogous. This is clearly observable in the holoptera as wasps and bees; also in flies and such creatures. And since to move anything, or do anything, is impossible without strength, and holding the breath produces strength—in creatures which inhale, the holding of that breath which comes from without, but in creatures which do not respire, of that which is connatural (which explains why winged insects, when they move, are perceived to make a humming noise, due to the friction of the connatural spirit colliding with the diaphragm of the holoptera); and since every animal moves if some sense-perception, either internal or external, occurs in the primary organ of sense, accordingly if sleeping and waking are affections of this organ, the place in which and the organ in which sleep and waking originate, is evident.

Some persons move in their sleep, and perform many acts like waking acts, but not without an image or an exercise of sense-perception; for a dream is in a certain way a sense-impression. But of them we have to speak later on. Why it is that persons when aroused remember their dreams, but do not remember these acts, which are like waking acts, had been explained in the work on *Problems*.

3 · The point for consideration next in order to the preceding is:—What are the processes in which the affection of waking and sleeping originates, and whence do they arise? Now, since it is when it has sense-perception that an animal must first take food and receive growth, and in all cases food in its ultimate form is, in sanguineous animals, the natural substance blood, or, in bloodless animals, that which is analogous to this; and since the veins are the place of the blood, while the origin of these is the heart—this is clear from the dissections—it is manifest that, when the external nutriment enters the parts fitted for its reception, the exhalation enters into the veins, and there, undergoing a change, is converted into blood, and makes its way to their source. We have treated of all this when discussing the subject of nutrition, but must here recapitulate what was there said, in order that we may consider the beginnings of the process, and come to know what happens to the organ of sense-perception to account for the occurrence of waking and sleep. For sleep, as has been shown, is not any given impotence of the perceptive faculty; for unconsciousness, a certain form of asphyxia, and swooning, all produce such impotence. And some persons in a profound trance have still had the imaginative faculty in play. This last point, indeed, gives rise to a difficulty; for if it is possible that one who had swooned should fall asleep, the image might be a dream. Persons who have fallen into a deep trance, and have come to be regarded as dead, say many things while in this condition. The same view, however, is to be taken of all these cases.

As we observed above, sleep is not any impotence of the perceptive faculty, but this affection is one which arises from the exhalation attendant upon the process of nutrition. The matter exhaled must be driven onwards to a certain point, then turn back and change like a tide-race. Now, in every animal the hot naturally tends to move upwards, but when it has reached the parts above, it turns back again, and moves downwards in a mass. This explains why fits of drowsiness are especially apt to come on after meals; for the matter, both the liquid and the corporeal, which is borne upwards in a mass, is then of considerable quantity. When, therefore, this comes to a stand it weighs a person down and causes him to nod, but when it has actually sunk downwards, and by its return has repulsed the hot, sleep comes on, and the animal is presently asleep. A confirmation of this appears from considering the things which induce sleep; they all, whether potable or edible, for instance poppy, mandragora, wine, darnel, produce a heaviness in the head; and persons borne down and nodding all seem affected in this way, i. e. they are unable to lift up the head or the eye-lids. And it is after meals especially that sleep comes on like this, for the exhalation from the foods eaten is then copious. It also follows certain forms of fatigue; for fatigue operates as a solvent, and the dissolved matter acts, if not cold, like food prior to digestion. Moreover, some kinds of illness have this same effect; those arising from moist and hot secretions, as happens with fever-patients and in cases of lethargy. Extreme youth also has this effect; infants, for example, sleep a great deal, because of the food being all borne upwards—a mark whereof appears in the disproportionately large size of the upper parts compared with the lower during infancy, which is due to the fact that growth predominates in the direction of the former. Hence also they are subject to epileptic seizures; for sleep is like epilepsy, and, in a sense, actually is a seizure of this sort. Accordingly, the beginning of this malady takes place with many during sleep, and their subsequent habitual seizures occur in sleep, not in waking hours. For when the spirit moves upwards in a volume, on its return downwards it distends the veins, and forcibly compresses the passage through which respiration is effected. This explains why wines are not good for infants or for wet nurses (for it makes no difference, doubtless, whether the infants themselves, or their nurses, drink them), but such persons should drink them diluted with water and in small quantity. For wine is spirituous, and of all wines the dark more so than any other. The upper parts, in infants, are so filled with nutriment that within five months they do not even turn the neck; for in them, as in persons deeply intoxicated, there is ever a large quantity of moisture ascending. It is reasonable, too, to think that this affection is the cause of the embryo's remaining at rest in the womb at first. Also, as a general rule, persons whose veins are inconspicuous, as well as those who are dwarf-like, or have abnormally large heads, are addicted to sleep. For in the former the veins are narrow, so that it is not easy for the moisture to flow down through them; while in the case of dwarfs and those whose heads are abnormally large, the impetus of the exhalation upwards is excessive. Those whose veins are large are, thanks to the easy flow through the veins, not addicted to sleep, unless, indeed, they labour under some other affection which counteracts this. Nor are the 'atrabilious' addicted to sleep, for in them the inward region is cooled so that the quantity of exhalation in their case is not great. For this reason they have large appetites, though spare and lean; for their bodily condition is as if they derived no benefit from what they eat. The dark bile, too, being itself naturally cold, cools also the nutrient tract, and the other parts wheresoever such secretion is potentially present.

Hence it is plain from what has been said that sleep is a sort of concentration, or natural recoil, of the hot matter inwards, due to the cause above mentioned.

Hence restless movement is a marked feature in the case of a person when drowsy. But where it begins to fail, he grows cool, and owing to this cooling process his eye-lids droop. Accordingly the upper and outward parts are cool, but the inward and lower, i. e. the parts at the feet and in the interior of the body, are hot.

Yet one might found a difficulty on the facts that sleep is most oppressive in its onset after meals, and that wine, and other such things, though they possess heating properties, are productive of sleep, for it is not probable that sleep should be a process of cooling while the things that cause sleeping are themselves hot. Is the explanation of this, then, to be found in the fact that, as the stomach when empty is hot, while replenishment cools it by the movement it occasions, so the passages and tracts in the head are cooled as the exhalation ascends thither? Or, as those who have hot water poured on them feel a sudden shiver of cold, just so in the case before us, may it be that, when the hot substance ascends, the cold rallying to meet it cools them, deprives their native heat of all its power, and compels it to retire? Moreover, when much food is taken, which the hot substance carries upwards, this latter, like a fire when fresh logs are laid upon it, is itself cooled, until the food has been digested.

For, as has been observed elsewhere, sleep comes on when the corporeal element is conveyed upwards by the hot, along the veins, to the head. But when that which has been thus carried up can no longer ascend, but is too great in quantity it forces the hot back again and flows downwards. Hence it is that men sink down when the heat which tends to keep them erect (man alone, among animals, being naturally erect) is withdrawn; and this, when it befalls them, causes unconsciousness, and afterwards imagination.

Or are the solutions thus proposed possible accounts of the refrigeration which takes place, while, as a matter of fact, the region of the brain is, as stated elsewhere, the main determinant of the matter? For the brain, or in creatures without a brain that which corresponds to it, is of all parts of the body the coolest. Therefore, as moisture turned into vapour by the sun's heat is, when it has ascended to the upper regions, cooled by the coldness of the latter, and becoming condensed, is carried downwards, and turned into water once more; just so the waste exhalation, when carried up by the heat to the region of the brain, is condensed into phlegm (which explains why catarrhs are seen to proceed from the head); while that exhalation which is nutrient and not unwholesome, becoming condensed, descends and cools the hot. The tenuity or narrowness of the veins about the brain itself contributes to its being kept cool, and to its not readily admitting the exhalation. This, then, is a sufficient explanation of the cooling which takes place, despite the fact that the exhalation is exceedingly hot.

A person awakes from sleep when digestion is completed: when the heat, which had been previously forced together in large quantity within a small compass from out the surrounding part, has once more prevailed, and when a separation has been effected between the more corporeal and the purer blood. The finest and purest blood is that contained in the head, while the thickest and most turbid is that in the lower parts. The source of all the blood is, as has been stated both here and elsewhere, the heart. Now of the chambers in the heart the central communicates with each of the two others. Each of the latter again acts as receiver from each of the two veins, the one called the 'great' and the 'aorta'. It is in the central chamber that the separation takes place. To go into these matters in detail would, however, be more properly the business of a different treatise from the present. Owing to the fact that the blood formed after the assimilation of food is especially in need of separation, sleep occurs until the purer part of this blood has been separated off into the upper parts of the body, and the more turbid into the lower parts. When this has taken place animals awake from sleep, being released from the heaviness consequent on taking food.

We have now stated the cause of sleeping, viz., that it consists in the recoil by the corporeal element, borne upwards by the connatural heat, in a mass upon the primary sense-organ; we have also stated what sleep is, having shown that it is a seizure of the primary sense-organ, rendering it unable to actualize its powers; arising of necessity (for it is impossible for an animal to exist if the conditions which render it an animal be not fulfilled), i.e., for the sake of its conservation; since remission of movement tends to the conservation of animals.

ON DREAMS

J. I. Beare

1 · We must, in the next place, investigate the subject of the dream, and first inquire to which of the faculties of the soul it presents itself, i.e. whether the affection is one which pertains to the faculty of thought or to that of sense-perception; for these are the only faculties within us by which we acquire knowledge.

If, then, the exercise of the faculty of sight is seeing, that of the auditory faculty, hearing, and, in general that of the faculty of sense-perception, perceiving; and if there are some perceptions common to the senses, such as figure, magnitude, motion, &c., while there are others, as colour, sound, taste, which are special; and further, if all creatures, when the eyes are closed in sleep, are unable to see, and the analogous statement is true of the other senses, it is clear that we perceive nothing when asleep; we may conclude that it is not by sense-perception we perceive a dream.

But neither is it by opinion that we do so. For we not only assert, e.g., that some object approaching is a man or a horse, but that the object is white or beautiful, points on which opinion without sense-perception would say nothing either truly or falsely. It is, however, a fact that the soul makes such assertions in sleep. We seem to see equally well that the approaching figure is a man, and that it is white. Again, we think of something else, over and above the dream, just as we do in waking moments when we perceive something; for we often also reason about that which we perceive. So, too, in sleep we sometimes have thoughts other than the images. This would be manifest to any one who should attend and try, immediately on arising from sleep, to remember. There are cases of persons who have seen such dreams, those, for example, who believe themselves to be mentally arranging a given list of subjects according to the mnemonic rule. They frequently find themselves to be mentally putting into its place some other image apart from the dream. Hence it is plain that not every image in sleep is a dream, and that the thinking which we perform then is due to an exercise of the faculty of opinion.

So much at least is plain on all these points, viz. that the faculty by which, in waking hours, we are subject to illusion when affected by disease, is identical with that which produces illusory effects in sleep. So, even when persons are in excellent

TEXT: W. D. Ross, *Aristotle: Parva Naturalia*, Clarendon Press, Oxford, 1955

health, and know the facts of the case perfectly well, the sun, nevertheless, appears to them to be only a foot wide. Now, whether the imaginative faculty of the soul be identical with, or different from, the faculty of sense-perception, in either case the thing does not occur without our seeing or perceiving something. Even to see wrongly or to hear wrongly can happen only to one who sees or hears something real, though not exactly what he supposes. But we have assumed that in sleep one
459a1 neither sees, nor hears, nor exercises any sense whatever. Perhaps we may regard it as true that the dreamer sees nothing, yet as false that his faculty of sense-perception is unaffected, the fact being that the sense of seeing and the other senses may possibly be then in a certain way affected, while each of these affections, as when he is awake, gives its impulse in a certain manner to his faculty of sense, though not in the same manner as when he is awake. Sometimes, too, opinion says, just as to those who are awake, that it is false; at other times it is inhibited, and follows the image.

It is plain therefore that this affection, which we name dreaming, is no exercise of opinion or thought but yet is not an affection of the faculty of perception in the simple sense. If it were the latter it would be possible to hear and see in the simple sense.

How then, and in what manner, it takes place, is what we have to examine. Let us assume, what is indeed clear enough, that the affection pertains to sense-perception as surely as sleep itself does. For sleep does not pertain to one organ in animals and dreaming to another; both pertain to the same organ.

But since we have, in our work on the soul, treated of imagination, and the faculty of imagination is identical with that of sense-perception, though the being of a faculty of imagination is different from that of a faculty of sense-perception; and since imagination is the movement set up by a sensory faculty when actually discharging its function, while a dream appears to be an image (for which occurs in sleep—whether simply or in some particular way—is what we call a dream): it manifestly follows that dreaming is an activity of the faculty of sense-perception, but belongs to this faculty *qua* imaginative.

2 · We can best consider the nature of the dream and the manner in which it originates by regarding it in the light of the circumstances attending sleep. The objects of sense-perception corresponding to each sensory organ produce sense-perception in us, and the affection due to their operation is present in the organs of sense not only when the perceptions are actualized, but even when they have departed.

What happens in these cases may be compared with what happens in the case of projectiles moving in space. For in the case of these the movement continues even when that which set up the movement is no longer in contact. For that which set them in motion moved a certain portion of air, and this, in turn, being moved excites motion in another portion; and so it is in this way that the bodies, whether in air or in liquids, continue moving, until they come to a standstill.

459b1 This we must likewise assume to happen in the case of qualitative change; for that part which has been heated by something hot, heats the part next to it, and this propagates the affection onwards to the starting-point. This must therefore happen in sense-perception, since actual perceiving is a qualitative change. This explains why the affection continues in the sensory organs, both in their deeper and in their more superficial parts, not merely while they are actually engaged in perceiving, but even after they have ceased to do so. That they do this, indeed, is obvious in cases where we continue for some time engaged in a particular form of perception; for then, when we shift the scene of our perceptive activity, the previous affection remains; for instance, when we have turned our gaze from sunlight into darkness. For the result of this is that one sees nothing, owing to the motion excited by the light still subsisting in our eyes. Also, when we have looked for a long while at one colour, e.g. at white or green, that to which we next transfer our gaze appears to be of the same colour. Again if, after having looked at the sun or some other brilliant object, we close the eyes, then, if we watch carefully, it appears in a right line with the direction of vision (whatever this may be), at first its own colour; then it changes to crimson, next to purple, until it becomes black and disappears. And also when persons turn away from looking at objects in motion, e.g. rivers, and especially those which flow very rapidly, things really at rest are then seen as moving; and persons become deaf after hearing loud noises, and after smelling very strong odours their power of smelling is impaired; and similarly in other cases. These phenomena manifestly take place in the way above described.

That the sensory organs are acutely sensitive to even a slight qualitative difference is shown by what happens in the case of mirrors; a subject to which, even taking it independently, one might devote close consideration and inquiry. At the same time it becomes plain from them that as the eye is affected, so also it produces a certain effect. For in the case of very bright mirrors, when women during their menstrual periods look into the mirror, the surface of the mirror becomes a sort of bloodshot cloud; and if the mirror is new, it is not easy to wipe off such a stain, while if it is old it is easier. The cause is, as we said, that the eye is not only affected by the 460a1
air but also has an effect upon it and moves it—as bright objects do (for the eye is a bright object and has colour). Now it is reasonable that the eyes, like any other part whatsoever, should be affected during the menstrual period; for they are veined by nature. That is why, when the menstrual discharges occur because of a disturbance and bloody inflammation, the change in the eyes is not evident to us although it is present (for the nature of the discharges is the same as that of semen); and the air is moved by them, and has a certain effect on the air on the surface of the mirror which is continuous with it, i.e. it makes that air affected in the same way that it is itself; and the air on the mirror affects the surface of the mirror.

As in the case of clothes, the purest mirrors are most quickly stained; for a pure mirror shows accurately whatever it receives, and the purest shows the smallest movements. The bronze, because it is smooth, perceives best any touch at all (one should think of the touch of the air as a sort of rubbing—like a wiping or a washing), and because it is pure the touch, however slight it may be, becomes apparent in it. The reason why the stain does not leave new mirrors quickly is their purity and smoothness; for in their case it penetrates both in depth and all over—in depth because of their purity, all over because of their smoothness. The stain does not remain on old mirrors because it does not penetrate in the same way but more superficially.

It is plain from this that motion is set up even by small differences, and that perception is swift, and that the organ which perceives colour is not only affected but also has an effect in return. Further evidence to the same point is afforded by what takes place in wines, and in the manufacture of unguents. For both oil, when prepared, and wine become rapidly infected by the odours of the things near them; they not only acquire the odours of the things thrown into or mixed with them, but also those of the things which are placed, or which grow, near the vessels containing them.

460b1 In order to answer our original question, let us now, therefore, assume one proposition, which is clear from what precedes, viz. that even when the external object of perception has departed, the impressions it has made persist, and are themselves objects of perception; and let us assume, besides, that we are easily deceived respecting the operations of sense-perception when we are excited by emotions, and different persons according to their different emotions; for example, the coward when excited by fear, the amorous person by amorous desire; so that, with but little resemblance to go upon, the former thinks he sees his foes approaching, the latter, that he sees the object of his desire; and the more deeply one is under the influence of the emotion, the less similarity is required to give rise to these impressions. Thus, too, both in fits of anger, and also in all states of appetite, all men become easily deceived, and more so the more their emotions are excited. This is the reason too why persons in the delirium of fever sometimes think they see animals on their chamber walls because of the faint resemblance to animals of the markings thereon when put together in patterns; and this sometimes corresponds with the emotional states of the sufferers, in such a way that, if the latter be not very ill, they know well enough that it is an illusion; but if the illness is more severe they actually move according to the appearances. The cause of these occurrences is that the faculty in virtue of which the controlling sense judges is not identical with that in virtue of which images come before the mind. A proof of this is, that the sun presents itself as only a foot in diameter, though often something else gainsays the imagination. Again, when the fingers are crossed, one object seems to be two; but yet we deny that it is two; for sight is more authoritative than touch. Yet, if touch stood alone, we should actually have pronounced the one object to be two. The ground of such false judgments is that any appearances whatever present themselves, not only when its object moves a sense, but also when the sense by itself alone is moved, provided only it be moved in the same manner as it is by the object. For example, to persons sailing past the land seems to move, when it is really the eye that is being moved by something else.

3 · From this it is manifest that the movements based upon sensory impressions, whether the latter are derived from external objects or from causes

within the body, not only when persons are awake, but also occur when this affection which is called sleep has come upon them, and at that time they appear more. For by day, while the senses and the intellect are working, they are extruded and obscured, just as a smaller is beside a larger fire, or as small beside great pains or pleasures, though, as soon as the latter have ceased, even those which are trifling emerge into notice. But by night owing to the inaction of senses, and their powerlessness to realize themselves, which arises from the reflux of the hot from the exterior parts to the interior, they are borne down to the source of sense-perception, and there display themselves as the disturbance subsides. We must suppose that, like the little eddies which are formed in rivers, so the movements are each a continuous process, often remaining like what they were when first started, but often, too, broken into other forms by collisions with obstacles. This gives the reason why no dreams occur in sleep after meals, or to sleepers who are extremely young, e.g., to infants. The movement in such cases is excessive, owing to the heat generated from the food. Hence, just as in a liquid, if one vehemently disturbs it, sometimes no reflected image appears, while at other times one appears, indeed, but utterly distorted, so as to seem quite unlike its original; while, when once the motion has ceased, the reflected images are clear and plain; in the same manner during sleep the images, or residuary movements, which are based upon the sensory impressions, become sometimes quite obliterated by the above described motion when too violent; while at other times the sights are indeed seen, but confused and weird, and the dreams are incoherent, like those of persons who are atrabilious, or feverish, or intoxicated with wine. For all such affections, being spirituous, cause much commotion and disturbance. In sanguineous animals, in proportion as the blood becomes calm and separated the fact that the movement, based on impressions derived from each of the organs of sense, is preserved in its integrity, renders the dreams coherent, causes an image to present itself, and makes the dreamer think, owing to the effects borne in from the organ of sight, that he actually sees, and owing to those which come from the organ of hearing, that he really hears; and so on with those also which proceed from the other sensory organs. For it is owing to the fact that the movement which reaches the source of sense comes from them, that one even when awake believes himself to see, or hear, or otherwise perceive; just as it is from a belief that the organ of sight is being stimulated, though in reality not so stimulated, that we sometimes declare ourselves to see, or that, from the fact that touch announces two movements, we think that the one object is two. For, as a rule, the governing sense affirms the report of each particular sense, unless another particular sense, more authoritative, makes a contradictory report. In every case an appearance presents itself, but what appears does not in every case seem real, unless when the deciding faculty is inhibited, or does not move with its proper motion. Moreover, as we said that different men are subject to illusions, each according to the different emotion present in him, so it is that the sleeper, owing to sleep, and to the movements then going on in his sensory organs, as well as to the other facts of the sensory process, is liable to illusion, so that what has little similarity to something appears to be the thing itself. For when one is asleep, in proportion as most of the blood sinks inwards, so the internal movements, some potential, others actual, accompany it inwards. They are so related that, if anything move the blood, some one sensory movement will emerge from it, while if this perishes another will take its place; while to one another also they are related in the same way as the artificial frogs in water which rise to the surface as the salt becomes dissolved. The residuary movements are like these: they are within the soul potentially, but actualize themselves only when the impediment to their doing so has been relaxed; and according as they are thus set free, they begin to move in the blood which remains in the sensory organs, and which is now but scanty, and take on likenesses after the manner of cloud-shapes, which in their rapid metamorphoses one compares now to human beings and a moment afterwards to centaurs. Each of them is however, as has been said, the remnant of a sensory impression taken when sense was actualizing itself; and when this, the true impression, has departed, its remnant is still there, and it is correct to say of it, that though not actually Coriscus, it is like Coriscus. When the person was actually perceiving, his controlling and judging sensory faculty did not call it Coriscus, but, prompted by this, called the genuine person yonder Coriscus. Accordingly, that which, when actually perceiving, says this (unless completely inhibited by the blood), now, as though it were perceiving, is moved by the movements persisting in the sense-organs, and that which is like the thing seems to it to be the thing itself; and the effect of sleep is so great that it causes this mistake to pass unnoticed. Accordingly, just as if a finger be pressed under the eyeball without being observed, one object will not only present two visual images, but will create an opinion of its being two objects; while if it be observed, the presentation will be the same, but the same opinion will not be formed of it; exactly so it is in states of sleep: if the sleeper perceives that he is asleep, and is conscious of the sleeping state during which the perception comes before his mind, it presents itself still, but something within him speaks to this effect: 'the image of Coriscus presents itself, but the real Coriscus is not present'; for often, when one is asleep, there is something in the soul which declares that what then presents itself is but a dream. If, however, he is not aware of being asleep, there is nothing which will contradict the testimony of the bare presentation.

That what we here urge is true, i.e. that there are such imaginative movements in the sensory organs, any one may convince himself, if he attends to and tries to remember the affections we experience when sinking into slumber or when being awakened. He will sometimes, in the moment of awakening, surprise the images which present themselves to him in sleep, and find that they are really but movements lurking in the organs of sense. And indeed some very young persons, if it is dark, though looking with wide open eyes, see multitudes of phantom figures moving before them, so that they often cover up their heads in terror.

From all this, then, the conclusion to be drawn is, that the dream is a sort of image and, more particularly, one which occurs in sleep; since the phantoms just mentioned are not dreams, nor is any other dream which presents itself when the sense-perceptions are in a state of freedom. Nor is every image which occurs in sleep necessarily a dream. For in the first place, some persons actually, in a certain way, perceive sounds, light, savour, and contact; feebly, however, and, as it were, remotely. For there have been cases in which persons while asleep, but with the eyes partly open, saw faintly in their sleep (as they supposed) the light of a lamp, and afterwards, on being awakened, recognized it at once as the actual light of the lamp; while, in other cases, persons who faintly heard the crowing of cocks or the barking of dogs identified these clearly as soon as they awoke. Some persons, too, return answers to questions put to them in sleep. For it is quite possible that, of waking or sleeping, while the one is present in the ordinary sense, the other also should be present in a certain way. But none of these occurrences should be called a dream. Nor should the true thoughts, as distinct from the images, which occur in sleep. The dream proper is an image based on the movement of sense impressions, when it occurs during sleep, insofar as it is asleep.

There are cases of persons who in their whole lives have never had a dream, while others dream when considerably advanced in years, having never dreamed before. The cause of their not having dreams appears somewhat like that which operates in the case of infants, and after meals. It is intelligible enough that no dream-image should occur to persons whose natural constitution is such that in them copious exhalation is borne upwards, which, when borne back downwards, causes a large quantity of motion. But it is not surprising that, as age advances, a dream should at length appear to them. For, when a change has occurred in them in proportion to age or emotional experience, this reversal must occur also.

ON DIVINATION IN SLEEP

J. I. Beare

1 · As to the divination which takes place in sleep, and is said to be based on dreams, we cannot lightly either dismiss it with contempt or give it confidence. The fact that all persons, or many, suppose dreams to possess a special significance, tends to inspire us with belief in it, as founded on the testimony of experience; and indeed that divination in dreams should, as regards some subjects, be genuine, is not incredible, for it has a show of reason; from which one might form a like opinion also respecting all other dreams. Yet the fact of our seeing no reasonable cause to account for such divination tends to inspire us with distrust. For, in addition to its further unreasonableness, it is absurd to combine the idea that the sender of such dreams should be God with the fact that those to whom he sends them are not the best and wisest, but merely people at random. If, however, we abstract from the causality of God, none of the other causes assigned appears reasonable. For that certain persons should have foresight in dreams concerning things destined to take place at the Pillars of Hercules, or on the banks of the Borysthenes, seems to be something to discover the explanation of which surpasses the wit of man. Well then, the dreams in question must be regarded either as causes, or as signs, of the events, or else as coincidences; either as all, or some, of these, or as one only. I use the word 'cause' in the sense in which the moon is the cause of an eclipse of the sun, or in which fatigue is a 'sign' of fever; in the sense in which the entrance of a star into the shadow is a sign of the eclipse, or roughness of the tongue of fever; while by 'coincidence' I mean, for example, the occurrence of an eclipse of the sun while
463a1 some one is taking a walk; for the walking is neither a sign nor a cause of the eclipse, nor the eclipse of the walking. For this reason no coincidence takes place according to a universal or general rule. Are we then to say that some dreams are causes, others signs, e.g. of events taking place in the bodily organism? At all events, even scientific physicians tell us that one should pay diligent attention to dreams, and to hold this view is reasonable also for those who are not practitioners, but speculative philosophers. For the movements which occur in the daytime are, unless very great and violent, lost sight of in contrast with the waking movements, which are more impressive. In sleep the opposite takes place, for then even trifling movements seem considerable. This is plain in what often happens during sleep; for example,

TEXT: W. D. Ross, *Aristotle: Parva Naturalia*, Clarendon Press, Oxford, 1955

dreamers fancy that they are affected by thunder and lightning, when in fact there are only faint ringings in their ears; or that they are enjoying honey or other sweet savours, when only a tiny drop of phlegm is flowing down; or that they are walking through fire, and feeling intense heat, when there is only a slight warmth affecting certain parts of the body. When they are awakened, these things appear to them in this their true character. But since the beginnings of all events are small, so, it is clear, are those also of the diseases or other affections about to occur in our bodies. In conclusion, it is manifest that these beginnings must be more evident in sleeping than in waking moments.

Indeed, it is not unreasonable that some of the images which come before the mind in sleep may even be causes of the actions cognate to each of them. For as when we are about to act, or are engaged in any course of action, or have already performed certain actions, we often find ourselves concerned with these actions, or performing them, in a vivid dream; and the cause of this is that the dream-movement has had a way paved for it from the original movements set up in the daytime; exactly so, but conversely, it must often happen that the movements set up first in sleep should also prove to be starting-points of actions to be performed in the daytime, since the recurrence by day of the thought of these actions also has had its way paved for it in the images before the mind at night. Thus then it is quite conceivable that some dreams may be signs and causes.

Most dreams are, however, to be classed as mere coincidences, especially all such as are extravagant, and those in the fulfilment of which the dreamers have no initiative, such as in the case of a sea-fight, or of things taking place far away. As regards these it is natural that the fact should stand as it does whenever a person, on mentioning something, finds the very thing mentioned come to pass. Why, indeed, should this not happen also in sleep? The probability is, rather, that many such things should happen. As, then, one's remembering a particular person is neither sign nor cause of this person's presenting himself, so, in the parallel instance, the dream is, to him who has seen it, neither sign nor cause of its fulfilment, but a mere coincidence. Hence the fact that many dreams have no fulfilment, for coincidences do not occur according to any universal or general law.

2 · On the whole, forasmuch as certain of the other animals also dream, it may be concluded that dreams are not sent by God, nor are they designed for this purpose. They have a mysterious aspect, however, for nature is mysterious, though not divine. A sign is this: the power of foreseeing the future and of having vivid dreams is found in persons of inferior type, which implies that God does not send their dreams; but merely that all those whose physical temperament is, as it were, garrulous and melancholic, see sights of all descriptions; for, inasmuch as they experience many movements of every kind, they just chance to have visions resembling objective facts, their luck in these matters being merely like that of persons who play at dice. For the principle which is expressed in the gambler's maxim: 'If you make many throws your luck must change,' holds good in their case also.

That many dreams have no fulfilment is not strange, for it is so too with many bodily symptoms and weather-signs, e.g., those of rain or wind. For if another movement occurs more influential than that from which, while the event still future, the given sign was derived, the event does not take place. So, of the things which ought to be accomplished by human agency, many, though well-planned, are by the operation of other principles more powerful brought to nought. For, speaking generally, that which was going to happen is not in every case what now is happening; nor is that which will in fact happen identical with that which is going to happen. Still, however, we must hold that the beginnings from which, as we said, no consummation follows, are indeed beginnings, and these constitute natural signs of certain events, even though the events do not come to pass.

As for dreams which involve not such beginnings as we have here described, but such as are extravagant in times, or places, or magnitudes; or those involving beginnings which are not extravagant in any of these respects, while yet the persons who see the dream do not have matters in their own hands: unless the foresight which such dreams give is the result of pure coincidence, the following would be a better explanation of it than that proposed by Democritus, who alleges phantoms and emanations as its cause. As, when something has caused motion in water or air, this moves another and, though the cause has ceased to operate, such motion propagates itself to a certain point, though there the prime mover is not present; just so it may well be that a movement and a consequent sense-perception should reach sleeping souls from the objects from which Democritus represents emanations as coming; that such movements, in whatever way they arrive, should be more perceptible at night, because when proceeding thus in the daytime they are more liable to dissolution (since at night the air is less disturbed, there being then less wind); and that they shall be perceived within the body owing to sleep, since persons are more sensitive even to slight internal movements when asleep than when awake. It is these movements then that cause images, as a result of which sleepers foresee the future even relatively to such events as those referred to above. These considerations also explain why this experience befalls people at random and not the most intelligent. For it would have regularly occurred both in the daytime and to the wise had it been God who sent it; but, as we have explained the matter, it is quite natural that random persons should be those who have foresight. For the mind of such persons is not given to thinking, but, as it were, derelict, or totally vacant, and, when once set moving, is borne passively on in the direction taken by that which moves it. With regard to the fact that some persons who are liable to derangement have this foresight, its explanation is that their normal mental movements do not impede the alien movements, but are beaten off by them. That is why they have an especially keen perception of the alien movements.

That certain persons in particular should have vivid dreams, e.g. that familiar friends should thus have foresight in a special degree respecting one another, is due to the fact that such friends are most solicitous on one another's behalf. For as acquaintances are quick to recognize and perceive one another a long way off, so also they do as regards the sensory movements respecting one another; for sensory movements which refer to persons familiarly known are themselves more familiar.

Atrabilious persons, owing to their impetuosity, are, when they, as it were, shoot from a distance, expert at hitting; while, owing to their mutability, the series of movements deploys quickly before their minds. For as even the insane recite the 464b1 poems of Philaenis, so what they say and think is connected by mere similarity—e.g. 'Aphrodite, phrodite'—and thus they go on stringing things together. Moreover, owing to their impetuosity, one movement within them is not liable to be knocked out of its course by some other movement.

The most skilful interpreter of dreams is he who has the faculty of observing resemblances. Any one may interpret dreams which are vivid and plain. But, speaking of resemblances, I mean that dream images are analogous to the forms reflected in water, as indeed we have already stated. In the latter case, if the motion in the water be great, the reflexion has no resemblance to its original, nor do the forms resemble the real objects. Skilful, indeed, would he be in interpreting such reflexions who could rapidly discern, and at a glance comprehend, the scattered and distorted fragments of such forms, so as to perceive that one of them represents a man, or a horse, or anything whatever—similarly, then, in the case of seeing what this dream means; for the internal movement effaces the clearness of the dream.

The questions, therefore, which we proposed as to the nature of sleep and the dream, and the cause to which each of them is due, and also as to divination as a result of dreams, in every form of it, have now been discussed.

ON LENGTH AND SHORTNESS OF LIFE

G. R. T. Ross

1 · The reasons for some animals being long-lived and others short-lived, and, in a word, the causes of the length and brevity of life call for investigation.

The necessary beginning to our inquiry is a statement of the difficulties about these points. For it is not clear whether in animals and plants universally it is a single or diverse cause that makes some to be long-lived, others short-lived. Plants too have in some cases a long life, while in others it lasts but for a year.

Further, in a natural structure are longevity and a sound constitution coincident, or is shortness of life independent of unhealthiness? Perhaps in the case of certain maladies a diseased state of the body and shortness of life are interchangeable, while in the case of others ill-health is perfectly compatible with long life.

Of sleep and waking we have already treated; about life and death we shall speak later on, and likewise about health and disease, in so far as it belongs to the science of nature to do so. But at present we have to investigate the causes of some creatures being long-lived, others short-lived as we have said before. We find this distinction affecting not only entire genera opposed as wholes to one another, but applying also to contrasted sets of individuals within the same species. As an instance of the difference applying to the genus I give man and horse (for mankind has a longer life than the horse), while within the species there is the difference between man and man; for of men also some are long-lived, others short-lived, differing from each other in respect of the different regions in which they dwell. Races inhabiting warm countries have longer life, those living in a cold climate live a shorter time. Likewise there are similar differences among individuals occupying the same locality.

2 · We must answer the question, What is that which, in natural objects, makes them easily destroyed, or the reverse? Since fire and water, and whatsoever is akin thereto, do not possess identical powers they are reciprocal causes of generation and decay. Hence it is natural to infer that everything else arising from them and composed of them should share in the same nature, in all cases where

TEXT: W. D. Ross, *Aristotle: Parva Naturalia*, Clarendon Press, Oxford, 1955

things are not, like a house, a composite unity formed by the synthesis of many things.

In other matters a different account must be given; for in many things their mode of dissolution is something peculiar to themselves, e.g. in knowledge and ignorance, health and disease. These pass away even though the medium in which they are found is not destroyed but continues to exist; for example, take the termination of ignorance, which is recollection or learning, while knowledge passes away into forgetfulness, or error. But accidentally the disintegration of a natural object is accompanied by the destruction of the other things; for, when the animal dies, the health or knowledge resident in it passes away too. Hence from these considerations we may draw a conclusion about the soul too; for, if the inherence of soul in body is not a matter of nature but like that of knowledge in the soul, there would be another mode of dissolution pertaining to it besides that which occurs when the body is destroyed. But since evidently it does not admit of this dual dissolution, the soul must stand in a different case in respect of its union with the body.

3 · Perhaps one might reasonably raise the question whether there is any place where what is corruptible becomes incorruptible, as fire does in the upper regions where it meets with no opposite. Opposites destroy each other, and hence accidentally, by their destruction, whatsoever is attributed to them is destroyed. But no opposite in a real substance is accidentally destroyed, because real substance is not predicated of any subject. Hence a thing which has no opposite, or which is situated where it has no opposite, cannot be destroyed. For what will that be which can destroy it, if destruction comes only through contraries, but no contrary to it exists either absolutely or in the particular place where it is? But perhaps this is in one sense true, in another sense not true, for it is impossible that anything containing matter should not have in any sense an opposite. Heat and straightness can be present in every part of a thing, but it is impossible that the thing should be nothing but hot or white or straight; for, if that were so, attributes would have a separate existence. Hence if, in all cases, whenever the active and the passive exist together, the one acts and the other is acted on, it is impossible that no change should occur. Further, this is so if a waste product is an opposite, and waste must always be produced; for opposition is always the source of change, and waste is what remains of the previous opposite. But, after expelling everything of a nature actually opposed, an object would in this case also be imperishable. Or would it be destroyed by the environment?

If then that is so, what we have said sufficiently accounts for the change; but, if not, we must assume that something of actually opposite character is in the changing object, and waste is produced.

Hence accidentally a lesser flame is consumed by a greater one, for the nutriment, to wit the smoke, which the former takes a long period to expend, is used up by the big flame quickly.[1]

[1] Ross excises this paragraph.

Hence all things are at all times in a state of transition and are coming into being or passing away. The environment acts on them either favourably or antagonistically, and, owing to this, things that change their situation become more or less enduring than their nature warrants, but never are they eternal when they contain contrary qualities; for their matter is an immediate source of contrariety, so that if it involves locality they show change of situation, if quantity, increase and diminution, while if it involves qualitative affection we find alteration of character.

466a1 4 · We find that a superior immunity from decay attaches neither to the largest animals (the horse has shorter life than man) nor to those that are small (for many insects live but for a year). Nor are plants as a whole less liable to perish than animals (many plants are annuals), nor have sanguineous animals the pre-eminence (for the bee is longer-lived than certain sanguineous animals). Neither is it the bloodless animals that live longest (for molluscs live only a year, though bloodless), nor terrestrial organisms (there are both plants and terrestrial animals of which a single year is the period), nor the occupants of the sea (for there we find the crustaceans and the molluscs, which are short-lived).

Speaking generally, the longest-lived things occur among the plants, e.g. the date-palm. Next in order we find them among the sanguineous animals rather than among the bloodless, and among land animals rather than among water animals. Hence, taking these two characters together, the longest-lived animals fall among sanguineous land animals, e.g. man and elephant. As a matter of fact also it is a general rule that the larger live longer than the smaller, for the other long-lived animals too happen to be of a large size, as are also those I have mentioned.

5 · The following considerations may enable us to understand the reasons for all these facts. We must remember that an animal is by nature humid and warm, and to live is to be of such a constitution, while old age is dry and cold, and so is a corpse. This is plain to observation. But the material constituting the bodies of all animals consists of the following—the hot and the cold, the dry and the moist. Hence when they age they must become dry, and therefore the fluid in them requires to be not easily dried up. Thus we explain why fat things are not liable to decay. The reason is that they contain air; now air relatively to the other elements is fire, and fire never becomes rotten.

Again the humid element in animals must not be small in quantity, for a small quantity is easily dried up. This is why both plants and animals that are large are, as a general rule, longer-lived than the rest, as was said before; it is to be expected that the larger should contain more moisture. But it is not merely this that makes them longer lived; for the cause is twofold, to wit, the quality as well as the quantity of the fluid. Hence the moisture must be not only great in amount but also warm, in order to be neither easily congealed nor easily dried up.

It is for this reason also that man lives longer than some animals which are larger; for animals live longer though there is a deficiency in the amount of their

moisture, if the ratio of its qualitative superiority exceeds that of its quantitative 466b1
deficiency.

In some creatures the warm element is their fatty substance, which prevents at once desiccation and cooling; but in others it assumes a different flavour. Further, that which is designed to be not easily destroyed should not yield waste products. Anything of such a nature causes death either by disease or naturally, for the potency of the waste product works adversely and destroys now the entire constitution, now a particular member.

This is why animals that copulate frequently and those abounding in seed age quickly; the seed is a residue, and further, by being lost, it produces dryness. Hence the mule lives longer than either the horse or the ass from which it sprang, and females live longer than males if the males copulate frequently. Accordingly cock-sparrows have a shorter life than the females. Again males subject to great toil are short-lived and age more quickly owing to the labour; toil produces dryness and old age is dry. But by natural constitution and as a general rule males live longer than females, and the reason is that the male is an animal with more warmth than the female.

The same kind of animals are longer-lived in warm than in cold climates for the same reason as they are of larger size. The size of animals of cold constitution illustrates this particularly well, and hence snakes and lizards and scaly reptiles are of great size in warm localities, as also are testacea in the Red Sea: the warm humidity there is the cause equally of their augmented size and of their life. But in cold countries the humidity in animals is more of a watery nature, and hence is readily congealed. Consequently it happens that animals with little or no blood are in northerly regions either entirely absent (both land and water animals) or, when they do occur, they are smaller and have shorter life; for the frost prevents growth.

Both plants and animals perish if not fed, for in that case they consume themselves; just as a large flame consumes and burns up a small one by using up its nutriment, so the natural warmth which is the primary cause of digestion consumes the material in which it is located.

Water animals have a shorter life than terrestrial creatures, not strictly
because they are humid, but because they are watery, and watery moisture is easily 467a1
destroyed, since it is cold and readily congealed. For the same reason bloodless animals perish readily unless protected by great size, for there is neither fatness nor sweetness about them. In animals fat is sweet, and hence bees are longer-lived than other animals of larger size.

6 · It is amongst the plants that we find the longest life—more than among the animals, for, in the first place, they are less watery and hence less easily frozen. Further they have an oiliness and a viscosity which makes them retain their moisture in a form not easily dried up, even though they are dry and earthy.

But we must discover the reason why trees are of an enduring constitution, for it is peculiar to them and is not found in any animals except the insects.

Plants continually renew themselves and hence last for a long time. New shoots continually come and the others grow old, and with the roots the same thing happens. But both processes do not occur together. Rather it happens that at one time the trunk and the branches alone die and new ones grow up beside them, and it is only when this has taken place that the fresh roots spring from the surviving part. Thus it continues, one part dying and the other growing, and hence also it lives a long time.

There is a similarity, as has been already said, between plants and insects, for they live, though divided, and two or more may be derived from a single one. Insects, however, though managing to live, are not able to do so long, for they do not possess organs; nor can the principle resident in each of the separated parts create organs. In the case of a plant, however, it can do so; every part of a plant contains potentially both root and stem. Hence it is from this source that issues that continued growth when one part is renewed and the other grows old; it is practically a case of longevity. The taking of cuttings furnishes a similar instance; for we might say that, in a way, when we take a cutting the same thing happens; the shoot cut off is part of the plant. Thus in taking cuttings this perpetuation of life occurs though their connexion with the plant is severed, but in the former case it is the continuity that is operative. The reason is that the life principle potentially belonging to them is present in every part.

Identical phenomena are found both in plants and in animals. For in animals the males are, in general, the longer-lived. They have their upper parts larger than the lower (the male is more of the dwarf type of build than the female), and it is in the upper part that warmth resides, in the lower cold. In plants also those with great heads are longer-lived, and such are those that are not annual but of the tree-type, for the roots are the head and upper part of a plant, and among the annuals growth occurs in the direction of their lower parts and the fruit.

These matters however will be specially investigated in the work *On Plants.* But this is our account of the reasons for the duration of life and for short life in animals. It remains for us to discuss youth and age, and life and death. To come to a definite understanding about these matters would complete our course of study on animals.

ON YOUTH, OLD AGE, LIFE AND DEATH, AND RESPIRATION

G. R. T. Ross

1 · We must now treat of youth and old age and life and death. We must probably also at the same time state the causes of respiration as well, since in some cases living and the reverse depend on this.

We have elsewhere given an account of the soul, and while it is clear that its substance cannot be corporeal, yet manifestly it must exist in some bodily part which must be one of those possessing control over the members. Let us for the present set aside the other parts or faculties of the soul (whichever of the two be the correct name). But as to being what is called an animal and a living thing, we find that in all beings endowed with both characteristics (viz. being an animal and being alive) there must be a single identical part in virtue of which they live and are called animals; for an animal *qua* animal cannot avoid being alive. But a thing need not, though alive, be animal; for plants live without having sensation, and it is by sensation that we distinguish animal from what is not animal.

This part, then, must be one and the same in number and yet multiple and disparate in being; for being animal and living are not identical. Since then the organs of special sensation have one common organ in which the senses when functioning must meet, and this must be situated midway between what is called before and behind (we call 'before' the direction from which sensation comes, 'behind' the opposite), further, since in all living things the body is divided into upper and lower (they all have upper and lower parts, so that this is true of plants as well), clearly the nutritive principle must be situated midway between these regions. That part where food enters we call upper, considering it by itself and not relatively to the surrounding universe, while downward is that part by which the primary excrement is discharged.

Plants are the reverse of animals in this respect. To man in particular among the animals, on account of his erect stature, belongs the characteristic of having his

TEXT: W. D. Ross, *Aristotle: Parva Naturalia*, Clarendon Press, Oxford, 1955

upper parts pointing upwards in the sense in which that applies to the universe, while in the others these are in an intermediate position. But in plants, owing to their being stationary and drawing their sustenance from the ground, the upper part must always be down; for there is a correspondence between the roots in a plant and what is called the mouth in animals, by means of which they take in their food, some from the earth, some by their own efforts.

2 · All perfectly formed animals are to be divided into three parts, one that by which food is taken in, one that by which excrement is discharged, and the third the region intermediate between them. In the largest animals this latter is called the chest and in the others something corresponding; in some also it is more distinctly marked off than in others. All those also that are capable of progression have additional members subservient to this purpose, by means of which they bear the whole trunk, to wit legs and feet and whatever parts are possessed of the same powers. Now it is evident both by observation and by inference that the source of the nutritive soul is in the middle of the three parts. For many animals, when either part—the head or the receptacle of the food—is cut off, retain life in that member to which the middle remains attached. This can be seen to occur in many insects, e.g. wasps and bees, and many animals also besides insects can, though divided, continue to live by means of the part connected with nutrition.

While this member is indeed in actuality single, yet potentially it is multiple, for these animals have a constitution similar to that of plants; plants when cut into sections continue to live, and a number of trees can be derived from one single source. A separate account will be given of the reason why some plants cannot live when divided, while others can be propagated by the taking of cuttings. In this
468b1 respect, however, plants and insects are alike.

It is true that the nutritive soul, in beings possessing it, while actually single must be potentially plural. And so it is too with the principle of sensation, for evidently the divided segments of these animals have sensation. They are unable, however, to preserve their constitution, as plants can, not possessing the organs on which the continuance of life depends; for some lack the means for seizing, others for receiving their food, and some lack both of these and others too.

Divisible animals are like a number of animals grown together, but animals of superior construction behave differently because their constitution is a unity of the highest possible kind. Hence some of the organs on division display slight sensitiveness because they retain some psychical susceptibility; the animals continue to move after the vitals have been abstracted: tortoises, for example, do so even after the heart has been removed.

3 · The same phenomenon is evident both in plants and in animals, and in plants we note it both in their propagation by seed and in grafts and cuttings. Genesis from seeds always starts from the middle. All seeds are bivalvular, and it is from the meeting-place and mid-point of the two parts that both root and stem of

growing things emerge; the starting-point is in a central position between them. In the case of grafts and cuttings this is particularly true of the buds; for the bud is in a way the starting-point of the branch, but at the same time it is in a central position. Hence it is either this that is cut off, or into this that the new shoot is inserted, when we wish either a new branch or a new root to spring from it; which proves that the point of origin in growth is intermediate between stem and root.

Likewise in sanguineous animals the heart is the first organ developed; this is evident from what has been observed in those cases where observation of their growth is possible. Hence in bloodless animals also what corresponds to the heart must develop first. We have already asserted in our treatise on the parts of animals that it is from the heart that the veins issue, and that in sanguineous animals the blood is the final nutriment from which the members are formed. Hence it is clear that there is one function in nutrition which the mouth has the faculty of performing, and a different one appertaining to the stomach. But it is the heart that has supreme control, exercising an additional and completing function. Hence in sanguineous animals the source both of the sensitive and the nutritive soul must be in the heart, for the functions relative to nutrition exercised by the other parts are ancillary to the activity of the heart. It is the part of the dominating organ to achieve the final result, as of the physician's efforts to be directed towards health, and not to be occupied with subordinate offices.

Certainly, however, all sanguineous animals have the supreme organ of the sense-faculties in the heart, for it is here that we must look for the common sensorium belonging to all the sense-organs. These in two cases, taste and touch, can be clearly seen to extend to the heart, and hence the others also must lead to it, for in it the other organs may possibly initiate changes, whereas with the upper region of the body taste and touch have no connexion. Apart from these considerations, if the life is always located in this part, evidently the principle of sensation must be situated there too, for it is *qua* animal that a body is said to be a living thing, and it is called animal because endowed with sensation. Elsewhere in other works we have stated the reasons why some of the sense-organs are, as is evident, connected with the heart, while others are situated in the head. (It is this fact that causes some people to think that it is in virtue of the brain that the function of perception belongs to animals.)

4 · Thus if, on the one hand, we look to the observed facts, what we have said makes it clear that the source of the sensitive soul, together with that connected with growth and nutrition, is situated in this organ and in the central one of the three divisions of the body. But it follows by reason also; for we see that in every case, when several paths are open, Nature always chooses the best. Now if both principles are located in the midst of the substance, the two parts of the body, viz. that which elaborates and that which receives the nutriment in its final form will best perform their appropriate function; for the soul will then be close to each, and the central situation which it will, as such, occupy the position of a dominating power.

Further, that which employs an instrument and the instrument it employs must be distinct both in capacity and, if possible, in location, just as the flute and that which plays it—the hand—are diverse. Thus if animal is defined by the possession of sensitive soul, this principle must in the sanguineous animals be in the heart, and, in the bloodless ones, in the corresponding part of their body. But in animals all the members and the whole body possess some connate natural heat, and hence when alive they are observed to be warm, but when dead and deprived of life they are the opposite. Indeed, the source of this warmth must be in the heart in sanguineous animals, and in the case of bloodless animals in the corresponding organ, for, though all parts of the body by means of their natural heat work upon and concoct the nutriment, the governing organ takes the chief share in this process. Hence, even when the other members become cold, life remains; but when the warmth here is quenched, death always ensues, because the source of heat in all the other members depends on this, and the soul is, as it were, set aglow with fire in this part, which in sanguineous animals is the heart and in the bloodless order the analogous member. Hence, of necessity, life must be simultaneous with the maintenance of heat, and what we call death is its destruction.

5 · However, it is to be noticed that there are two ways in which fire ceases to exist; it may go out either by exhaustion or by extinction. That which is self-caused we call exhaustion, that due to its opposites extinction. But either of these ways in which fire ceases to be may be brought about by the same cause, for, when there is a deficiency of nutriment and the warmth can obtain no maintenance, the fire fails; and the reason is that the opposite, checking digestion, prevents the fire from being fed. But in other cases the result is exhaustion,—when the heat accumulates excessively owing to lack of respiration and of refrigeration. For the heat, accumulating in great quantity, quickly uses up its nutriment and consumes it all before more is sent up by exhalation. Hence not only is a smaller fire readily put out by a larger one, but of itself the lamp's flame is consumed when inserted in a large blaze, just as is the case with any other combustible. The reason is that the nutriment in the flame is seized by the larger one before fresh fuel can be added, for fire is ever coming into being and flowing like a river, but so speedily as to elude observation.

Clearly, therefore, if the bodily heat must be conserved (as is necessary if life is to continue), there must be some way of cooling the heat resident in the source of warmth. Take as an illustration what occurs when coals are confined in a brazier. If they are kept covered up continuously by the so-called 'choker', they are quickly extinguished, but, if the lid is in rapid alternation lifted up and put on again they remain glowing for a long time. Banking up a fire also keeps it in, for the ashes, being porous, do not prevent the passage of air, and again they enable it to resist extinction by the surrounding air by means of the supply of heat which it possesses. However, we have stated in the *Problems* the reasons why these operations, namely banking up and covering up a fire, have the opposite effects (in the one case the fire goes out, in the other it continues alive for a considerable time).

6 · Everything living has soul, and it, as we have said, cannot exist without the presence of natural heat. In plants the natural heat is sufficiently well kept alive by the aid which their nutriment and the surrounding air supply. For the food has a cooling effect when it enters (as it does for men immediately after a meal), whereas abstinence from food produces heat and thirst. The air, if it be motionless, becomes hot, but by the entry of food a motion is set up which lasts until digestion is completed and so cools it. If the surrounding air is excessively cold owing to the time of year, there being severe frost, the force of the heat dwindles; but when there are hot spells and the moisture drawn from the ground cannot produce its cooling effect, the heat comes to an end by exhaustion. Trees suffering at such seasons are said to be blighted or star-stricken. Hence the practice of laying beneath the roots stones of certain species or water in pots, for the purpose of cooling the roots of the plants.

Some animals pass their life in the water, others in the air, and therefore these media furnish the source and means of refrigeration, water in the one case, air in the other. We must proceed—and it will require further application on our part—to give an account of the way and manner in which this refrigeration occurs.

7(1) · A few of the earlier natural scientists have spoken of respiration. The reason, however, why it exists in animals they have either not declared or, when they have, their statements are not correct and show a comparative lack of acquaintance with the facts. Moreover they assert that all animals respire—which is untrue. Hence these points must first claim our attention, in order that we may not be thought to make unsubstantiated charges against authors no longer alive.

First then, it is evident that all animals with lungs breathe, but in some cases breathing animals have a bloodless and spongy lung, and then there is less need for respiration. These animals can remain under water for a time, which relatively to their bodily strength, is considerable. All oviparous animals, e.g. the frog-tribe, have a spongy lung. Also turtles and terrapins can remain for a long time immersed in water; for their lung, containing little blood, has not much heat. Hence, when once it is inflated, it itself, by means of its motion, produces a cooling effect and enables the animal to remain immersed for a long time. Suffocation, however, always ensues if the animal is forced to hold its breath for too long a time, for none of this class take in water in the way fishes do. On the other hand, animals which have the lung charged with blood have greater need of respiration on account of the amount of their heat, while none at all of the others which do not possess lungs, breathes.

8(2) · Democritus of Abdera and certain others who have treated of respiration, while saying nothing definite about the lungless animals, nevertheless seem to speak as if all breathed. But Anaxagoras and Diogenes both maintain that all breathe, and state the manner in which fishes and oysters respire. Anaxagoras says that when fishes discharge water through their gills, air is formed in the mouth, for there can be no vacuum, and that it is by drawing in this that they respire.

Diogenes' statement is that, when they discharge water through their gills, they suck the air out of the water surrounding the mouth by means of the vacuum formed in the mouth, for he believes there is air in the water.

But these theories are untenable. Firstly, they state only what is the common element in both operations and so leave out the half of the matter. For what goes by the name of respiration consists, on the one hand, of inhalation, and, on the other, of the exhalation of breath; but, about the latter they say nothing, nor do they describe how such animals emit their breath. Indeed, explanation is for them impossible for, when the creatures respire, they must discharge their breath by the same passage as that by which they draw it in, and this must happen in alternation. Hence, as a result, they must take the water into their mouth at the same time as they breathe out. But the air and the water must meet and obstruct each other. Further, when they discharge the water they must emit their breath by the mouth or the gills, and the result will be that they will breathe in and breathe out at the same time, for it is at that moment that respiration is said to occur. But it is impossible that they should do both at the same time. Hence, if respiring creatures must both exhale and inhale the air, and if none of these animals can breathe out, evidently none can respire at all.

9(3) · Further, the assertion that they draw in air out of the mouth or out of the water by means of the mouth is an impossibility, for, not having a lung, they have no windpipe; rather the stomach is closely juxtaposed to the mouth, so that they must do the sucking with the stomach. But in that case the other animals would do so also, which is not the truth; and the water-animals also would be seen to do it when out of the water, whereas quite evidently they do not. Further, in all animals that respire and draw breath there is to be observed a certain motion in the part of the body which draws in the air, but in the fishes this does not occur. Fishes do not appear to move any of the parts in the region of the stomach, except the gills alone, and these move both when they are in the water and when they are thrown on to dry land and gasp. Moreover, always when respiring animals are killed by being suffocated in water, bubbles are formed of the air which is forcibly discharged, as happens, e.g. when one forces a tortoise or a frog or any other animal of a similar class to stay beneath water. But with fishes this result never occurs, in whatsoever way we try to obtain it, since they do not contain air drawn from an external source. Again, the manner of respiration said to exist in them might occur in the case of men also when they are under water. For if fishes draw in air out of the surrounding water by means of their mouth why should not men too and other animals do so?—they should also, in the same way as fishes, draw in air out of the mouth. If in the former case it were possible, so also should it be in the latter. But, since in the one it is not so, neither does it occur in the other. Furthermore, why do fishes, if they respire, die in the air and gasp (as can be seen) as in suffocation? It is not want of food that produces this effect upon them, and the reason given by Diogenes is foolish, for he says that in air they take in too much air and hence die, but in the water they take in a moderate amount. But that should be a possible occurrence with land animals also; as facts are, however, no land animal is suffocated by excessive respiration. Again, if all animals breathe, insects must do so also. But many of them seem to live though divided not merely into two, but into several parts, e.g. those called millipedes. But how can they, when thus divided, breathe, and what is the organ they employ? The main reason why these writers have not given a good account of these facts is that they have no acquaintance with the internal parts, and that they did not grasp that nature does everything for the sake of some end. If they had asked for what purpose respiration exists in animals, and had considered this with reference to the parts, e.g. the gills and the lungs, they would have discovered the reason more speedily.

10(4) · Democritus, however, does teach that in the breathing animals there is a certain result produced by respiration; he asserts that it prevents the soul from being extruded from the body. Nevertheless, he by no means asserts that it is for this purpose that nature so contrives it, for he, like the other natural scientists, altogether fails to attain to any such explanation. His statement is that the soul and the hot element are identical, being the primary forms among the spherical particles. Hence, when these are being separated out by the surrounding atmosphere thrusting them out, respiration, according to his account, comes in to succour them. For in the air there are many of those particles which he calls mind and soul. Hence, when we breathe and the air enters, these enter along with it, and by their action cancel the pressure, thus preventing the expulsion of the soul which resides in the animal.

This explains why life and death are bound up with the taking in and letting out of the breath; for death occurs when the compression by the surrounding air gains the upper hand, and, the animal being unable to respire, the air from outside can no longer enter and counteract the compression. Death is the departure of those forms owing to the expulsive pressure exerted by the surrounding air. As to the reason why all must die at some time—not, however, at any chance time but, when natural, owing to old age, and, when unnatural, to violence.

But the reason for this and why all must die Democritus has by no means made clear. And yet, since evidently death occurs at one time of life and not at another, he should have said whether the cause is external or internal. Neither does he assign the cause of the beginning of respiration, nor say whether it is internal or external. Indeed, it is not the case that the external mind superintends the reinforcement; rather the origin of breathing and of the respiratory motion must be within: it is not due to pressure from around. It is absurd also that what surrounds should compress and at the same time by entering dilate. This then is practically his theory, and how he puts it.

But if we must consider that our previous account is true, and that respiration does not occur in every animal, we must deem that this explains death not universally, but only in respiring animals. Yet neither is it a good account of these even, as may clearly be seen from the facts and phenomena of which we all have experience. For in hot weather we grow warmer, and, having more need of

respiration, we always breathe faster. But, when the air around is cold and contracts and solidifies the body, retardation of the breathing results. Yet this was just the
472b1 time when the external air should enter and annul the expulsive movement, whereas it is the opposite that occurs. For when the breath is not let out and the heat accumulates too much then we need to respire, and to respire we must draw in the breath. When hot, people breathe rapidly, because they must do so in order to cool themselves, just when the theory of Democritus would make them add fire to fire.

11(5) · The theory found in the *Timaeus,* of the passing round of the breath by pushing, by no means determines how, in the case of the animals other than land-animals, their heat is preserved, and whether it is due to the same or a different cause. For if respiration occurs only in land-animals we should be told what is the reason of that. Likewise, if it is found in others also, but in a different form, this form of respiration, if they all can breathe, must also be described.

Further, the method of explaining involves a fiction. It is said that when the hot air issues from the mouth it pushes the surrounding air, which being carried on enters the very place whence the internal warmth issued, through the interstices of the porous flesh; and this reciprocal replacement is due to the fact that a vacuum cannot exist. But when it has become hot the air passes out again by the same route, and pushes back inwards through the mouth the air that had been discharged in a warm condition. It is said that it is this action which goes on continuously when the breath is taken in and let out.

But according to this way of thinking it will follow that we breathe out before we breathe in. But the opposite is the case, as evidence shows, for though these two functions go on in alternation, yet the last act when life comes to a close is the letting out of the breath, and hence its admission must have been the beginning of the process.

Once more, those who give this kind of explanation by no means state the final cause of the presence in animals of this function (to wit the admission and emission of the breath), but treat it as though it were a contingent accompaniment of life. Yet it evidently has control over life and death, for when respiring animals are unable to breathe they perish. Again, it is absurd that the passage of the hot air out through the mouth and back again should be quite perceptible, while we were not able to detect the passage of the breath into the thorax and its return outwards once more when heated. It is also nonsense that respiration should consist in the entrance of heat, for the evidence is to the contrary effect; what is breathed out is hot, and what is breathed in is cold. When it is hot we pant in breathing, for, because what
473a1 enters does not adequately perform its cooling function, we have as a consequence to draw the breath frequently.

12(6) · But we must not entertain the notion that it is for purposes of *nutrition* that respiration is designed, and believe that the internal fire is fed by the breath; respiration, as it were, adding fuel to the fire, while the feeding of the flame results in the outward passage of the breath. To combat this doctrine I shall repeat what I said in opposition to the previous theories. This, or something analogous to it, should occur in the other animals also, for all possess vital heat. Further, how are we to describe this fictitious process of the generation of heat from the breath? Observation shows rather that it is a product of the food. A consequence also of this theory is that the nutriment would enter and the refuse be discharged by the same channel, but this does not appear to occur in the other instances.

13(7) · Empedocles also gives an account of respiration without, however, making clear what its purpose is, or whether or not it is universal in animals. Also when dealing with respiration by means of the nostrils he imagines he is dealing with what is the primary kind of respiration. Even the breath which passes through the nostrils passes through the windpipe out of the chest as well, and without the latter the nostrils cannot act. Again, when animals are bereft of respiration through the nostrils, no detrimental result ensues, but, when prevented from breathing through the windpipe, they die. Nature employs respiration through the nostrils as a secondary function in certain animals in order to enable them to smell. That is why though almost all animals are endowed with the sense of smell, the sense-organ is not the same in all.

A more precise account has been given about this elsewhere. Empedocles, however, explains the passage inwards and outwards of the breath, by the theory that there are certain blood-vessels, which, while containing blood, are not filled by it, but have passages leading to the outer air, the calibre of which is fine in contrast to the size of the solid particles, but large relatively to those in the air. Hence, since it is the nature of the blood to move upwards and downwards, when it moves down the air rushes in and inspiration occurs; when the blood rises, the air is forced out and the outward motion of the breath results. He compares this process to what occurs in a clepsydra.[1]

Thus all things outwards breathe and in;—their flesh has tubes
Bloodless, that stretch towards the body's outmost edge,
Which, at their mouths, full many frequent channels pierce,
Cleaving the extreme nostrils through; thus, while the gore
Lies hid, for air is cut a thoroughfare most plain.
And thence, whenever shrinks away the tender blood,
Enters the blustering wind with swelling billow wild.
But when the blood leaps up, backward it breathes. As when
With clepsydra of polished bronze a maiden sporting,
Sets on her comely hand the narrow of the tube
And dips it in the frail-formed water's silvery sheen;
Not then the flood the vessel enters, but the air,
Pressing within on the dense orifices, checks it,

Until she frees the crowded stream. But then indeed
Upon the air's escape runs in the water meet.

[1]The clepsydra was a device for lifting small quantities of liquid, similar in operation to the modern pipette.

So also when within the vessel's deeps the water
Remains, the opening by the hand of flesh being closed,
The outer air that entrance craves restrains the flood
At the gates of the sounding, upon the surface pressing,
474a1 Until the maid withdraws her hand. But then in contrariwise
Once more the air comes in and water meet flows out.
Thus too the subtle blood, surging throughout the limbs,
Whene'er it shrinks away into the far recesses
Admits a stream of air rushing with swelling wave,
But, when it backward leaps, in like bulk air flows out.

This then is what he says of respiration. But, as we said, all animals that evidently respire do so by means of the windpipe, when they breathe either through the mouth or through the nostrils. Hence, if it is of this kind of respiration that he is talking, we must ask how it tallies with the explanation given. But the facts seem to be quite opposed. The region is raised in the manner of a forge-bellows when the breath is drawn in—it is quite reasonable that it should be heat which raises it up and that the blood should occupy the hot region—but it collapses and sinks down, like the bellows once more, when the breath is let out. The difference is that in a bellows it is not by the same channel that the air is taken in and let out, but in breathing it is.

But, if Empedocles is accounting only for respiration through the nostrils, he is much in error, for that does not involve the nostrils alone, but passes by the channel beside the uvula where the extremity of the roof of the mouth is, some of the air going this way through the apertures of the nostrils and some through the mouth, both when it enters and when it passes out. Such then is the nature and magnitude of the difficulties besetting the theories of other writers concerning respiration.

14(8) · We have already stated that life and the presence of soul involve a certain heat. Not even the digesting process to which is due the nutrition of animals occurs apart from soul and warmth, for it is fire that in all cases does the work. It is for this reason, precisely, that the primary nutritive soul also must be located in that part of the body and in that division of this region which is the immediate vehicle of
474b1 this principle. The region in question is intermediate between that where food enters and that where excrement is discharged. In bloodless animals it has no name, but in the sanguineous class this part is called the heart. The blood constitutes the nutriment from which the parts of the animal are directly formed. Likewise the blood-vessels must have the same originating source, as the blood, since the one exists for the sake of the other—as a vessel or receptacle for it. In sanguineous animals the heart is the starting-point of the veins; they do not traverse it, but are found to stretch out from it, as dissections enable us to see.

Now the other faculties of the soul cannot exist apart from the power of nutrition (the reason has already been stated in the treatise on the soul), and this depends on the natural fire, by the union with which Nature has set it aglow. But fire, as we have already stated, is destroyed in two ways, either by extinction or by exhaustion. It suffers extinction from its opposites. Hence it can be extinguished by the surrounding cold both when in mass and (though more speedily) when scattered. Now this way of perishing is due to violence equally in living and in lifeless objects, for the division of an animal by instruments and consequent congelation by excess of cold cause death. But exhaustion is due to excess of heat; for, if there is too much heat close at hand and the thing burning does not have a fresh supply of fuel added to it, it goes out by exhaustion, not by the action of cold. Hence, if it is going to continue it must be cooled, for cold is a preventive against this form of extinction.

15(9) · Some animals occupy the water, others live on land, and, that being so, in the case of those which are very small and bloodless the refrigeration due to the surrounding water or air is sufficient to prevent destruction from this cause. Having little heat, they require little cold to combat it. Hence too such animals are almost all short-lived, for, being small, they have less scope for deflection towards either extreme. But some insects are longer-lived (though bloodless, like all the 475a1
others), and these have a deep indentation beneath the waist, in order to secure cooling through the membrane, which there is thinner. They are warmer animals and hence require more refrigeration, and such are bees (some of which live as long as seven years) and all that make a humming noise, like wasps, cockchafers, and crickets. They make a sound as if of panting by means of air; for, in the middle section itself which rises and falls with the intake breath, friction is produced against the membrane. The way in which they move this region is like the motion due to the lungs in animals that breathe the outer air, or to the gills in fishes. What occurs is comparable to the suffocation of a respiring animal by holding its mouth, for then the lung causes a heaving motion of this kind. In the case of these animals this motion is not sufficient for refrigeration, but in insects it is. It is by friction against the membrane that they produce the humming sound, as we say, in the way that children do by blowing through the holes of a reed covered by a fine membrane. It is thus that the singing crickets too produce their song; they possess greater warmth and are indented at the waist, but the songless variety have no fissure there.

Animals also which are sanguineous and possess a lung, though that contains little blood and is spongy, can in some cases, owing to the latter fact, live a long time without breathing; for the lung, containing little blood or fluid, can rise a long way: its own motion can for a long time produce sufficient refrigeration. But at last it ceases to suffice, and the animal dies of suffocation if it does not respire—as we have already said. For of exhaustion that kind which is destruction due to lack of refrigeration is called suffocation, and whatsoever is thus destroyed is said to be suffocated.

We have already stated that among animals insects do not respire, and the fact is evident in the case of even small creatures like flies and bees, for they can swim about in a fluid for a long time if it is not too hot or too cold. Yet animals with little 475b1 strength tend to breathe more frequently. These, however, die of what is called suffocation when the stomach becomes filled and the heat in the central segment is destroyed. This explains also why they revive after being among ashes for a time.

Again among water-animals those that are bloodless remain alive longer in air than those that have blood and admit the sea-water, as, for example, fishes. Since it is a small quantity of heat they possess, the air is for a long time adequate for the purposes of refrigeration in such animals as the crustacea and the polyps. Their lack of heat does not, however, suffice to keep them finally in life; for many fishes also live in the earth, yet in a motionless state, and are to be found by digging. For all animals that have no lung at all or have a bloodless one require less refrigeration.

16(10) · Concerning the bloodless animals we have declared that in some cases it is the surrounding air, in others fluid, that aids the maintenance of life. But in the case of animals possessing blood and heart, all which have a lung admit the air and produce the cooling effect by breathing in and out. All animals have a lung that are viviparous and are so internally, not externally merely (the Selachia are viviparous, but not internally), and of the oviparous class those that have wings, e.g. birds, and those with scales, e.g. tortoises, lizards, and snakes. The former class have a lung charged with blood, but in the most part of the latter it is spongy. Hence they employ respiration more sparingly as already said. The function is found also in all that frequent and pass their life in the water, e.g. the class of water-snakes and frogs and crocodiles and turtles, both sea- and land-tortoises, and seals.

All these and similar animals both bring forth on land and sleep on shore or, when they do so in the water, keep the head above the surface in order to respire. But all with gills produce refrigeration by taking in water; the Selachia and all other footless animals have gills. Fish are footless, and the limbs they have get their name from their similarity to wings. But of those with feet one only, so far as observed, has gills. It is called the newt.

No animal yet has been seen to possess both lungs and gills, and the reason for this is that the lung is designed for the purpose of refrigeration by means of the air (it seems to have derived its name (*πνεύμων*) from its function as a receptacle of the breath (*πνεῦμα*)), while gills are relevant to refrigeration by water. Now for one purpose one organ is adapted and one single means of refrigeration is sufficient in every case. Hence, since we see that nature does nothing in vain, and if there were two organs one would be purposeless, this is the reason why some animals have gills, others lungs, but none possess both.

17(11) · Every animal in order to exist requires nutriment, in order to prevent itself from dying, refrigeration; and so nature employs the same organ for both purposes. For, as in some cases the tongue serves both for discerning tastes and for speech, so in animals with lungs the mouth is employed both in working up the food and in the passage of the breath outwards and inwards. In lungless and non-respiring animals it is employed in working up the food, while in those of them that require refrigeration it is the gills that serve for this purpose.

We shall state further on how it is that these organs have the faculty of producing refrigeration. But to prevent their food from impeding these operations there is a similar contrivance in the respiring animals and in those that admit water. At the moment of respiration they do not take in food, for otherwise suffocation results owing to the food, whether liquid or dry, slipping in through the windpipe and lying on the lung. The windpipe is situated before the oesophagus, through which food passes into what is called the stomach, but in quadrupeds which are sanguineous there is, as it were, a lid over the windpipe—the epiglottis. In birds and oviparous quadrupeds this covering is absent, but its office is discharged by a contraction of the windpipe. The latter class contract the windpipe when swallowing their food; the former close down the epiglottis. When the food has passed, the epiglottis is in the one case raised, and in the other the windpipe is expanded, and the air enters to effect refrigeration. In animals with gills the water is first discharged through them and then the food passes in through the mouth; they have no windpipe and hence can take no harm from liquid lodging in this organ, only from its entering the stomach. For these reasons the expulsion of water and the seizing of their food is rapid, and their teeth are sharp and in almost all cases arranged in a saw-like fashion, for they are debarred from chewing their food.

18(12) · Among water-animals the cetaceans may give rise to some perplexity, though they too can be rationally explained.

Examples of such animals are dolphins and whales, and all others that have a blow-hole. They have no feet, yet possess a lung though admitting the sea-water. The reason for possessing a lung is that which we have just stated; the admission of water is not for the purpose of refrigeration. That is effected by respiration, for they have a lung. Hence they sleep with their head out of the water, and dolphins, at any rate, snore. Further, if they are entangled in nets they soon die of suffocation owing to lack of respiration, and hence they can be seen to come to the surface owing to the necessity of breathing. But since they have to feed in the water, they must admit it, and it is in order to discharge this that they all have a blow-hole; after admitting the water they expel it through the blow-hole as the fishes do through the gills. The position of the blow-hole is an indication of this, for it leads to none of the organs which are charged with blood, but lies before the brain.

It is for the very same reason that molluscs and crustaceans admit water—I mean such animals as crayfish and crabs. For none of these is refrigeration a necessity, for in every case they have little heat and are bloodless, and hence are sufficiently cooled by the surrounding water. But in feeding they expel the water in order to prevent its being swallowed simultaneously with the food. Thus crustaceans, like the crayfish and crabs, discharge water through the folds beside their shaggy parts, while cuttle-fish and the polyps employ for this purpose the hollow above the head. There is, however, a more precise account of these in the *History of Animals*.

Thus it has been explained that the cause of the admission of the water is refrigeration, and the fact that animals constituted for a life in water must feed in it.

19(13) · An account must next be given of refrigeration and the manner in which it occurs in respiring animals and those possessed of gills. We have already said that all animals with lungs respire. The reason why some creatures have this part, and why those having it need respiration, is that the higher animals have a greater proportion of heat, for at the same time they must have been assigned a higher soul and they have a higher nature than plants.[2] Hence too those with most blood and most warmth in the lung are of greater size, and that animal in which the blood in the lung is purest and most plentiful is the most erect, namely man; and the reason why he alone has his upper part directed to the upper part of the universe is that he possesses such a part. Hence this as much as any other part must be assigned as a cause of the essence of the animal both in man and in other cases.

This then is the purpose of refrigeration. As for the constraining and efficient cause, we must believe that it created animals like this, just as it created many others also not of this constitution. For some have a greater proportion of earth in their composition, like plants, and others, e.g. aquatic animals, contain a larger amount of water; while winged and terrestrial animals have an excess of air and fire respectively. Each has its station in the appropriate regions.

20(14) · Empedocles is then in error when he says that those animals
477b1 which have the most warmth and fire live in the water to counterbalance the excess of heat in their constitution, in order that, since they are deficient in cold and fluid, they may be kept in life by the contrary character of the region they occupy; for water has less heat than air. But it is wholly absurd that the water-animals should in every case originate on dry land, and afterwards change their place of abode to the water; for they are almost all footless. He, however, when describing their original structure says that, though originating on dry land, they have abandoned it and migrated to the water. But again it is evident that they are not warmer than land-animals, for in some cases they have no blood at all, in others little.

The question, however, as to what sorts of animals should be called warm and what cold, has in each special case received consideration. Though in one respect there is reason in the explanation which Empedocles aims at establishing, yet his account is not correct. Excess in a bodily state is cured by a situation or season of opposite character, but the constitution is best maintained by an environment akin to it. There is a difference between the material of which any animal is constituted and the states and dispositions of that material. For example, if nature were to constitute a thing of wax or of ice, she would not preserve it by putting it in a hot place, for the opposing quality would quickly destroy it, seeing that heat dissolves that which cold congeals. Again, a thing composed of salt or nitre would not be taken and placed in water, for fluid dissolves that of which the consistency is due to the dry.

Hence if the fluid and the dry supply the material for all bodies, it is reasonable that things the composition of which is due to the fluid should have liquid for their

[2] Retaining φυτῶν.

medium, while that which is due to the dry will be found in the dry. Thus trees grow not in water but on dry land. But the same theory would relegate them to the water, on account of their excess of dryness, just as it does the things that are excessively fiery. They would have migrated there not on account of its cold but owing to its fluidity.

Thus the natural character of the material of objects is of the same nature as the region in which they exist; the liquid is found in liquid, the dry on land, the warm in air. With regard, however, to states of body, a cold situation has, on the other hand, a beneficial effect on excess of heat, and a warm environment on excess 478a1
of cold, for the region reduces to a mean the excess in the bodily condition. This must be sought in the regions appropriate to each type of matter, and according to the changes of the seasons which are common to all; for, while states of the body can be opposed in character to the environment, the material of which it is composed can never be so. This, then, is a sufficient explanation of why it is not owing to the heat in their constitution that some animals are aquatic, others terrestrial, as Empedocles maintains, and of why some possess lungs and others do not.

21(15) · The explanation of the admission of air and respiration in those animals in which a lung is found, and especially in those in which it is full of blood, is to be found in the fact that it is of a spongy nature and full of tubes, and that it is the most fully charged with blood of all the visceral organs. All animals with a full-blooded lung require rapid refrigeration because there is little scope for deviation from the normal amount of their vital fire; the air also must penetrate all through it on account of the large quantity of blood and heat it contains. But both these operations can be easily performed by air, for, being of a subtle nature, it penetrates everywhere and that rapidly, and so performs its cooling function; but water has the opposite characteristics.

The reason why animals with a full-blooded lung respire most is hence manifest; the more heat there is, the greater is the need for refrigeration, and at the same time breath can easily pass to the source of heat in the heart.

22(16) · In order to understand the way in which the heart is connected with the lung by means of passages, we must consult both dissections and the account in the *History of Animals*. In general, the constitution of animals needs refrigeration because the soul is ignited in the heart. Respiration is the means of effecting refrigeration, of which those animals make use that possess a lung as well as a heart. But when they, as for example the fishes, which on account of their aquatic nature have no lung, possess the latter organ without the former, the cooling is effected through the gills by means of water. For ocular evidence to how the heart is situated relatively to the gills we must employ dissections, and for precise details 478b1
we must refer to the *History of Animals*. As a summarizing statement, however, and for present purposes, the following is the account of the matter.

It might appear that the heart has not the same position in terrestrial animals and in fishes, but the position really is identical, for the apex of the heart is in the direction in which they incline their heads. But it is towards the mouth in fishes that the apex of the heart points, seeing that they do not incline their heads in the same direction as land-animals do. Now from the extremity of the heart a tube of a sinewy, arterial character runs to the centre where the gills all join. This then is the largest of those ducts, but on either side of the heart others also issue and run to the extremity of each gill, and by means of the ceaseless flow of water through the gills, effect the cooling which passes to the heart.

In similar fashion as the fish move their gills, respiring animals with rapid action raise and let fall the chest according as the breath is admitted or expelled. If the air is limited in amount and unchanged they are suffocated, for either medium, owing to contact with the blood, rapidly becomes hot, and, being hot, counteracts the refrigeration. And when respiring animals can no longer move the lung or aquatic animals their gills, whether owing to disease or old age, their death ensues.

23(17) · To be born and to die are common to all animals, but there are specifically diverse ways in which these phenomena occur; of destruction there are different types, though yet something is common to them all. There is violent death and again natural death, and the former occurs when the cause of death is external, the latter when it is internal, and involved from the beginning in the constitution of the organ, and not an affection derived from a foreign source. In the case of plants the name given to this is withering, in animals old age. Death and decay pertain to all things that are not imperfectly developed; to the imperfect also they may be ascribed in nearly the same but not an identical sense. Under the imperfect I class eggs and seeds of plants as they are before the root appears.

It is always to some lack of heat that death is due, and in perfect creatures the cause is its failure in the organ containing the source of the creature's essential nature. This member is sited, as has been said, at the junction of the upper and lower parts; in plants it is intermediate between the root and the stem, in
479a1 sanguineous animals it is the heart, and in those that are bloodless the corresponding part of their body. But some of these animals have potentially many sources of life, though in actuality they possess only one. This is why some insects live when divided, and why, even among sanguineous animals, all whose vitality is not intense live for a long time after the heart has been removed. Tortoises, for example, do so and make movements with their feet, so long as the shell is left, a fact to be explained by the natural inferiority of their constitution, as it is in insects also.

The source of life is lost to its possessors when the heat with which it is bound up is no longer tempered by cooling, for, as I have often remarked, it is consumed by itself. Hence when, owing to lapse of time, the lung in the one class and the gills in the other get dried up, these organs become hard and earthy and incapable of movement and cannot be expanded or contracted. Finally things come to a climax, and the fire goes out from exhaustion.

Hence a small disturbance will speedily cause death in old age. Little heat remains, for the most of it has been breathed away in the long period of life preceding, and hence any increase of strain on the organ quickly causes extinction.

It is just as though the heart contained a tiny feeble flame which the slightest movement puts out. Hence in old age death is painless, for no violent disturbance is required to cause death, and the severance of the soul is entirely imperceptible. All diseases which harden the lung by forming tumours or waste residues, or by excess of morbid heat, as happens in fevers, accelerate the breathing owing to the inability of the lung to move far either upwards or downwards. Finally, when motion is no longer possible, the breath is given out and death ensues.

24(18) · Generation is the initial participation, mediated by warm substance, in the nutritive soul, and life is the maintenance of this participation. Youth is the period of the growth of the primary organ of refrigeration, old age of its decay, while the intervening time is the prime of life.

A violent death or dissolution consists in the extinction or exhaustion of the vital heat (for either of these may cause dissolution), while natural death is the exhaustion of the heat owing to lapse of time, and occurring at the end of life. In plants this is to wither, in animals to die. Death, in old age, is the exhaustion due to inability on the part of the organ, owing to old age, to produce refrigeration.

This then is our account of generation and life and death, and the reason for their occurrence in animals.

25(19) · It is hence also clear why respiring animals are suffocated in water and fishes in air. For it is by water in the latter class, by air in the former that refrigeration is effected, and either of these means of performing the function is removed by a change of environment.

There is also to be explained in either case the cause of the motion of the gills and of the lungs, the rise and fall of which effects the admission and expulsion of the breath or of water. The following, moreover, is the manner of the constitution of the organ.

26(20) · In connexion with the heart there are three phenomena, which, though apparently of the same nature, are really not so, namely palpitation, pulsation, and respiration.

Palpitation is the rushing together of the hot substance in the heart owing to the chilling influence of residual or waste products. It occurs, for example, in the ailment known as spasms and in other diseases. It occurs also in fear, for when one is afraid the upper parts become cold, and the hot substance, fleeing away, by its concentration in the heart produces palpitation. It is crushed into so small a space that sometimes life is extinguished, and the animals die of the fright and morbid disturbance.

The beating of the heart, which, as can be seen, goes on continuously, is similar to the throbbing of an abscess. That, however, is accompanied by pain, because the change produced in the blood is unnatural, and it goes on until the matter formed by concoction is discharged. There is a similarity between this phenomenon and that of boiling; for boiling is due to the volatilization of fluid by heat and the expansion consequent on increase of bulk. But in an abscess, if there is no evaporation through 480a1 the walls, the process terminates in suppuration due to the thickening of the liquid, while in boiling it ends in the escape of the fluid out of the containing vessel.

In the heart the beating is produced by the heat expanding the fluid, of which the food furnishes a constant supply. It occurs when the fluid rises to the outer wall of the heart, and it goes on continuously; for there is a constant flow of the fluid that goes to constitute the blood, it being in the heart that the blood is first created. That this is so we can perceive in the initial stages of generation, for the heart can be seen to contain blood before the veins become distinct. This explains why pulsation in youth exceeds that in older people, for in the young the exhalation is more abundant.

All the veins pulse, and do so simultaneously with each other, owing to their connexion with the heart. The heart always beats, and hence they also beat continuously and simultaneously with each other and with it.

Palpitation, then, is the recoil of the heart against the compression due to cold; and pulsation is the volatilization of the heated fluid.

27(21) · Respiration takes place when the hot substance which is the seat of the nutritive principle increases. For it, like the rest of the body, requires nutrition, and more so than the other parts, for it is through it that they are nourished. But when it increases it necessarily causes the organ to rise. This organ we must take to be constructed like the bellows in a smithy, for both heart and lungs conform pretty well to this shape. Such a structure must be double, for the nutritive principle must be situated in the centre of the cooling force.

Thus on increase of bulk expansion results, which necessarily causes the surrounding parts to rise. Now this can be seen to occur when people respire; they raise their chest because the principle of the organ described resident within the chest causes an identical expansion of this organ. When it dilates the outer air, being cold, must rush in as into a bellows, and by its chilling influence reduce by 480b1 extinction the excess of the fire. But, as the increase of bulk causes the organ to dilate, so diminution causes contraction, and when it collapses the air which entered must pass out again. When it enters the air is cold, but on issuing it is warm owing to its contact with the heat resident in this organ, and this is specially the case in those animals that possess a full-blooded lung. The numerous canal-like ducts in the lung, into which it passes, have each a blood-vessel lying alongside, so that the whole lung is thought to be full of blood. The inward passage of the air is called respiration, the outward expiration, and this double movement goes on continuously just so long as the animal lives and keeps this organ in continuous motion; it is for this reason that life depends on the passage of the breath outwards and inwards.

It is in the same way that the motion of the gills in fishes takes place. When the hot substance in the blood throughout the members rises, the gills rise too, and let the water pass through, but when it is chilled and retreats through its channels to the heart, they contract and eject the water. As the heat in the heart continually rises, so the heart continually receives it and expels it again when it is chilled.

Hence, as in respiring animals life and death depend on respiration, so in the other animals they depend on the admission of water.

Our discussion of life and death and kindred topics is now practically complete. But as to health and disease, not only the physician but also the natural scientist must, up to a point, give an account of their causes. The extent to which these two differ and investigate diverse provinces must not escape us, since facts show that their inquiries are, to a certain extent, at least co-terminous. For those physicians who are cultivated and learned make some mention of natural science, and claim to derive their principles from it, while the most accomplished investigators into nature generally push their studies so far as to conclude with an account of medical principles.

ON BREATH**

J. F. Dobson

481a1 **1** · What is the mode of growth of the natural breath and its mode of maintenance? For we see that it increases in volume and strength in accordance with both changes of age and the varying condition of the body. May we suppose that it increases as the other parts do, through the addition of some substance to it? Now it is nutriment that is thus added to living creatures; so that we must consider the nature and origin of the nutriment in this case.

Nutrition may result in either of two ways—by means of respiration, or, as in the case of the other parts of the body, by the digestive process consequent on the introduction of the nutriment; and of the two the process by means of the nutriment is perhaps the more likely; for body is nourished by body, and the breath is of the nature of body.

What then is the method? Clearly we must suppose that the breath is nourished by drawing and digesting nutriment from the vein-system, for the blood is the ultimate and universal nutriment. So the breath receives nutriment into the hot element as into its vessel and receptacle.[1]

The air draws the nutriment and imparts the activity, and applying to itself the digestive power is the cause of its own growth and nutrition.

Perhaps there is nothing absurd in this, but rather in the proposition that the breath is originally derived from the nutriment; for that which is akin to the soul is purer—unless we were to say that the soul itself is a later product than the body, arising when the seeds are sorted out and move towards the development of their nature.

Again, if[2] there is some residue left from all nutriment, by what passage is it ejected in this case? It is not reasonable to suppose that it is by the process of exhalation, for this succeeds immediately to the inhalation. Clearly there remains only the explanation that it is through the ducts of the wind-pipe.

The residue which is secreted from it must be either finer or coarser; in either case there is a grave difficulty, if the breath is assumed to be the purest of all substances. But if it is coarser we shall have to assume that there are certain ducts of larger size.

TEXT: W. W. Jaeger, Teubner, Leipzig, 1913

[1]Reading τὸ περιέχον.

[2]Reading εἴ τε.

The assumption that we take in and expel the breath by the same ducts is again strange and unreasonable.

Such then are the questions raised by the theory that the breath is maintained and increased by nutriment.

2 · Aristogenes supposes that the growth of the breath is due to respiration, the air being digested in the lungs; for the breath, he holds, is also a form of nutriment, and is distributed into the various vessels, and the refuse is ejected again.

This theory involves more difficulties, for what can cause this digestion? Apparently the breath digests itself, as it digests other things; but this is strange intrinsically, unless the breath is different from the external air. If it is different, perhaps the bodily warmth in it may cause digestion.

However, it may be reasonably maintained that the breath[3] is coarser than the outside air, since it is combined with the moisture from the vessels and from the solid parts in general; so that digestion will be a process towards corporeality; but the theory that it is finer is not convincing.

Moreover, the rapidity of its digestion is contrary to reason; for the exhalation follows immediately on the inhalation. What then is the agent which so quickly changes and modifies it?

We must naturally suppose that it is the warmth of the body, and the evidence of sense supports this, for the air when exhaled is warm.

Again, if the substance which is digested is in the lungs and the wind-pipe, the active warmth must also reside there: but the common view is that it is not so, but that the nutriment is evaporated by the motion of the breath.

It is still more astonishing if the breath in process of digestion attracts the warmth to itself or receives it because some other agent sets it in motion; moreover, on this theory it is not in itself the primary moving cause.

Then again, respiration extends as far as the lungs only, as the followers of Aristogenes themselves state; but the natural breath is distributed throughout the whole body. If it is from the lungs that the breath is distributed to all parts of the body, including those lower than the lungs, how can the process of its digestion be so rapid? This is more remarkable and involves a greater difficulty; for the lungs cannot distribute the air to the lower parts during the actual process of its digestion. And yet to some extent it would seem that this must be the case, if the digestion takes place in the lungs, and the lower parts also are affected by the respiration.

But the conclusion in this case is still more remarkable and important—namely that the digestion is effected, as it were, entirely by transit and contact.

This also is unreasonable, and still more untenable,[4] since it assumes that the same duct is used by the nutriment and the excretions; while if we assume that digestion is effected by any of the other internal parts, the objections already stated will apply: unless we were to assume that excrement is not formed from all

[3]Reading αὐτό (and ὄν in line 6).
[4]Reading λογοδεέστερον.

nutriment, nor in all animals, any more than in plants, for we cannot find it in every one of the bodily parts, or even if we do, at least not in all animals.[5]

But according to this view the vessels grow just like the other parts, and as they become broadened and distended, the volume of air which flows in and out is increased: and if there must inevitably be some air contained in them, the actual question which we are now asking,[6] 'What is the air which naturally exists in them; and how does this increase under healthy conditions?' will be obvious from the preceding statement.

How is the natural breath nourished and developed in the case of creatures which have not respiration? For in their case the nutriment can no longer come from without. If in the former case it was from forces within, and from the common nutriment of the body, it is reasonable to say that the same is true in their case also, for similar effects come in like manner from the same causes—unless really in the case of these creatures too it is from without, like their perception of smell; but then they must have some process similar to respiration.[7]

Under this head we might raise the question whether such creatures can truly be called non-respiratory—pointing to this argument and also to the way in which they take in nutriment; for we should say that they must draw in some breath at the same time; and we should further urge that they must respire for the sake of refrigeration, which they must require just as other creatures do.

But if in their case the refrigeration takes place through the diaphragm, it is clear that the entry of the air must also be by the same pressure; so that there is some process similar to respiration.

But it cannot be determined how or by what agency the air is drawn in; or if there is a drawing in, how the entry takes place—unless, indeed, it is spontaneous. This is a subject for separate investigation.

But how is the natural breath nourished and increased in the case of creatures that live in the water? Apart from their inability to respire, we say further that air cannot exist in water: so it only remains to say that in their case it is by means of the food: and so either all creatures are not uniform in their methods, or else in the case of the others also it is by means of the food. Such are the three possible theories, of which one must be right. So much, then, as regards the nutrition and growth of the breath.

3 · With regard to respiration, some philosophers—such as Empedocles and Democritus—do not deal with its purpose, but only describe the process; others do not even deal with the process at all, but assume it as obvious. But we ought further to make it quite clear whether its purpose is refrigeration. For if the bodily heat is inherent in the upper parts, it follows that the lower parts would have no need of refrigeration: but as a matter of fact the innate breath pervades the whole body, and its origin is from the lungs.

[5]Retaining οὔτι γε.
[6]Reading αὐτὸ ὃ ζητεῖται.
[7]Reading οὕτως γε.

The inspired breath also is thought to be distributed uniformly over all parts, so that it remains to be proved that this is not the case.

Again, it is strange if the lower parts do not require some motive force and, as it were, some nutriment. And it would no longer be for the sake of refrigeration, if it 482b1
does pervade the whole.

Further, the process of the breath's distribution in general is imperceptible, and so is its speed; and again, the matter of its counter-flow, if, as assumed, it is from all parts, is remarkable, unless it flows back from the most remote parts in some different way, while in its proper and primary sense the action takes place from the regions about the heart.

In many instances such a want of symmetry in functions and faculties may be observed.

However, it is at any rate[8] strange if breath is distributed even into the bones—for they say that this is the case, and that it passes there from the air-ducts. Therefore, as I have shown, we must consider the respiration—its purpose, and the parts which it affects, and how it affects them. Again, nutriment is not carried by the air-ducts to all parts, for instance to the vessels themselves and certain other parts; but nevertheless plants live and receive nourishment.[9] This question belongs rather to a treatise on methods of nutrition.

4 · Whereas there are three motions belonging to the breath in the windpipe—respiration, pulsation, and a third which introduces and assimilates the nutriment—we must define how and where and for what purpose each takes place.

Of these, the motion of the pulse is perceptible by the senses wherever we touch the body. That of the respiration is perceptible up to a certain point, but is recognized in the majority of parts by a reasoning process. That of nutrition is in practically all parts determinable by reasoning, but by sense in so far as it can be observed from its results.

Now clearly the respiration has its motive principle from the inward parts, whether we ought to call this principle a power of the soul, the soul, or some other combination of bodies which through their agency causes this attraction, and the nutritive faculty would seem to be caused by the respiration, for the respiration corresponds to it, and is in reality similar to it. And to discover whether the whole body is not uniform with regard to the time taken by such motion, or whether there is no difference as to its simultaneity, we must consider all the parts.[10]

The pulse is something peculiar and distinct from the other motions and in some respects may be seen to be contingent, assuming that when there is an excess of warmth in a fluid, that fluid which is evaporated must set up a pulsation owing to the air being intercepted in the interior, and pulsation must arise in the originating part and in the earliest stage, since it is inborn in the earliest parts. For it arises firstly and in the greatest degree in the heart, and thence extends to the other

[8]Reading γοῦν.
[9]Omitting ὥσπερ.
[10]Omitting the comma after μή (line 26) and the full stop after κίνησιν (line 28).

parts.[11] Perhaps this must be an inseparable consequence of the essential nature underlying the living creature, which is manifested when the creature is in a condition of activity.

That the pulse has no connexion with the respiration is shown by the following indication—whether one breathes quickly or regularly, violently or gently, the pulse remains the same and unchanged, but it becomes irregular and spasmodic owing to certain bodily affections and in consequence of fear, hope, and anguish affecting the soul.

Next we ought to consider whether the pulse occurs also in the arteries and with the same rhythm and regularity. This does not appear to be so in the case of parts widely separated, and, as has been noted, it seems to serve no purpose whatsoever.

For, on the other hand, the respiration and reception of food, whether they are regarded as quite independent or as correlated, clearly exist for a purpose, and admit of rational explanation.

And of the three, we may reasonably say that the pulsatory and respiratory motions are prior to the other, for nutrition assumes their pre-existence. Or is this not so? for respiration begins when the young is separated from the mother; the reception of nutriment, and nutrition, occur both while the embryo is forming and after it is formed; but the pulsation occurs at the earliest stage, as soon as the heart begins to form, as is evident in the case of eggs. So the pulse comes first, and resembles an activity and not an interception of the breath, unless that also can conduce towards its activity.

5 · They say that the breath which is respired is carried into the belly, not through the gullet—that is impossible—but there is a duct along the loins through which the breath is carried by the respiration from the trachea into the belly and out again: and this can be perceived by the sense.

The question of this perception raises a difficulty: for if the windpipe alone has perception, does it perceive by means of the wind which passes through it, or by its bulk or by its bodily constitution? Or if the air comes first below soul, may it perceive by means of this air which is superior and prior in origin?

What then is the soul? They make it out to be a potentiality which is the cause of such a motion as this. Or is it clear that you will not be right in impugning those who say it is the rational and spirited faculty? for they too refer to these as potentialities.

But if the soul resides in this air, the air is at any rate a neutral substance. Surely, if it becomes animate or becomes soul, it suffers some change and alteration, and so naturally moves towards what is akin to it, and like grows by the addition of like. Or is it otherwise? for it may be contended that the air is not the whole of soul but is something which contributes to this potentiality or in this sense makes it,[12] and that which has made it is its principle and foundation.

[11] Jaeger excises this sentence.
[12] Reading ἀήρ, ἢ οὕτω ταύτην.

In the case of non-respiring creatures, where the internal air is not mixed with the external[13]—or is this not the case, is it rather mixed in some other way than by respiration?—what is the difference between the air in the air-duct and the outside air? It is reasonable—perhaps inevitable—to suppose that the former surpasses the latter in fineness. 483b1

Again, is it warm by its inherent nature or by the influence of something else? For it seems that the inner air is just like the outer, but it is helped by the cooling. But which is really the case? for when outside it is soft, but when enclosed the air becomes breath, being as it were condensed and in some manner distributed through the vessels. Or must it be mixed in some way, when it moves about in the fluids, and among the solid particles of the body? It is not, therefore, the finest of substances, if it is mixed. We may, however, reasonably expect that the substance which is first capable of receiving soul should be the finest, unless, indeed, soul is something such as has been described, i.e. something not pure nor unmixed: and that the air-duct should be capable of receiving the breath, while the sinew is not.

There is this difference too, that the sinew is tensible, but the air-duct is easily broken, just like a vein.

The skin contains veins, sinews, and air-ducts—veins because when pricked it exudes blood, sinews because it is elastic, air-ducts because air is breathed through it—for only an air-duct can admit air.

The veins must have pores in which resides the bodily heat which heats the blood as if in a cauldron; for it is not hot by nature, but is diffused like molten metals. For this reason too the air-duct becomes hardened, and has moisture both in itself and in the coats which surround its hollow passage.

It is also proved both by dissection and by the fact that the veins and air-ducts, which apparently conduct the nutriment, connect with the intestines and the belly. From the veins the nutriment is distributed to the flesh—not sideways from the veins but out at their mouths, as it were through pipes. For fine veins run sideways[14] from the great vein and the windpipe along each rib, and a vein and an air-duct always run side by side.

The sinews and veins form the connexion between the bones, joining them with the centre of the body, and also form the meeting-place between the head and the body, through which fishes receive nutriment and breathe; if they did not respire, they would die immediately on being taken out of the water.

But it is plain even from observations of sense that the veins and air-ducts connect with each other; but this would not occur if the moisture did not require breath and the breath moisture,—because there is warmth both in sinew, in air-duct, and in vein, and that which is in the sinew is hottest and most similar to that of the veins. Now the heat seems unsuited to the space where the breath is located, especially with a view to refrigeration: but if the animal produces and as it were re-kindles the heat by heat from without, then there may well be heat there. Besides this, permanence is in a sense natural to all things which have warmth, 484a1

[13]Placing ἢ οὐ . . . μειγνύμενος in parentheses.
[14]Omitting φλεβῶν.

provided that nothing resists or cools it;[15] for that all things require refrigeration is practically proved by the fact that the blood retains its heat in the veins and as it were shelters it there; so when the blood has flowed out it loses its heat, and the creature dies, through the liver having no air-duct.

6 · Does the seed pass through the air-duct? Is its passage due also to pressure, and does this take place only in process of emission? Through this we have evidence of the transformation of the blood into flesh—through the fact that the sinews are nourished from the bones; for they join the bones together. Or is this not true? For sinew is found in the heart, and sinews are attached to the bones: but those in the heart do not connect with anything else, but they end in the flesh. Or does this amount to nothing, and would those which connect the bones be nourished from the bones? But we might say, that rather the bones themselves get their nutriment from the sinew. For this too is strange—since the bone is dry by nature and has no ducts for fluid;[16] while the nutriment is fluid. But we must consider first, if the nutriment of the sinews is from the bones, what is the nutriment of the bone. Do the ducts carry it both from the veins and from the air-duct into the bone itself? In many parts these ducts are visible, particularly those leading to the spine, and those leading from the bones are continuous, e.g. in the case of the ribs; but how do we suppose that these ducts lead from the belly, and how does the drawing of the nutriment take place?

Surely most bones are without cartilage like the spine, in no way adapted to motion. Or are they designed to form connexions? And similarly, if bone is nourished from sinew, we must know the means by which sinew is nourished. We say that it is from the fluid surrounding the sinew, which is of a glutinous nature: but we must determine whence and how this arises. To say that the flesh is nourished from vein and air-duct, on the ground that blood comes from any point where you prick it, is false in the case of the other animals, e.g. birds, snakes, and fishes, and oviparous creatures in general. The universal dispersion of the blood is a peculiarity of creatures with a large blood-supply: for e.g. even when a small bird's breast is cut, not blood but serum flows.

Empedocles says that nail is formed from sinew by a hardening process. Is the
484b1 same true of skin in relation to flesh?

But how can hard and soft-shelled creatures get their nutriment from outside? On the contrary it seems that they get it from inside rather than out. Again, how and by what course does the passage of foods from the belly take place, and again their return into the form of flesh, unaccountable as it is? For this process seems extraordinary and absolutely impossible.

Do different things, then, have different nutriment, not all things being nourished by the blood except indirectly?

[15]Reading *σύμφυτόν πως . . . καταψύχοντος· ὅτι.*
[16]Reading *ὑγροῦ.*

7 · We must then consider the nature of bone, whether it exists with a view to motion or to support, or covering and surrounding, and further, whether some bones are as it were originators of motion, like the axis of the universe.

By motion I mean, e.g. that of the foot, the hand, the leg, or the elbow, both the bending motion and motion from place to place—for the latter cannot take place either without the bending, and usually the supporting functions belong to these same bones. And by covering and surrounding I mean as e.g. the bones in the head surround the brain; and those who make the marrow the originator of motion treat the bones as primarily meant to protect it. The ribs are for the purpose of locking together; the originator of motion, itself immovable, is the spine, from which spring the ribs for the purpose of locking the body together: for there must be something of this kind, since everything that is in motion depends on something that is in a state of rest.

At the same time a final cause must exist—under which head some class the originator of motion; i.e. the spinal marrow and the brain.

Besides these there are others which are at a joining[17] and whose purpose is locking together, e.g. the collar-bone, which perhaps is named the 'key-bone' from its functions. Every one is well adapted for its purpose, for there could be no flexion either of whole or parts, if the parts were not such as they are: e.g. the spine, foot, and elbow: for the bending of the elbow must be inwards to serve our purpose. Similarly, the bending of the foot and the other parts must be such as it is. All exist for a purpose, and so do the smaller bones contained in these larger ones—e.g. the radius in the fore-arm to enable us to twist the fore-arm and the hand; for we should not be able to turn the palm down or up nor lift nor bend the feet if there were not the two radii which are used in these motions. Similarly we must investigate the other details, e.g. whether the motion of the neck is due to only one bone or more. Also we must examine all that are for the purpose of gripping or knitting together, e.g. the patella over the knee; and why other parts have no such bone.

Now all parts which are capable of motion are connected with sinews—and perhaps those concerned with action in a positive way are especially so—thus we find sinews in the elbow, the legs, the hands, and the feet; the other sinews are for the purpose of fastening together all those bones which require fastening; for perhaps some, e.g. the spine, have little or no function except that of bending,[18] for the substance which connects the vertebrae is a serum or mucous fluid; others are bound together by sinews—thus we find sinews in the joints of the limbs.

8 · The best description of everything may be obtained by an investigation like the present; but we must adequately investigate the final causes. We must not suppose that the bones are for the sake of movement; that is rather the purpose of the sinews or what corresponds to them, viz. the immediate receptacle of the breath which causes motion, since even the belly moves and the heart has sinews—but only

[17]Reading *ἐπὶ συναφῆς*.
[18]Reading *ἄλλ' ἢ κάμψις*.

some, not all parts have bones: every part must have sinews appropriate for performing such motion or for . . .[19] For the octopus walks little and walks badly. We must take as a starting-point the fact that all animals have different organs for different purposes with a view to the peculiar motion of each, e.g. terrestrial animals have feet—those that are upright having two; others which move altogether upon the earth, the material of whose bodies is more earthy and colder, have several.

Some creatures again may be entirely without feet, for it is possible for them under these conditions to be moved only by external force. Similarly, flying creatures have wings, and their shape is appropriate to their nature. The parts differ in proportion as they are to fly faster or slower. They have feet for the purpose of seeking food and to enable them to stand; bats are an exception; as they cannot use their feet, they get their food in the air, and do not need to rest for the purpose; for they certainly do not need to do so for any other reason.

The hard-shelled aquatic animals have feet on account of their weight; thus they are enabled to move from place to place: all that concerns their other needs is as ordered by the individual requirements of each, even if the principle is not clear—e.g. why many-footed creatures are the slowest, and yet quadrupeds are swifter than bipeds. Is it because the whole of their body is on the ground or because they are naturally cold and hard to move, or for some other reason?

9 · We cannot agree with those who say that it is not the heat-principle which is active in bodies, or that fire has only one kind of motion and one power—the power to cleave. For in the case of inanimate things the action of fire is not universally[20] the same on all—some it condenses, others it rarefies; some it dissolves, others it hardens; and so we must suppose that in the case of animate creatures the same results are found, and we must investigate the fire of nature by comparing her processes to those of an art; for different results are achieved by fire in the work of the goldsmith, the coppersmith, the carpenter, and the cook—though, perhaps, it is truer to say that the arts themselves achieve these different results, for that by using fire as an instrument they soften, liquefy, and desiccate substances, and some they temper.

Individual natures work in the same way, and so they differ one from another; so that it is ridiculous to judge by externals; for whether we regard the heat as separating or refining, or whatever the effect of warming or burning is, the results will be different according to the different natures of the agencies which employ it. But while the crafts use the fire merely as an instrument, nature uses it as a material as well.

Certainly no difficulty is involved in this; but rather it is remarkable that nature, who employs the instrument, is herself an intelligent agent, who will assign to objects their proper symmetry together with the visible effects of her action: for this is no longer a function either of fire or of breath, so it is remarkable that we should find such a faculty combined with these two bodies. Again, with regard to

[19] Jaeger marks a lacuna here.
[20] Reading ὅλως.

soul we find the same cause of wonder, for it must be assumed in the functions of these two, and therefore there is some sense in referring to the same agent—either generally or to some particular creative part—the fact that its motion always operates[21] in the same way; for nature, from which they are generated, is always constant. But now what variation can there be in individual heat, whether we regard it as an instrument or material, or both? The variations in fire are simply quantitative; but this is practically a question of whether it is mixed with other substances or unmixed, for the purer substance has the proper qualities of its kind in a higher degree.

The same statement applies in the case of all other simple things; for whereas there is a difference between the bone and flesh of a horse and those of an ox,[22] this must be the case either because they are produced from different materials, or because the materials are used differently. Now if they are different, what are the distinctive characteristics of each of the simple things and what is . . .?[23] for it is these that we are seeking.

But if they are the same in nature, they may be different in their proportions: for one or the other must be the case—as holds good with other things—for the consistencies of wine and honey are different on account of the difference of substance; difference in wine itself, if there is any, is a matter of proportion.

And so Empedocles stated the nature of bone too simply;[24] for,[25] on the supposition that all bones follow the same proportion in the mixture of elements, the bones of a lion, a horse, and a man ought to be indistinguishable; whereas they actually differ in hardness and softness, density, and other qualities. Similarly with the flesh and other parts of the body.

Further, the various parts in the same creature differ in density and rarity, and in other qualities, so that the blending of their constituents cannot be identical; for, granted that coarseness and fineness, greatness and smallness are quantitative differences, hardness, density, and the opposites certainly depend on the qualitative nature of the mixing. But those who give this account of it must know how the creature element can vary, by excess or deficiency, by being in isolation or in 486a1
combination or heated in something else, like food that is boiled or baked,—which last is perhaps the true explanation; for in the process of mixing it produces the effect designed by nature.

So I suppose we must give the same account of flesh; for the variations are the 486b1
same; and practically the same observations apply to the veins and air-ducts and the rest; so that, in conclusion, either the proportion observed in their mixture is not constant, or the definitions must not be stated in terms of hardness, density, and their opposites.

[21]Retaining ἐνέργειαν.
[22]Reading ἡ ἵππου καὶ ἡ βοός. [23]Jaeger marks a lacuna here.
[24]Reading λίαν ἁπλῶς.
[25]Reading ἐπεὶ εἴπερ.

HISTORY OF ANIMALS

d'A. W. Thompson

BOOK I

1 · Of the parts of animals some are simple: to wit, all such as divide into parts uniform with themselves, as flesh into flesh; others are composite, such as divide into parts not uniform with themselves, as, for instance, the hand does not divide into hands nor the face into faces.

And of such as these, some are called not parts merely, but members. Such are those parts that, while entire in themselves, have within themselves other parts: as, for instance, the head, foot, hand, the arm as a whole, the chest; for these are all in themselves entire parts, and there are other parts belonging to them.

All those parts that do not subdivide into parts uniform with themselves are composed of parts that do so subdivide, for instance, hand is composed of flesh, sinews, and bones.

Of animals, some resemble one another in all their parts, while others have parts wherein they differ. Sometimes the parts are identical in form, as, for instance, one man's nose or eye resembles another man's nose or eye, flesh flesh, and bone bone; and in like manner with a horse, and with all other animals which we reckon to be of one and the same species; for as the whole is to the whole, so each to each are the parts severally. In other cases the parts are identical, save only for a difference in the way of excess or defect, as is the case in such animals as are of one and the same genus. By 'genus' I mean, for instance, Bird or Fish; for each of these is subject to difference in respect of its genus, and there are many species of fishes and of birds.

Among them, most of the parts as a rule exhibit differences through contrariety of properties, such as colour and shape, in that some are more and some in a less degree the subject of the same property; and also in the way of multitude or fewness, magnitude or smallness, in short in the way of excess or defect. Thus in some the texture of the flesh is soft, in others firm; some have a long bill, others a short one; some have abundance of feathers, others have only a small quantity. It happens further that, even in the cases we are considering, some have parts that others have not: for instance, some have spurs and others not, some have crests and others not; but as a general rule, most parts and those that go to make up the bulk of

TEXT: L. Dittmeyer, Teubner, Leipzig, 1907

the body are either identical with one another, or differ from one another in the way of contrariety and of excess and defect. For the more and the less may be represented as excess and defect.

There are some animals whose parts are neither identical in form nor differing in the way of excess or defect; but they are the same only in the way of analogy, as, for instance, bone is only analogous to fish-bone, nail to hoof, hand to claw, and scale to feather; for what the feather is in a bird, the scale is in a fish.

The parts, then, which animals severally possess are diverse from, or identical with, one another in the fashion above described. And they are so furthermore in the way of local disposition; for many animals have identical parts that differ in position; for instance, some have teats in the breast, others close to the thighs.

Of the substances that are composed of parts uniform with themselves, some are soft and moist, others are dry and solid. The moist are such either absolutely or so long as they are in their natural conditions, as, for instance, blood, serum, lard, suet, marrow, sperm, gall, milk in such as have it, flesh and the like; and also, in a different way, the waste products, as phlegm and the excretions of the belly and the bladder. The dry and solid are such as sinew, skin, vein, hair, bone, gristle, nail, horn (a term which as applied to the part involves an ambiguity, when the whole also by virtue of its form is designated horn),[1] and such parts as present an analogy to these.

Animals differ from one another in their modes of subsistence, in their actions, in their habits, and in their parts. Concerning these differences we shall first speak in broad and general terms, and subsequently we shall treat of the same with close reference to each particular genus.

Differences are manifested in modes of subsistence, in habits, and in actions as follows: some animals live in water and others on land. And of those that live in water some do so in one way, and some in another: that is to say, some live and feed in the water, take in and emit water, and cannot live if deprived of water, as is the case with the great majority of fishes; others get their food and spend their days in the water, but do not take in water but air, nor do they bring forth in the water. Many of these creatures are furnished with feet, as the otter, the beaver, and the crocodile; some are furnished with wings, as the diver and the grebe; some are destitute of feet, as the water-snake. Some creatures get their living in the water and cannot exist outside it: but for all that do not take in either air or water, as, for instance, the sea-anemone and the oyster. And of creatures that live in the water some live in the sea, some in rivers, some in lakes, and some in marshes, as the frog and the newt.

Of animals that live on land some take in air and emit it, which phenomena are termed 'inhalation' and 'exhalation'; as, for instance, man and all such land animals as are furnished with lungs. Others, again, do not inhale air, yet live and find their sustenance on dry land; as, for instance, the wasp, the bee, and all other insects. And by insects I mean such creatures as have notches on their bodies, either on their bellies or on both backs and bellies.

[1]The text of the parenthesis is uncertain, and Peck is perhaps right to excise it.

And of land animals many, as has been said, derive their subsistence from the water; but of creatures that live in and inhale water none derives its subsistence from the land.

Some animals at first live in water, and by and by change their shape and live out of water, as is the case with river worms—for out of these the gadfly develops.[2]

Furthermore, some animals are stationary, and some move about. Stationary animals are found in water, but no such creature is found on land. In the water are many creatures that live in close adhesion to an external object, as is the case with several kinds of shellfish. (The sponge actually appears to be endowed with a certain sensibility: as a sign of which it is alleged that the difficulty in detaching it is increased if the movement is not covertly applied.)

Other creatures adhere at one time to an object and detach themselves from it at other times, as is the case with a species of the so-called sea-anemone; for some of these creatures seek their food in the night-time loose and unattached.

Many creatures are unattached but motionless, as is the case with oysters and the so-called holothuria. Some can swim, as, for instance, fishes, molluscs, and crustaceans, such as the crayfish. But some move by walking, as the crab, for it is the nature of the creature, though it lives in water, to move by walking.

Of land animals some are furnished with wings, such as birds and bees, and these are so furnished in different ways one from another; others are furnished with feet. Of the animals that are furnished with feet some walk, some creep, and some wriggle. But no creature is able only to move by flying, as the fish is able only to swim; for the animals with leathern wings can walk, the bat has feet, and the seal has imperfect feet.

Some birds have feet of little power, and are therefore called *apodes*.[3] This little bird is powerful on the wing; and, as a rule, birds that resemble it are weak-footed and strong-winged, such as the swallow and the swift; for all these birds resemble one another in their habits and in their wings and look like one another. (The *apous* is to be seen at all seasons, but the swift only after rainy weather in summer; for this is the time when it is seen and captured, though, as a general rule, it is a rare bird.)

Again, many animals move by walking as well as by swimming.

Furthermore, the following differences are manifest in their modes of living and in their actions. Some are gregarious, some are solitary, whether they be furnished with feet or wings or be fitted for a life in the water; and some partake of both characters. And of the gregarious, some are social, others independent.

Gregarious creatures are, among birds, such as the pigeon, the crane, and the swan (no bird furnished with crooked talons is gregarious). Of creatures that live in water many kinds of fishes are gregarious, such as the so-called migrants, the tunny, the pelamys, and the bonito.

Man partakes of both characters.

Social creatures are such as have some one common object in view; and this

[2]Dittmeyer excises 'for . . . develops'.
[3]ἄποδες = 'the footless'; perhaps martins.

property is not common to all creatures that are gregarious. Such social creatures are man, the bee, the wasp, the ant, and the crane.

Again, of these social creatures some submit to a ruler, others are subject to no rule: as, for instance, the crane and the several sorts of bee submit to a ruler, whereas ants and numerous other creatures are subject to no rule.

And again, both of gregarious and of solitary animals, some are attached to a fixed home and others are nomadic.

Also, some are carnivorous, some graminivorous, some omnivorous: whilst some feed on a peculiar diet, as for instance the bees and the spiders (for the bee lives on honey and certain other sweets, and the spider lives by catching flies); and some creatures live on fish. Again, some creatures catch their food, others treasure it up, whereas others do not.

Some creatures provide themselves with a dwelling, others go without one: of the former kind are the mole, the mouse, the ant, the bee; of the latter kind are many insects and quadrupeds. Further, in respect to locality of dwelling-place, some creatures dwell under ground, as the lizard and the snake; others live on the surface of the ground, as the horse and the dog. Some make themselves holes, others do not do so.[4]

Some are nocturnal, as the owl and the bat; others live in the daylight.

Moreover, some creatures are tame and some are wild: some are at all times tame, as the jennet and the mule; others are at all times wild, as the leopard and the wolf; and some creatures can be rapidly tamed, as the elephant.

Again, we may regard animals in another light. For, whenever a race of animals is found domesticated, the same is always to be found in a wild condition; as we find to be the case with horses, cattle, pigs, donkeys,[5] sheep, goats, and dogs.

Further, some animals emit sound while others are mute, and some are endowed with voice: of these latter some have articulate speech, while others are inarticulate; some are noisy, some are prone to silence; some are musical, and some unmusical; but all animals without exception exercise their power of singing or chattering chiefly in connexion with the intercourse of the sexes.

Again, some creatures live in the fields, as the cushat; some on the mountains, as the hoopoe; some frequent the abodes of men, as the pigeon.

Some, again, are peculiarly salacious, as the partridge and the cockerel; others are inclined to chastity, as the whole tribe of crows, for birds of this kind indulge but rarely in sexual intercourse.

Of marine animals, again, some live in the open seas, some near the shore, some on rocks.

Furthermore, some are combative, others defensive. Of the former kind are such as act as aggressors upon others or retaliate when subjected to ill usage, and of the latter kind are such as have some means of guarding themselves against attack.

Animals also differ from one another in regard to character in the following

[4]Dittmeyer excises this sentence.
[5]Reading ὄνοι for ἄνθρωποι.

respects. Some are good-tempered, sluggish, and not prone to ferocity, as the ox; others are quick-tempered, ferocious and unteachable, as the wild boar; some are intelligent and timid, as the stag and the hare;[6] others are mean and treacherous, as the snake; others are free and courageous and high-bred, as the lion; others are thorough-bred and wild and treacherous, as the wolf. (An animal is high-bred if it come from a good stock, and an animal is thorough-bred if it does not deflect from its natural characteristics.)

Further, some are crafty and mischievous, as the fox; some are spirited and affectionate and fawning, as the dog; others are easy-tempered and easily domesticated, as the elephant; others are cautious and watchful, as the goose; others are jealous and self-conceited, as the peacock. But of all animals man alone is capable of deliberation.

Many animals have memory, and are capable of instruction; but no other creature except man can recall the past at will.

With regard to the several genera of animals, particulars as to their characters and ways of life will be discussed more precisely later on.

2 · Common to all animals are the parts by which and the parts into which they take food; and these are either identical with one another, or are diverse in the ways above specified: to wit, either identical in form, or varying in respect of excess or defect, or resembling one another analogically, or differing in position.

Furthermore, the great majority of animals have other parts besides these in common, whereby they discharge the residuum of their food—but this is not true of all. The part by which food is taken in is called the mouth, and the part into which it is taken, the belly; the remainder has a great variety of names.

Now the residuum of food is twofold in kind and such creatures as have parts receptive of wet residuum are found with parts receptive of dry residuum too; but such as have the latter do not all have the former. That is why an animal has a belly if it has a bladder; but those that have a belly do not all have a bladder. For the part receptive of wet residuum is termed 'bladder', and that of dry residuum 'belly'.

3 · Of the rest, a great many have, besides the parts above-mentioned, a part for the emission of the sperm; and of animals capable of generation one emits into another, and the other into itself. The latter is termed 'female', and the former 'male'; but some animals have neither male nor female. Consequently, the parts connected with this function differ in form; for some animals have a womb and others an organ analogous thereto.

The above-mentioned parts, then, are the most indispensable for animals; and with some of them all animals, and with others animals for the most part, are provided.

One sense, and one alone, is common to all animals—the sense of touch. Consequently, there is no special name for the part in which it has its seat; for in some groups of animals it is identical, in others it is analogous.

[6] Dittmeyer excises 'and the hare'.

4 · Every animal is supplied with moisture, and if the animal be deprived of the same by natural causes or by violence, death ensues; further, every animal has another part in which the moisture is contained. These parts are blood and vein, and in other animals there is something to correspond; but in these latter the parts are imperfect, being fibre and serum.

Touch has its seat in a part uniform with itself as in the flesh or something of the kind, and generally, with animals supplied with blood, in the parts charged with blood. In other animals it has its seat in parts analogous to the parts charged with blood; but in all cases it is seated in parts that are uniform with themselves.

The active faculties, on the contrary, are seated in the parts that are not uniform: as, for instance, the business of preparing the food is seated in the mouth, and the office of locomotion in the feet, the wings, or in organs to correspond.

Again, some animals are supplied with blood, as man, the horse, and all such animals as are, when full-grown, either destitute of feet, or two-footed, or four-footed; other animals are bloodless, such as the bee and the wasp, and, of marine animals, the cuttle-fish, the crayfish, and all such animals as have more than four feet.

5 · Again, some animals are viviparous, others oviparous, other vermiparous. Some are viviparous, such as man, the horse, the seal, and all other animals that are hair-coated, and, of marine animals, the cetaceans, as the dolphin, and the so-called selachia. (Of these latter animals, some have a tubular air-passage and no gills, as the dolphin and the whale: the dolphin with the air-passage going through its back, the whale with the air-passage in its forehead; others have uncovered gills, as the selachia, the sharks and rays.)

What we term an egg is a certain completed result of conception out of which the animal that is to be develops—from a part of it at first, while the rest serves for food as it develops. A grub on the other hand is a thing out of which in its entirety the animal in its entirety develops, by differentiation and growth of the embryo.

Of viviparous animals, some hatch eggs in their own interior, as the selachia; others engender in their interior, as man and the horse. When the result of conception is perfected, with some animals a living creature is brought forth, with others an egg is brought to light, with others a grub. Of the eggs, some have egg-shells and are of two different colours, such as birds' eggs; others are soft-skinned and of uniform colour, as the eggs of the selachia. Of the grubs, some are from the first capable of movement, others are motionless. However, with regard to these phenomena we must speak precisely hereafter when we come to treat of generation.

Furthermore, some animals have feet and some do not. Of such as have feet, some animals have two, as is the case with men and birds only; some have four, as the lizard and the dog; some have more, as the centipede and the bee; but all have an even number of feet.

Of swimming creatures that are destitute of feet, some have fins, as fishes: and of these some have four fins, two above on the back, two below on the belly, as the gilt-head and the basse; some have two only,—to wit, such as are exceedingly long and smooth, as the eel and the conger; some have none at all, as the muraena and others that use the sea just as snakes use dry ground—and snakes swim in water in just the same way. Of the selachia some have no fins, such as those that are flat and long-tailed, as the ray and the sting-ray, but these fishes swim actually by means of their flat bodies; the fishing-frog however, has fins, and so likewise have all such fishes as have not their flat surfaces thinned off to a sharp edge.

Of those swimming creatures that appear to have feet, as is the case with the molluscs, these creatures swim by the aid of their feet and their fins as well, and they swim most rapidly backwards in the direction of the trunk, as is the case with the cuttle-fish and the calamary; but neither of these latter can walk as the octopus can.

The hard-skinned animals, like the crayfish, swim by their tail-parts; and they swim most rapidly tail foremost, by the aid of the fins developed upon that member. The newt swims by means of its feet and tail; and its tail resembles that of the sheat-fish, to compare little with great.

Of animals that can fly some are furnished with feathered wings, as the eagle and the hawk; some are furnished with membranous wings, as the bee and the cockchafer; others are furnished with leathern wings, as the flying fox and the bat. Those possessed of blood have feathered wings or leathern wings; the bloodless creatures have membranous wings, as insects. The creatures that have feathered wings or leathern wings all have either two feet or no feet at all:[7] for there are said to be certain flying serpents in Ethiopia of this sort.

Creatures that have feathered wings are classed as a genus under the name of 'bird'; the other two genera have no single name.

Of creatures that can fly and are bloodless some are coleopterous; for they have their wings in a sheath or shard, like the cockchafer and the dung beetle; others are sheathless, and of these latter some are dipterous and some tetrapterous: tetrapterous, such as are large or have their stings in the tail, dipterous, such as are small or have their stings in front. The coleoptera are, without exception, devoid of stings; the diptera have the sting in front, as the fly, the horsefly, the gadfly, and the gnat.

Bloodless animals are all inferior in point of size to blooded animals; but there are found in the sea some few bloodless creatures of larger size, as in the case of certain molluscs. And of these bloodless genera, those are the largest that dwell in milder climates, and those that inhabit the sea are larger than those living on dry land or in fresh water.

All creatures that are capable of motion move with four or more points of motion; the blooded animals with four only: as, for instance, man with two hands and two feet, birds with two wings and two feet, quadrupeds and fishes severally with four feet and four fins. Creatures that have two fins, or that have none at all like serpents, move all the same with four points of motion; for they have four joints, or two plus their fins. Bloodless many-footed animals, whether furnished with wings or feet, move with more than four points of motion; as, for instance, the dayfly

[7] Omitting Dittmeyer's addition.

moves with four feet and four wings—for this creature is exceptional not only in 490b1
regard to the duration of its existence, whence it receives its name, but also because though a quadruped it has wings also.

All animals move alike, four-footed and many-footed; they all move cross-corner-wise. And animals in general have two feet in advance; the crab alone has four.

6 · Very extensive genera of animals, into which other subdivisions fall, are the following: one, of birds; one, of fishes; and another, of cetaceans. Now all these creatures are blooded.

There is another genus of the hard-shell kind, which is called the shell-fish; another of the soft-shell kind, not designated by a single term, such as the crayfish and the various kinds of crabs and lobsters; and another of molluscs, as the two kinds of calamary and the cuttle-fish; that of insects is different. All these are bloodless, and such of them as have feet have a large number of them; and of the insects some have wings as well as feet.

Of the other animals the genera are not extensive. For in them one species does not comprehend many species; but in one case, as man, the species is simple, admitting of no differentiation, while other cases admit of differentiation, but the species lack particular designations.

So, for instance, creatures that are quadrupedal and unprovided with wings are blooded without exception, but some of them are viviparous, and some oviparous. Such as are viviparous are hair-coated, and such as are oviparous have a horny tessellation—the tessellation holds the place of scales.

An animal that is blooded and terrestrial, but is naturally unprovided with feet, belongs to the serpent genus; and animals of this genus possess tessellation. Serpents in general are oviparous; the adder alone is viviparous; for not all viviparous animals are hair-coated, and some fishes also are viviparous.

All animals, however, that are hair-coated are viviparous. For one must regard as a kind of hair such prickly hairs as hedgehogs and porcupines carry; for these spines perform the office of hair, and not of feet as is the case with similar parts in sea-urchins.

In the genus that combines all viviparous quadrupeds are many species, but under no common appellation. They are only named as it were one by one, as man is—e.g. the lion, the stag, the horse, the dog, and so on; though there is actually[8] a
single genus in the case of the so-called bushy-tailed animals, such as the horse, the 491a1
ass, the mule, the jennet, and the animals that are called mules in Syria,—from their resembling mules, though they are not strictly of the same species, for they mate with and breed from one another.

For all these reasons, we must take animals species by species, and discuss their peculiarities severally.

These preceding statements, then, have been put forward thus in a general way, as a kind of foretaste of the number of subjects and of the properties that we

[8]Retaining καί.

have to consider in order that we may first get a clear notion of their actual differences and common properties. By and by we shall discuss these matters with greater accuracy.

After this we shall pass on to the discussion of causes. For to do this when the investigation of the details is complete is the natural method; for from them the subjects and the premisses of our proof become clear.

In the first place we must look to the constituent parts of animals. For it is relative to these parts, first and foremost, that animals in their entirety differ from one another: either in the fact that some have this or that, while they have not that or this; or by peculiarities of position or of arrangement; or by the differences that have been previously mentioned, depending upon form, on excess, on analogy, or on contrariety of qualities.

To begin with, we must take into consideration the parts of man. For, just as any group tests coinage against that with which it is most familiar, so must we do in other matters. And, of course, man is the animal with which we are the most familiar.

Now the parts are obvious enough to perception. However, with the view of observing due order and sequence and of combining reason with perception, we shall proceed to enumerate the parts: firstly, the organic, and afterwards the uniform.

7 · The chief parts into which the body as a whole is divided, are the head, the neck, the thorax, two arms and two legs.

Of the parts of which the head is composed the hair-covered portion is called the skull. The front portion of it is termed the sinciput, developed after birth—for it is the last of all the bones in the body to acquire solidity,—the hinder part is termed the occiput, and the part intervening between the sinciput and the occiput is the crown. The brain lies underneath the sinciput; the occiput is hollow. The skull consists entirely of thin bone, rounded in shape, and contained within a wrapper of fleshless skin.

The skull has sutures: one, of circular form, in the case of women; in the case of men, as a general rule, three meeting at a point. Instances have been seen of a man's skull devoid of suture altogether. In the skull the middle line, where the hair parts, is called the crown. In some cases the parting is double; that is to say, some men are double-crowned, not in regard to the bony skull, but in consequence of the parting of the hair.

8 · The part that lies below the skull is called the face: but in the case of man only, for the term is not applied to a fish or to an ox. In the face the part below the sinciput and between the eyes is termed the forehead. When men have large foreheads, they are slow; when they have small ones, they are quickly moved; when they have broad ones, they are apt to be distraught; when they have foreheads rounded, they are quick-tempered.[9]

[9] Retaining θυμικοί.

9 · Underneath the forehead are two eyebrows. Straight eyebrows are a sign of softness of disposition; such as curve in towards the nose, of harshness; such as curve out towards the temples, of humour and dissimulation.

Under the eyebrows come the eyes. These are naturally two in number. Each of them has an upper and a lower eyelid, and the hairs on the edges of these are termed eyelashes. The inner part of the eye includes the moist part whereby vision is effected, termed the pupil, and the part surrounding it called the iris; the part outside this is the white. A part common to the upper and lower eyelid is a pair of nicks, one in the direction of the nose, and the other in the direction of the temples. When these are long they are a sign of bad disposition; if the side toward the nostril be fleshy, as in the case of kites,[10] they are a sign of dishonesty.

All the other animals are provided with eyes, excepting the ostracoderms and other imperfect creatures; at all events, all viviparous animals have eyes, with the exception of the mole. And yet one might assert that, though the mole has not eyes in the full sense, yet it has eyes in a kind of way. For in point of fact it cannot see, and has no eyes visible externally; but when the outer skin is removed, it is found to have the place where eyes are usually situated, and the black parts of the eyes rightly situated, and all the place that is usually devoted on the outside to eyes: showing that the parts are stunted in development, and the skin allowed to grow over.

10 · Of the eye the white is pretty much the same in all creatures; but what is called the iris differs. In some it is black, in some distinctly blue, in some greyish-blue, in some greenish; and this last colour is the sign of an excellent disposition, and is particularly well adapted for sharpness of vision.

Man is the only, or nearly the only, creature, that has eyes of diverse colours. The others have eyes of one colour only. Some horses have blue eyes.

Of eyes, some are large, some small, some medium-sized; of these, the medium-sized are the best. Moreover, eyes sometimes protrude, sometimes recede, sometimes are neither protruding nor receding. Of these, the receding eye is in all animals the most acute; but the last kind are the sign of the best disposition. Again, eyes are sometimes inclined to blink, sometimes to stare, and sometimes neither. The last kind are the sign of the best nature, and of the others, the latter kind indicates impudence, and the former indecision.

11 · Furthermore, there is a portion of the head, whereby an animal hears, a part incapable of breathing, the ear. For Alcmaeon is mistaken when he says that goats inspire through their ears. Of the ear one part is unnamed, the other part is called the lobe; and it is entirely composed of gristle and flesh. The ear is constructed internally like the trumpet-shell, and the innermost-bone is like the ear itself, and into it at the end the sound makes its way, as into a jar. This does not communicate by any passage with the brain, but does so with the palate, and a vein extends from the brain towards it. The eyes also are connected with the brain, and

[10] Reading οἱ ἰκτῖνες.

each of them lies at the end of a little vein.[11] Of animals possessed of ears man is the only one that cannot move this part. Of creatures possessed of hearing, some have ears, whilst others have none, but merely have the passages for ears visible, as, for example, feathered animals or animals with horny tessellation.

Viviparous animals, with the exception of the seal, the dolphin, and those others which after a similar fashion to these are cetaceans, are all provided with ears; [for the shark-kind are also viviparous. But man alone does not move his ears. Now, the seal has the passages visible whereby it hears; but the dolphin can hear, but has no ears. All other animals can move them.][12] And the ears lie on the same circumference as the eyes, and not in a plane above them as is the case with some quadrupeds. Of ears, some are smooth, some are shaggy, and some are of medium texture; the last kind are best for hearing, but they serve in no way to indicate
492b1 character. Some ears are large, some small, some medium-sized; again, some stand out far, some not at all, and some take up a medium position; of these the medium sort are indications of the best disposition, while the large and outstanding ones indicate a tendency to irrelevant talk or chattering. The part between the eye, the ear, and the crown is termed the temple.

Again, there is a part of the countenance that serves as a passage for the breath, the nose. For a man inhales and exhales by this organ, and sneezing is effected by its means—this is an outward rush of collected breath, and is the only mode of breath used as an omen and regarded as supernatural. Both inhalation and exhalation go right on towards the chest; and with the nostrils alone and separately it is impossible to inhale or exhale, owing to the fact that the inspiration and respiration take place from the chest along the windpipe, and not by any portion connected with the head; and indeed it is possible for a creature to live without using its nose.

Again, smelling takes place by means of the nose—that is, perception of odour. And the nostril admits of easy motion, and is not, like the ear, intrinsically immovable. A part of it, composed of gristle, constitutes a septum, and part is an open passage; for the nostril consists of two separate channels. The nostril of the elephant is long and strong, and the animal uses it like a hand; for by means of this organ it draws objects towards it, and takes hold of them, and introduces its food into its mouth, whether liquid or dry food, and it is the only living creature that does so.

Furthermore, there are two jaws; the front part of them constitutes the chin, and the hinder part the cheek. All the animals move the lower jaw, with the exception of the river-crocodile; this creature moves the upper jaw only.

Next after the nose come two lips, composed of flesh, and facile of motion. The mouth lies inside the jaws and lips. Parts of the mouth are the roof and the pharynx.

The part that is sensible of taste is the tongue. The sensation has its seat at the tip—if something is placed on the flat surface of the organ, the taste is less. The

[11] Dittmeyer excises this sentence.
[12] Dittmeyer excises the bracketed sentences: the text is plainly corrupt.

tongue can also perceive everything that flesh in general can—e.g. hardness, or warmth and cold, in any part of it, just as it can appreciate taste. The tongue is sometimes broad, sometimes narrow, and sometimes of medium width; the last kind is the best and the clearest. Moreover, the tongue is sometimes loosely hung, and sometimes fastened: as in the case of those who mumble and who lisp.

The tongue consists of flesh, soft and spongy, and the so-called epiglottis is a part of this organ.

That part of the mouth that splits into two bits is called the tonsils; that part that splits into many bits, the gums. Both the tonsils and the gums are composed of flesh. In the gums are teeth, composed of bone.

Inside the mouth is another part, shaped like a bunch of grapes, a pillar streaked with veins. If this pillar gets moistened and inflamed it is called the uvula, and it then has a tendency to bring about suffocation.[13]

12 · The neck is the part between the face and the trunk. [Of this the front part is the larynx and the back part the gullet.][14] The front part, composed of gristle, through which respiration and speech is effected, is termed the wind-pipe; the part that is fleshy is the gullet, inside just in front of the chine. The part to the back of the neck is the shoulder-point.

These then are the parts to be met with before you come to the thorax.

To the trunk there is a front part and a back part. Next after the neck in the front part is the chest, with a pair of breasts. To each of the breasts is attached a nipple, through which in the case of females the milk percolates; and the breast is soft. Milk is found at times in the male; but with the male the flesh of the breast is tough, with the female it is spongy and porous.

13 · Next after the thorax and in front comes the stomach, and its root the navel. Underneath this root the bilateral part is the flank; the undivided part below the navel is the abdomen, the extremity of which is the region of the pubes; and above the navel the hypochondrium; the part common to the hypochondrium and the flank is the gut-cavity.

Serving as a brace-girdle to the hinder parts is the pelvis, and hence it gets its name (*ὀσφύς*), for it is symmetrical (*ἰσοφυές*) in appearance; of the fundament the part for resting on is termed the buttock, and the part whereon the thigh pivots is termed the socket.

The womb is a part peculiar to the female; and the penis is peculiar to the male. This latter organ is external and situated at the extremity of the trunk; it is composed of two separate parts: of which the extreme part is fleshy, hardly alters in size, and is called the glans; and round about it is a skin devoid of any specific title, which never grows together again if it is cut any more than does the jaw or the eyelid. And the connexion between the latter and the glans is called the frenum. The remaining part of the penis is composed of gristle; it is easily susceptible of

[13]The last two paragraphs are excised by Dittmeyer.
[14]Peck rightly excises the bracketed sentence.

enlargement; and it protrudes and recedes in the opposite way to that of the cat.[15] Underneath the penis are two testicles, and the integument of these is a skin that is termed the scrotum.

493b1 Testicles are not identical with flesh, and are not altogether diverse from it. But by and by we shall treat in an accurate way regarding all such parts.

14 · The privy part of the female is in character opposite to that of the male. In other words, the part under the pubes is hollow, and not, like the male organ, protruding. Further, there is an urethra outside the womb which serves as a passage for the sperm of the male, and as an outlet for liquid excretion to both sexes.

The part common to the neck and chest is the throat; the armpit is common to side, arm, and shoulder; and the groin is common to thigh and abdomen. The part inside the thigh and buttocks is the perineum, and the part outside the thigh and buttocks is the hypoglutis.

The front parts of the trunk have now been enumerated.

The part behind the chest is termed the back.

15 · Parts of the back are a pair of shoulder-blades, the back-bone, and, underneath on a level with the stomach in the trunk, the loins. Common to the upper and lower part of the trunk are the ribs, eight on either side, for as to the so-called seven-ribbed Ligyans we have not received any trustworthy evidence.

Man, then, has an upper and a lower part, a front and a back part, a right and a left side. Now the right and the left side are pretty well alike in their parts and identical throughout, except that the left side is the weaker of the two; but the back parts do not resemble the front ones, neither do the lower ones the upper: only that these upper and lower parts may be said to resemble one another thus far, that, if the face be plump or meagre, the abdomen is plump or meagre to correspond; and that the legs correspond to the arms, and where the upper arm is short the thigh is usually short also, and where the feet are small the hands are small correspondingly.

Of the limbs, one set, forming a pair, is arms. To the arm belong the shoulder, upper-arm, elbow, forearm, and hand. To the hand belong the palm, and the five fingers. The part of the finger that bends is the knuckle, the part that is inflexible is the phalanx. The thumb is single-jointed, the other fingers are double-jointed. The bending both of the arm and of the finger takes place inwards in all cases; and the arm bends at the elbow. The inner part of the hand is the palm, and is fleshy and divided by joints: in the case of long-lived people by one or two extending right
494a1 across, in the case of the short-lived by two, not so extending. The joint between hand and arm is the wrist. The outside or back of the hand is sinewy, and has no specific designation.

There is another two-parted limb, the leg. Of this limb the double-knobbed part is the thigh, the sliding part is the knee-cap, the double-boned part is the lower

[15]Reading αἰλούροις for λοφούροις.

leg; the front part of this latter is the shin, and the part behind it is the calf, wherein the flesh is sinewy and venous, in some cases drawn upwards towards the hollow behind the knee, as in the case of people with large hips, and in other cases drawn downwards. The lower extremity of the shin is the ankle, duplicate in either leg. The part of the limb that contains a multiplicity of bones is the foot. The hinder part of the foot is the heel; at the front of it the divided part consists of toes, five in number; the fleshy part underneath is the ball; the upper part at the top is sinewy and has no particular appellation; of the toe, one portion is the nail and another the joint, and the nail is in all cases at the extremity; and toes are without exception single-jointed. Men that have the inside of the foot thick and not arched, that is, that walk resting on the entire under-surface of their feet, are prone to roguery. The joint common to thigh and shin is the knee.

These, then, are the parts common to the male and the female sex. The relative position of the parts as to up and down, or to front and back, or to right and left, all this as regards externals might safely be left to mere ordinary perception. But for all that, we must treat of them for the same reason as the one underlying our previous remarks; that is to say, we must refer to them in order that a due and regular sequence may be observed in our exposition, and in order that by their enumeration due attention may be subsequently given to those parts in men and other animals that are diverse in any way from one another.

In man, above all other animals, the upper and lower parts are arranged in accordance with their natural positions; for in him, upper and lower are the same as in the case of the universe as a whole. In like manner the parts in front, behind, right and left, are in accordance with nature. But in regard to other animals, in some cases these distinctions do not exist, and in others they do so, but in a vague way. For instance, the head with all animals is up and above in respect to their bodies; but man alone, as has been said, has, in maturity, this part uppermost in respect to the universe.

Next after the head comes the neck, and then the chest and the back: the one in front and the other behind. Next after these come the stomach, the loins, the sexual parts, and the haunches; then the thigh and shin; and, lastly, the feet.

The legs bend frontwards, in the direction of actual progression, and frontwards also lies that part of the foot which is the most effective of motion, and its bending; but the heel lies at the back, and the ankle-bones lie laterally, earwise. The arms are situated to right and left, and bend inwards: so that the convexities formed by bent arms and legs are practically face to face with one another in the case of man.

As for the senses and for the organs of sensation, the eyes, the nostrils, and the tongue, all alike are situated frontwards; the sense of hearing, and the organ of hearing, the ear, is situated sideways, on the same circumference with the eyes. The eyes in man are, in proportion to his size, nearer to one another than in any other animal.

Of man's senses, touch is the most accurate; taste is second; in the others, man is surpassed by a great number of animals.

16 · The parts, then, that are externally visible are arranged in the way above stated, and as a rule have their special designations, and from use and wont are known familiarly to all; but this is not the case with the inner parts. For the fact is that the inner parts of man are to a very great extent unknown, and the consequence is that we must have recourse to an examination of the inner parts of other animals whose nature in any way resembles that of man.

In the first place then, the brain lies in the front part of the head. And this holds alike with all animals possessed of a brain; and all blooded animals are possessed thereof, and molluscs as well. But, taking size for size of animal, the largest brain, and the moistest, is that of man. Two membranes enclose it: the stronger one is nearer the bone; the one round the brain itself is finer. The brain in all cases is bilateral. Behind this, right at the back, comes what is termed the cerebellum, differing in form from the brain as we may both feel and see.

The back of the head is with all animals empty and hollow, whatever be its size in the different animals. For some creatures have big heads while the face below is small in proportion, as is the case with round-faced animals; some have little heads and long jaws, as is the case, without exception, among animals with bushy tails.

The brain in all animals is bloodless, devoid of veins, and naturally cold to the touch; in the great majority of animals it has a small hollow in its centre. The caul around it is veined; and this brain-caul is that skin-like membrane which closely surrounds the brain. Above the brain is the thinnest and weakest bone of the head, which is termed the sinciput.

From the eye there go three ducts to the brain: the largest and the medium-sized to the cerebellum, the least to the brain itself; and the least is the one situated nearest to the nostril. The two largest ones, then, run side by side and do not meet; the medium-sized ones meet—and this is particularly visible in fishes,—for they lie nearer than the large ones to the brain; the smallest pair are the most widely separate from one another, and do not meet.

Inside the neck is what is termed the oesophagus (whose name, 'gullet' (*στόμαχος*), is derived from its length and narrowness), and the windpipe. The windpipe is situated in front of the oesophagus in all animals that have a windpipe, and all animals have one that are furnished with lungs. The windpipe is made up of gristle, is sparingly supplied with blood, and is streaked all round with numerous minute veins; it is situated, in its upper part, near the mouth, below the aperture formed by the nostrils into the mouth—an aperture through which, when men, in drinking, choke on any of the liquid, this liquid finds its way out through the nostrils. In betwixt the two openings comes the so-called epiglottis, an organ capable of being drawn over and covering the orifice of the windpipe communicating with the mouth; the end of the tongue is attached to the epiglottis. In the other direction the windpipe extends to the interval between the lungs, and hereupon bifurcates into each of the two divisions of the lung; for the lung in all animals possessed of the organ has a tendency to be double. In viviparous animals, however, the duplication is not so plainly discernible as in other species, and the duplication is least discernible in man. And in man the organ is not split into many parts, as is the case with some vivipara, neither is it smooth, but its surface is uneven.

In the case of the ovipara, such as birds and oviparous quadrupeds, the two parts of the organ are separated to a distance from one another, so that the creatures appear to be furnished with a pair of lungs; and from the windpipe, itself single, there branch off two separate parts extending to each of the two divisions of the lung. It is attached also to the great vein and to what is designated the aorta. When the windpipe is charged with air, the air passes on to the hollow parts of the lung. These parts have divisions, composed of gristle, which meet at an acute angle; from the divisions run passages through the entire lung, giving off smaller and smaller ramifications. The heart also is attached to the windpipe, by connexions of fat, gristle, and sinew; and at the point of juncture there is a hollow. When the windpipe is charged with air, the entrance of the air into the heart, though imperceptible in some animals, is perceptible enough in the larger ones. Such are the properties of the windpipe, and it takes in and throws out air only, and takes in nothing else either dry or liquid, or else it causes you pain until you shall have coughed up whatever may have gone down.

The gullet communicates at the top with the mouth, close to the windpipe, and is attached to the backbone and the windpipe by membranous ligaments, and at last finds its way through the midriff into the belly. It is composed of flesh-like substance, and is elastic both lengthways and breadthways.

The stomach of man resembles that of a dog; for it is not much bigger than the bowel, but is somewhat like a bowel of more than usual width; then comes the bowel, single, convoluted, moderately wide. The lower part of the gut is like that of a pig; for it is broad, and the part from it to the buttocks is thick and short. The caul is attached to the middle of the stomach, and consists of a fatty membrane, as is the case with all other animals whose stomachs are single and which have teeth in both jaws.

The mesentery is over the bowels; this also is membranous and broad, and turns to fat. It is attached to the great vein and the aorta, and there run through it a number of veins closely packed together, extending towards the region of the bowels, beginning above and ending below.

So much for the properties of the oesophagus, the windpipe, and the stomach.

17 · The heart has three cavities, and is situated above the lung at the division of the windpipe, and is provided with a fatty and thick membrane where it fastens on to the great vein and the aorta. It lies with its tapering portion upon the aorta, and this portion is similarly situated in relation to the chest in all animals that have a chest. In all animals alike, in those that have a chest and in those that have none, the apex of the heart points forwards, although this fact might possibly escape notice by a change of position under dissection. The rounded end of the heart is at the top. The apex is to a great extent fleshy and close in texture, and in the cavities of the heart are sinews. As a rule the heart is situated in the middle of the chest in animals that have a chest, and in man it is situated a little to the left-hand side, leaning a little way from the division of the breasts towards the left breast in the upper part of the chest.

The heart is not large, and in its general shape it is not elongated; in fact, it is somewhat round in form: only it is sharp-pointed at the bottom. It has three cavities, as has been said: the right-hand one the largest of the three, the left-hand one the least, and the middle one intermediate in size. All these cavities, even the two small ones, are connected by passages with the lung, and this fact is rendered quite plain in one of the cavities. And below, at the point of attachment, in the largest cavity there is a connexion with the great vein near which the mesentery lies; and in the middle one there is a connexion with the aorta.[16]

Passages lead from the heart into the lung, and branch off just as the windpipe does, running all over the lung parallel with the passages from the windpipe. The canals from the heart are uppermost; and there is no common passage, but the passages through their having a common wall receive the breath and pass it on to the heart; and one of the passages conveys it to the right cavity, and the other to the left.

With regard to the great vein and the aorta we shall, by and by, treat of them together in a discussion devoted to them alone.

In all animals that are furnished with a lung, and that are both internally and externally viviparous, the lung is of all parts the most richly supplied with blood; for the lung is throughout spongy in texture, and along by every single pore in it go branches from the great vein. Those who imagine it to be empty are altogether mistaken; and they are led into their error by their observation of lungs removed from animals under dissection, out of which organs the blood has all escaped immediately after death.

Of the other internal organs the heart alone contains blood. And the lung has blood not in itself but in its veins, but the heart has blood in itself; for in each of its three cavities it has blood, but the thinnest blood is what it has in its central cavity.

Under the lung comes the thoracic diaphragm or midriff, attached to the ribs, the hypochondria and the backbone, with a thin membrane in the middle of it. It has veins running through it; and the diaphragm in the case of man is thick in proportion to the size of his frame.

Under the diaphragm on the right-hand side lies the liver, and on the left-hand side the spleen, alike in all animals that are provided with these organs in a natural and not a monstrous way; for in some quadrupeds these organs have been found in a transposed position. These organs are connected with the stomach by the caul.

To outward view the spleen of man is narrow and long, resembling that of the pig. The liver for the most part and in most animals is provided with a gall-bladder; but the latter is absent in some. The liver of a man is round-shaped, and resembles that of the ox. This occurs in the case of sacrificial animals too; e.g. in a certain district of the Chalcidic settlement in Euboea the sheep are devoid of gall-bladders; and in Naxos nearly all the quadrupeds have one so large that foreigners when they offer sacrifice are astounded, under the impression that this is not the animals' nature but a sign peculiar to themselves.

[16]Dittmeyer excises 'It has three cavities . . . with the aorta'.

Again, the liver is attached to the great vein, but it has no communication with the aorta; for the vein that goes off from the great vein goes right through the liver, at a point where are the so-called portals of the liver. The spleen also is connected only with the great vein, for a vein extends to the spleen off from it.

After these organs come the kidneys, and these are placed close to the backbone, and resemble in character the same organ in the ox. In all animals that are provided with this organ, the right kidney is situated higher up than the other. It 497a1 has also less fatty substance than the left-hand one and is less moist. And this is found in all the other animals alike.

Furthermore, passages lead into the kidneys both from the great vein and from the aorta, only not into the cavity. For there is a cavity in the middle of the kidney, bigger in some creatures and less in others; but there is none in the case of the seal. This latter animal has kidneys resembling those of the ox, but more solid than in any other creature. The passages that lead into the kidneys lose themselves in the substance of the kidneys themselves; and a sign that they extend no farther rests on the fact that they[17] contain no blood, nor is any clot found therein. The kidneys, however, have, as has been said, a small cavity.[18] From this cavity in the kidney there lead two considerable passages into the bladder; and others spring from the aorta, strong and continuous. And to the middle of each of the two kidneys is attached a hollow sinewy vein, stretching right along the spine through the narrows; by and by these veins are lost in either loin, and again become visible extending to the flank. And these off-branchings of the veins terminate in the bladder. For the bladder lies at the extremity, and is held in position by the ducts stretching from the kidneys, along the stalk that extends to the urethra; and pretty well all round it is fastened by fine sinewy membranes, that resemble to some extent the thoracic diaphragm. The bladder in man is tolerably large.

To the stalk of the bladder the private part is attached, the endmost part of it being a single united orifice; but a little lower down, one of the openings communicates with the testicles and the other with the bladder. The penis is gristly and sinewy. With it are connected the testicles in male animals, and the properties of these organs we shall discuss in our general account.

All these organs are similar in the female; for there is no difference in regard to the internal organs, except in respect to the womb. The appearance of this organ can be investigated from the diagrams in the *Anatomies;* its position is over the bowel, and the bladder lies over the womb. But we must treat by and by of the womb of all female animals viewed generally. For the wombs of all female animals are not identical, neither do their local dispositions coincide.

These are the organs, internal and external, of man, and such is their nature 497b1 and such their local disposition.

[17]Omitting Dittmeyer's addition.
[18]Dittmeyer excises this sentence.

BOOK II

1 · With regard to animals in general, some parts or organs are common to all, as has been said, and some are common only to particular genera; the parts, moreover, are identical with or different from one another on the lines already repeatedly laid down. For as a general rule all animals that are generically distinct have the majority of their parts different in form; and some of them they have only analogically similar and diverse in genus, while they have others that are alike in genus but specifically diverse; and many exist in some animals, but not in others.

For instance, viviparous quadrupeds have all a head and a neck, and all the parts of the head, but they differ each from other in the shapes of the parts. The lion has its neck composed of one single bone instead of vertebrae; but, when opened up, the animal is found in all internal characteristics to resemble the dog.

The quadruped vivipara instead of arms have forelegs. This is true of all quadrupeds, but such of them as have toes have, practically speaking, organs analogous to hands; at all events, they use these fore-limbs for many purposes as hands—except for the elephant.

This animal has its toes somewhat indistinctly defined, and its front legs are much bigger than its hinder ones; it is five-toed, and has short ankles to its hind feet. But it has a nose of such a sort and size as to allow of its being used as a hand. For it eats and drinks by lifting up its food with the aid of this organ into its mouth, and it lifts up articles to its driver and it pulls up trees, and when walking through water it spouts the water up by means of it; and this organ bends but is not jointed, for it is composed of gristle.

Of all animals man alone can learn to make equal use of both hands.

All animals have a part analogous to the chest in man, but not similar to his; for the chest in man is broad, but that of all other animals is narrow. Moreover, no other animal but man has breasts in front; the elephant, certainly, has two breasts,
498a1 not however in the chest, but near it.

Moreover, animals have the flexions of their fore and hind limbs in directions opposite to one another, and in directions opposite to the joints in man; with the exception of the elephant. For with the viviparous quadrupeds the front legs bend forwards and the hind ones backwards, and the concavities of the two pairs of limbs thus face one another.

The elephant is not as some used to assert, but it bends its legs and settles down; only that in consequence of its weight it cannot bend its legs on both sides simultaneously, but falls into a recumbent position on one side or the other, and in this position it goes to sleep. And it bends its hind legs just as a man bends his legs.

In the case of ovipara, as the crocodile and the lizard and the like, both pairs of legs, fore and hind, bend forwards, with a slight swerve to one side. The flexion is similar in the case of the multipeds; only that the legs in between the extreme ends always move in an intermediate manner and bend sideways rather. But man bends his arms and his legs towards the same point, and therefore in opposite ways: he bends his arms backwards, with just a slight inclination inwards, and his legs frontwards. No animal bends both its fore-limbs and hind-limbs backwards; but in the case of all animals the flexion of the shoulders is in the opposite direction to that of the elbows or the joints of the forelegs, and, in the hind legs, the flexure in the hips to that of the knees: so that since man differs from other animals in flexion, those animals that possess such parts as these move them contrariwise to man.

Birds have the flexions of their limbs like those of the quadrupeds; for, although bipeds, they bend their legs backwards, and instead of arms or front legs have wings which bend frontwards.

The seal is a kind of imperfect quadruped; for just behind the shoulder-blade its front feet are placed, resembling hands, like the front paws of the bear; for they are furnished with five toes, and each of the toes has three flexions and a nail of inconsiderable size. The hind feet are also furnished with five toes, and in their 498b1
flexions and nails they resemble the front feet; but in shape they resemble a fish's tail.

The movements of animals, quadruped and multiped, are crosswise and they stand in this way; and it is always the limb on the right-hand side that is the first to move. The lion, however, and the two species of camel, both the Bactrian and the Arabian, progress laterally; and in lateral progress sometimes[1] the right foot is not advanced before the left but follows it.

Whatever parts men have in front, these parts quadrupeds have below, on the belly: and whatever parts men have behind, these parts quadrupeds have on their backs. Most quadrupeds have a tail; for even the seal has a tiny one resembling that of the stag. Regarding the tails of the pithecoids we must give their distinctive properties by and by.

All viviparous quadrupeds are hair-coated, whereas man has only a few short hairs excepting on the head, but, so far as the head is concerned, he is hairier than any other animal. Further, of the other hair-coated animals, the back is hairier and the belly is either entirely smooth or less hairy; but with man the reverse is the case.

Man also has upper and lower eyelashes, and hair under the armpits and on the pubes. No other animal has hair in either of these localities, or has a lower eyelash; though in the case of some animals soft hairs grow below the eyelid.

Of hair-coated quadrupeds some are hairy all over the body, as the pig, the bear, and the dog; others are especially hairy on the neck and all round about it, as is the case with animals that have a shaggy mane, such as the lion; others again are especially hairy on the upper surface of the neck from the head as far as the withers, namely, such as have a crested mane, as is the case with the horse, the mule, and, among the undomesticated horned animals, the bison.

The so-called hippelaphus also has a mane on its withers, and the animal called pardion, in either case a thin mane extending from the head to the withers; the hippelaphus has, exceptionally, a beard by the larynx. Both these animals have 499a1
horns and are cloven-footed; the female, however, of the hippelaphus has no horns.

[1]Reading ἔστιν ὅτε.

This latter animal resembles the stag in size; it is found in the territory of the Arachotae, where the wild cattle also are found.

Wild cattle differ from their domesticated congeners just as the wild boar differs from the domesticated one. That is to say they are black, strong looking, with a hook-nosed muzzle, and with horns lying more over the back. The horns of the hippelaphus resemble those of the gazelle.

The elephant is the least hairy of all quadrupeds. With animals, as a general rule, the tail corresponds with the body as regards thickness or thinness of hair-coating; that is, with animals that have long tails, for some creatures have tails of altogether insignificant size.

Camels have an exceptional part wherein they differ from all other quadrupeds, and that is the so-called hump on their back. The Bactrian camel differs from the Arabian; for the former has two humps and the latter only one, though it has a kind of a hump below like the one above, on which, when it kneels, the weight of the whole body rests. The camel has four teats like the cow, a tail like that of an ass, and the privy parts of the male are directed backwards. It has one knee in each leg, and not, as some say, several joints, although they appear to have several because of the constricted shape of the region of the belly. It has a huckle-bone like that of the ox, but meagre and small in proportion to its bulk. It is cloven-footed, and has not got teeth in both jaws; and it is cloven-footed in the following way: at the back there is a slight cleft extending as far up as the second joint of the toes; and in front there is a long cleft, extending as far as the first joint of the toes, but superficial; and there is something actually between the clefts, as in geese. The foot is fleshy underneath, like that of the bear; so that, when the animal goes to war, they protect its feet, when they get sore, with sandals.

The legs of all quadrupeds are bony, sinewy, and fleshless; and in point of fact such is the case with all animals that are furnished with feet, with the exception of
499b1 man. They are also unfurnished with buttocks; and this last point is plain in an especial degree in birds. It is the reverse with man; for there is scarcely any part of the body in which man is so fleshy as in the buttock, the thigh, and the lower leg; for the part of the lower leg called the calf is fleshy.

Of blooded and viviparous quadrupeds some have the foot cloven into many parts, as is the case with the hands and feet of man (for some animals are many-toed, as the lion, the dog, and the leopard); others have feet cloven in two, and instead of nails have hooves, as the sheep, the goat, the deer, and the hippopotamus; others are uncloven, such for instance as the solid-hooved animals, the horse and the mule. Swine may be either cloven-footed or uncloven-footed; for there are in Illyria and in Paeonia and elsewhere solid-hooved swine. The cloven-footed animals have two clefts behind; in the solid-hooved this part is continuous.

Furthermore, of animals some are horned, and some are not so. The great majority of the horned animals are cloven-footed by nature, as the ox, the stag, the goat; and a solid-hooved animal with a pair of horns has never yet been met with. But a few animals are known to be single-horned and single-hooved, as the Indian ass; and the oryx is single-horned and cloven-hooved.

Of all solid-hooved animals the Indian ass alone has a huckle-bone; for the pig, as was said above, is either solid-hooved or cloven-footed, and consequently has no well-formed huckle-bone. Of the cloven-footed many are provided with a huckle-bone. Of those whose feet are cloven in many parts, none has been observed to have a huckle-bone, none of the others any more than man. The lynx, however, has one like a half huckle-bone, and the lion has one like the 'labyrinth' used in sculpting. All the animals that have a huckle-bone have it in the hind legs. They have also the bone placed straight up in the joint; the upper part, outside; the lower part, inside; the sides called Coa inside and turned towards one another, the sides called Chia outside, and the horns on the top. This, then, is the position of the huckle-bone in the case of all animals provided with the part.

Some animals are, at one and the same time, furnished with a mane and furnished also with a pair of horns bent in towards one another, as is the bison, which is found in Paeonia and Maedica. But all animals that are horned are quadrupedal, except in cases where a creature is said metaphorically, or by a figure of speech, to have horns; just as the Egyptians describe the serpents found in the neighbourhood of Thebes, which have protuberances sufficiently large to suggest such an epithet.

Of horned animals the deer alone has a horn hard and solid throughout. The horns of other animals are hollow for a certain distance, and solid towards the extremity. The hollow part is derived from the skin, but the core round which this is wrapped—the hard part—is derived from the bones; as is the case with the horns of oxen. The deer is the only animal that sheds its horns, and it does so annually, after reaching the age of two years, and again renews them. All other animals retain their horns permanently, unless the horns be damaged by accident.

Again, with regard to the breasts and the generative organs, animals differ widely from one another and from man. For instance, the breasts of some animals are situated in front, either on the chest or near to it, and there are in such cases two breasts and two teats, as is the case with man and the elephant, as previously stated. For the elephant has two breasts in the region of the axillae; and the female elephant has two breasts insignificant in size and in no way proportionate to the bulk of the entire frame, in fact, so insignificant as to be invisible in a sideways view; the males also have breasts, like the females, exceedingly small. The she-bear has four breasts. Some animals have two breasts, but situated near the thighs, and teats, likewise two in number, as the sheep; others have four teats, as the cow. Some have breasts neither on the chest nor at the thighs, but on the belly, as the dog and pig; and they have a considerable number of breasts, but not all of equal size. Thus the she-leopard has four on the belly, the lioness two, and others more. The she-camel, also, has two breasts and four teats, like the cow. Of solid-hooved animals the males have no breasts, excepting in the case of males that take after the mother, which phenomenon is observable in horses.

Of male animals the genitals of some are external, as is the case with man, the horse, and many other creatures; some are internal, as with the dolphin. With those that have the organ externally placed, the organ in some cases is situated in front, as in the cases already mentioned, and of these some have the organ hanging loose, both penis and testicles, as man; others have penis and testicles closely attached to the belly, some more closely, some less; for this organ is not equally loose in the wild boar and in the horse.

The penis of the elephant resembles that of the horse; compared with the size of the animal it is disproportionately small; the testicles are not visible, but are inside in the vicinity of the kidneys; and for this reason the male speedily gives over in the act of intercourse. The genitals of the female are situated where the udder is in sheep; when she is in heat, she draws the organ back and exposes it externally, to facilitate the act of intercourse for the male; and the organ opens out to a considerable extent.

With most animals the genitals have the position above assigned; but some animals discharge their urine backwards, as the lynx, the lion, the camel, and the hare. Male animals differ from one another, as has been said, in this particular, but all female animals urinate backwards: even the female elephant, like other animals, though she has the privy part below the thighs.

In the male organ itself there is a great diversity. For in some cases the organ is composed of flesh and gristle, as in man; in such cases, the fleshy part does not become inflated, but the gristly part is subject to enlargement. In other cases, the organ is sinewy, as with the camel and the deer; in other cases it is bony, as with the fox, the wolf, the marten, and the weasel; for this organ in the weasel has a bone.

Furthermore, when man has arrived at maturity, his upper part is smaller than the lower one, but with all other blooded animals the reverse holds good. By the upper part we mean everything extending from the head down to the parts used for excretion of residuum, and by the lower part all else. With animals that have feet the hind legs are to be rated as the lower part in our comparison of magnitudes, and with animals devoid of feet, the tail, and the like.

When animals arrive at maturity, their properties are as above stated; but they differ greatly from one another in their growth towards maturity. For instance, man, when young, has his upper part larger than the lower, but in course of growth he comes to reverse this condition; and that is why man alone does not progress in early life as he does at maturity, but in infancy creeps on all fours; but some animals, in growth, retain the relative proportion of the parts, as the dog. Some animals at first have the upper part smaller and the lower part larger, and in course of growth the upper part gets to be the larger, as is the case with the bushy-tailed animals; for in their case there is never, subsequently to birth, any increase in the part extending from the hoof to the haunch.

Again, in respect to the teeth, animals differ greatly both from one another and from man. All animals that are quadrupedal, blooded, and viviparous, are furnished with teeth; but, to begin with, some have teeth in both jaws, and some do not. For instance, horned quadrupeds do not; for they have not got the front teeth in the upper jaw; and some hornless animals, also, do not have teeth in both jaws, as the camel. Some animals have tusks, like the boar, and some have not. Further, some animals are saw-toothed, such as the lion, the leopard, and the dog; and some have teeth that do not interlock, as the horse and the ox; and by 'saw-toothed' we mean such animals as interlock the sharp-pointed teeth. No animal possesses both tusks and horns, nor yet do either of these exist in any animal possessed of saw-teeth. The front teeth are usually sharp, and the back ones flat. The seal is saw-toothed throughout, inasmuch as he is a sort of link with the class of fishes; for fishes are almost all saw-toothed.

No animal of these genera is provided with double rows of teeth. There is, however, an animal of the sort, if we are to believe Ctesias. He assures us that the Indian beast called the 'martichoras' has a triple row of teeth in both upper and lower jaw; that it is as big as a lion and equally hairy, and that its feet resemble those of the lion; that it resembles man in its face and ears; that its eyes are blue, and its colour vermilion; that its tail is like that of the land-scorpion; that it has a sting in the tail, and has the faculty of shooting off the spines that are attached to the tail; that the sound of its voice is a something between the sound of a pipe and that of a trumpet; that it can run as swiftly as a deer, and that it is savage and a man-eater.[2] 501b1

Man sheds his teeth, and so do other animals, as the horse, the mule, and the ass. And man sheds his front teeth; but there is no instance of an animal that sheds its molars. The pig sheds none of its teeth at all.

2 · With regard to dogs some doubts are entertained, as some contend that they shed no teeth whatever, and others that they shed the canines only; but it has been observed that they do shed their teeth like man, but that the circumstance escapes notice, owing to the fact that they never shed them until equivalent teeth have grown up under them. We shall be justified in supposing that the case is similar with wild beasts in general; for they are said to shed their canines only. Young can be distinguished from old by their teeth; for the teeth in young dogs are white and sharp-pointed; in old dogs, black and blunted.

3 · In this particular, the horse differs from the other animals; for, generally speaking, as animals grow older their teeth get blacker, but the horse's teeth grow whiter with age.

The so-called canines come in between the sharp teeth and the flat ones, partaking of the form of both kinds; for they are flat below and sharp above.

Males have more teeth than females in the case of men, sheep, goats, and swine; in the case of other animals observations have not yet been made. Those that have more teeth are longer-lived as a rule; those with fewer teeth more thinly set are shorter-lived as a rule.

4 · The last teeth to come in man are molars called wisdom-teeth, which come at the age of twenty years, in the case of both sexes. Cases have been known in women of eighty years old where molars have come up at the ends of the jaw, causing great pain in their coming; and cases have been known of the like phenomenon in men too. This happens in the case of people whose wisdom-teeth have not come up in early years.

[2]Dittmeyer excises the description of the martichoras.

5 · The elephant has four teeth on either side, by which it munches its food, grinding it like so much barley-meal, and, quite apart from these, it has two great teeth. In the male these are comparatively large and curved upwards; in the female, they are comparatively small and point in the opposite direction; that is, they look downwards. The elephant is furnished with teeth at birth, but the tusks are not then visible.

6 · The tongue of the elephant is exceedingly small, and back in the mouth, so that it is difficult to get a sight of it.

7 · Furthermore, animals differ from one another in the size of their mouths. In some animals the mouth opens wide, as in the case with the dog, the lion, and with all the saw-toothed animals; other animals have small mouths, as man; and others have mouths of medium capacity, as the pig and his congeners.

[The Egyptian hippopotamus has a mane like a horse, is cloven-footed like an ox, and is snub-nosed. It has a huckle-bone like cloven-footed animals, and tusks just visible; it has the tail of a pig, the neigh of a horse, and the dimensions of an ass. The hide is so thick that spears are made out of it. In its internal organs it resembles the horse and the ass.][3]

8 · Some animals share the properties of man and the quadrupeds, as the ape, the monkey, and the baboon. The monkey is a tailed ape. The baboon resembles the ape in form, only that it is bigger and stronger, more like a dog in face, and is more savage in its habits, and its teeth are more dog-like and more powerful.

Apes are hairy on the back in keeping with their quadrupedal nature, and hairy on the belly in keeping with their human form—for, as was said above, this characteristic is reversed in man and the quadruped—only that the hair is coarse, so that the ape is thickly coated both on the belly and on the back. Its face resembles that of man in many respects; for it has similar nostrils and ears, and teeth like those of man, both front teeth and molars. Further, whereas quadrupeds in general are not furnished with lashes on one of the two eyelids, this creature has them on both, only very thinly set, especially the under ones and very short. The other quadrupeds have no under eyelash at all.

The ape has also in its chest two teats upon small breasts. It has also arms like man, only covered with hair, and it bends both these and its legs like man, with the convexities of both limbs facing one another. In addition, it has hands and fingers and nails like man, only that all these parts are somewhat more beast-like in appearance. Its feet are exceptional in kind. That is, they are like large hands, and the toes are like fingers, with the middle one the longest of all, and the under part of the foot is like a hand except for its length, and stretches out towards the extremities

[3] Dittmeyer excises the paragraph.

like the palm of the hand; and this palm at the after end is unusually hard, and in a rough obscure kind of way resembles a heel. The creature uses its feet either as hands or feet, and doubles them up as one doubles a fist. Its upper-arm and thigh are short in proportion to the forearm and the shin. It has no projecting navel, but only a hardness in the ordinary locality of the navel. Its upper part is much larger than its lower part, as is the case with quadrupeds; in fact, the proportion of the former to the latter is about five to three. Owing to this circumstance and to the fact that its feet resemble hands and are composed in a manner of hand and of foot: of foot in the heel extremity, of the hand in all else—for even the toes have what is called a palm:—for these reasons the animal is oftener to be found on all fours than upright. It has neither hips, inasmuch as it is a quadruped, nor yet a tail, inasmuch as it is a biped, except a very small one—a sort of hint of a tail. The genitals of the female resemble those of the female in the human species; those of the male are more like those of a dog than are those of a man.

9 · The monkey, as has been observed, is furnished with a tail. In all such creatures the internal organs are found under dissection to correspond to those of man.

So much then for the properties of the parts of such animals as bring forth their young into the world alive.

10 · Oviparous and blooded quadrupeds—and no terrestrial blooded animal is oviparous unless it is quadrupedal or is devoid of feet altogether—are furnished with a head, a neck, a back, upper and under parts, the front legs and hind legs, and the part analogous to the chest, all as in the case of viviparous quadrupeds, and with a tail, usually large, in a few cases small. And all these creatures are many-toed, and the several toes are cloven apart. Furthermore, they all have the ordinary organs of sensation, including a tongue, with the exception of the Egyptian crocodile.

This latter animal resembles certain fishes. For, as a general rule, fishes have a prickly tongue, not free in its movements; though there are some fishes that present a smooth undifferentiated surface where the tongue should be, until you draw their lips right back.

Again, all these animals are unprovided with ears, but possess only the passage for hearing; neither have they breasts, nor a copulatory organ, nor visible external testicles, but internal ones only; neither are they hair-coated, but are in all cases covered with horny tessellations. Moreover, they are all saw-toothed.

River crocodiles have pigs' eyes, large teeth and tusks, and strong nails, and an impenetrable skin composed of horny tessellations. They see poorly under water, but above the surface of it with remarkable acuteness. As a rule, they pass the day-time on land and the night-time in the water; for it is warmer than the open air.

11 · The chameleon resembles the lizard in the general configuration of its body, but the ribs stretch downwards and meet together under the belly as is the

case with fishes, and the spike sticks up as with the fish. Its face resembles that of the baboon. Its tail is exceedingly long, terminates in a fine point, and is for the most part coiled up, like a strap of leather. It stands higher off the ground than the lizard, but the flexure of the legs is the same in both creatures. Each of its feet is divided into two parts, which bear the same relation to one another that the thumb and the rest of the hand bear to one another in man. Each of these parts is for a short distance divided after a fashion into toes; on the front feet the inside part is divided into three and the outside into two, on the hind feet the inside part into two and the outside into three; it has claws also on these parts resembling those of birds of prey. Its body is rough all over, like that of the crocodile. Its eyes are situated in a hollow recess, and are very large and round, and are enveloped in a skin resembling that which covers the rest of its body; and in the middle a slight aperture is left for vision, through which the animal sees, for it never covers up this aperture with its skin. It keeps twisting its eyes round and shifting its line of vision in every direction, and thus contrives to get a sight of any object that it wants to see. The change in its colour takes place when it is inflated with air; it is then black, not unlike the crocodile, or green like the lizard but black-spotted like the leopard. This change of colour takes place over the whole body, for the eyes and tail come alike under its influence. In its movements it is very sluggish, like the tortoise. It assumes a greenish hue in dying, and retains this hue after death. It resembles the lizard in the position of the gullet and the windpipe. It has no flesh anywhere except a few scraps of flesh on the head and on the jaws and near to the root of the tail. It has blood only round about the heart, the eyes, the region above the heart, and in all the veins extending from these parts; and in all these there is but little blood after all. The brain is situated a little above the eyes, but connected with them. When the outer skin is drawn aside from off the eye, something is found surrounding the eye, that gleams through like a thin ring of copper. Membranes extend pretty well over its entire frame, numerous and strong, and surpassing those found in any other animal. After being cut open along its entire length it continues to breathe for a considerable time; a very slight motion goes on in the region of the heart, and, while contraction is especially manifested in the neighbourhood of the ribs, a similar motion is more or less discernible over the whole body. It has no spleen visible. It hibernates, like the lizard.

12 · Birds also in some parts resemble the above-mentioned animals; that is to say, they have in all cases a head, a neck, a back, a belly, and what is analogous to the chest. The bird is remarkable among animals as having two feet, like man; but it bends them backward as quadrupeds do, as was noticed previously. It has neither hands nor front feet, but wings which mark it off from other animals. Its haunch-bone is long, like a thigh, and is attached to the body as far as the middle of the belly; so that when viewed separately it looks like a thigh, while a real thigh is a separate structure extending to the shin. Of all birds those that have crooked talons have the biggest thighs and the strongest breasts. All birds are furnished with many claws, and all have the toes separated more or less; for in the greater part the toes

are distinct from one another, and the swimming birds, although they are web-footed, have still their claws fully articulated and separated from one another. Birds that fly high are in all cases four toed; for the greater part have three toes in front and one behind in place of a heel; some few have two in front and two behind, as the wryneck.

This latter bird is somewhat bigger than the chaffinch, and is mottled in appearance. It is peculiar in the arrangement of its toes, and resembles the snake in the structure of its tongue; for the creature can protrude its tongue to the extent of four inches and then draw it back again. Moreover, it can twist its head backwards while keeping all the rest of its body still, like the serpent. It has big claws, somewhat resembling those of the woodpecker. Its note is a shrill chirp.

Birds are furnished with a mouth, but with an exceptional one, for they have neither lips nor teeth, but a beak. Neither have they ears nor a nose, but only passages for the sensations connected with these organs: that for the nostrils in the beak, and that for hearing in the head. Like all other animals they all have two eyes, and these are devoid of lashes. The heavy-bodied birds close the eye by means of the lower lid, and all birds blink by means of a skin extending over the eye from the inner corner; the owl and its congeners also close the eye by means of the upper lid. The same phenomenon is observable in the animals that have horny tessellations, as in the lizard and its congeners; for they all close the eye with the lower lid, but they do not blink like birds.

Further, birds have neither tessellations nor hair, but feathers; and the feathers are invariably furnished with quills. They have no tail, but a rump with tail-feathers, short in such as are long-legged and web-footed, large in others. These latter kinds of birds fly with their feet tucked up close to the belly; but the small-rumped birds fly with their legs stretched out at full length. All are furnished with a tongue, but the organ is variable, being long in some birds and broad in others. Certain species of birds above all other animals, and next after man, possess the faculty of uttering articulate sounds; and this faculty is chiefly developed in broad-tongued birds. No oviparous creature has an epiglottis over the windpipe, but these animals so manage the opening and shutting of the windpipe as not to allow any solid substance to get down into the lung.

Some species of birds are furnished additionally with spurs, but no bird with crooked talons is found so provided. The birds with talons are among those that fly well, but those that have spurs are among the heavy-bodied.

Again, some birds have a crest. In some the crest sticks up, and is composed of feathers only; but the crest of the cock is exceptional in kind, for it is not flesh but something like flesh.

13 · Of water animals the genus of fishes constitutes a single group apart from the rest, and including many diverse forms.

The fish has a head, a back, a belly, in the neighbourhood of which last are placed the stomach and viscera; and behind it has a tail of continuous, undivided shape, but not in all cases alike. No fish has a neck, or any limb or testicles at all, within or without, or breasts. This is true not only of all non-viviparous animals: viviparous animals are not in all cases provided with the organ, but only those which are directly viviparous without being first oviparous. Thus the dolphin is directly viviparous, and accordingly we find it furnished with two breasts, not situated high up, but in the neighborhood of the genitals. And this creature is not provided, like quadrupeds, with visible teats, but has two vents, one on each flank, from which the milk flows; and its young have to follow after it to get suckled, and this phenomenon has been actually witnessed by some people.

Fishes, then, as has been observed, have no breasts and no passage for the genitals visible externally. But they have an exceptional organ in the gills, whereby, after taking the water in by the mouth, they discharge it again; and in the fins, of which the greater part have four, and the lanky ones two, as, for instance, the eel, and these two situated near to the gills. In like manner the grey mullet—as, for instance, the mullet found in the lake at Siphae—have only two fins; and the same is the case with the fish called Ribbon-fish. Some of the lanky fishes have no fins at all, such as the muraena, nor gills articulated like those of other fish.

505a1 And of those fish that are provided with gills, some have coverings for this organ, whereas all the selachians have the organ unprotected by a cover. And those fishes that have coverings have in all cases their gills placed sideways; whereas, among selachians, the broad ones have the gills down below on the belly, as the torpedo and the ray, while the lanky ones have the organ placed sideways, as is the case in all the dog-fish.

The fishing-frog has gills placed sideways, and covered not with a spiny cover, as in all but the selachian fishes, but with one of skin.

Moreover, with fishes furnished with gills, the gills in some cases are simple in other duplicate; and the last gill in the direction of the body is always simple. And, again, some fishes have few gills, and others have a great number; but all alike have the same number on both sides. Those that have the least number have one gill on either side, and this one duplicate, like the boar-fish; others have two on either side, one simple and the other duplicate, like the conger and the scarus; others have four on either side, simple, as the elops, the synagris, the muraena, and the eel; others have four, all, with the exception of the hindmost one, in double rows, as the wrasse, the perch, the sheat-fish and the carp. The dog-fish have all their gills double, five on a side; and the sword-fish has eight double gills. So much for the number of gills as found in fishes.

Again, fishes differ from other animals in more ways than as regards the gills. For they are not covered with hairs as are viviparous land animals, nor, as is the case with certain oviparous quadrupeds, with tessellations, nor, like birds, with feathers; but for the most part they are covered with scales. Some few are rough-skinned, while the smooth-skinned are very few indeed. Of the Selachia some are rough-skinned and some smooth-skinned; and among the smooth-skinned fishes are included the conger, the eel, and the tunny.

All fishes are saw-toothed except the scarus; and the teeth in all cases are sharp and set in many rows, and in some cases are placed on the tongue. The tongue is hard and spiny, and so firmly attached that fishes in many instances seem to be devoid of the organ altogether. The mouth in some cases is wide-stretched, as it is with some viviparous quadrupeds. . . .[4]

As to the sense-organs, except for eyes fish have none that are apparent—neither the organ itself nor its passages—either for hearing or for smelling; but all fishes are furnished with eyes, and the eyes devoid of lids, though the eyes are not hard.

Fishes without exception are supplied with blood. Some of them are oviparous, and some viviparous; scaly fish are invariably oviparous, but the Selachia are all viviparous with the exception of the fishing-frog.

14 · Of blooded animals there now remains the serpent genus. This genus is common to both elements, for, while most species comprehended therein are land animals, a small minority, to wit the aquatic species, pass their lives in fresh water. There are also sea-serpents, in shape to a great extent resembling their congeners of the land, with this exception that the head in their case is somewhat like the head of the conger; and there are several kinds of sea-serpent, and they differ in colour; these animals are not found in very deep water. Serpents, like fish, are devoid of feet.

There are also sea-millipedes resembling in shape their land congers, but somewhat less in regard to magnitude. These creatures are found in the neighbourhood of rocks; as compared with their land congeners they are redder in colour, are furnished with feet in greater numbers and with legs of more delicate structure. And the same remark applies to them as to the sea-serpents, that they are not found in very deep water.

Of fishes whose habitat is in the vicinity of rocks there is a tiny one, which some call the 'ship-holder', and which is by some people used as a charm to bring luck in affairs of law and love. The creature is unfit for eating. Some people assert that it has feet, but this is not the case: it appears, however, to be furnished with feet from the fact that its fins resemble those organs.[5]

So much, then for the external parts of blooded animals, as regards their numbers, their properties, and their relative diversities.

15 · As for the properties of the internal parts, these we must first discuss in the case of the animals that are supplied with blood. For the principal genera differ from the rest of animals, in that the former are supplied with blood and the latter are not; and the former are the oviparous and viviparous quadrupeds, birds, fishes, cetaceans,[6] and all the others that come under no general designation by reason of their being no genus but a simple species covering the individual cases, e.g. man.[7]

[4]There is a lacuna in the MSS: Dittmeyer suggests adding 'in others, tapering'.

[5]Dittmeyer excises the whole of ch. 14 up to this point.

[6]Reading *τὰ τε ᾠότοκα* for *ἄνθρωπός τε*, and excising *ἔτι . . . τετραπόδων* in line 29 (Balme).

[7]Reading *ἄνθρωπος* (Balme), for *ὄφις καὶ κροκόδειλος*.

All viviparous quadrupeds, then, are furnished with a gullet and a windpipe, situated as in man; the same statement is applicable to oviparous quadrupeds and to 506a1 birds, only that the latter present diversities in the shapes of these organs. As a general rule, all animals that take up air and breathe it in and out are furnished with a lung, a windpipe, and a gullet, with the windpipe and gullet not admitting of diversity in situation but admitting of diversity in properties, and with the lung admitting of diversity in both these respects. Further, all blooded animals have a heart and a diaphragm or midriff; but in small animals the existence of the latter organ is not so obvious owing to its delicacy and minute size.

In regard to the heart[8] there is an exceptional phenomenon observable in oxen. For there is one species of ox where, though not in all cases, a bone is found inside the heart. And the horse's heart also has a bone inside it.[9]

They are not in all cases furnished with a lung; for instance, the fish is devoid of the organ, as is also every animal furnished with gills. All blooded animals are furnished with a liver. As a general rule blooded animals are furnished with a spleen; but with the great majority of non-viviparous but oviparous animals the spleen is so small as all but to escape observation; and this is the case with almost all birds, as with the pigeon, the kite, the falcon, the owl; and the aegocephalus is devoid of the organ altogether. With oviparous quadrupeds the case is much the same; that is to say, they also have the spleen exceedingly minute, as the tortoise, the freshwater tortoise, the toad, the lizard, the crocodile, and the frog.

Some animals have a gallbladder close to the liver, and others have not. Of viviparous quadrupeds the deer is without the organ, as also the roe, the horse, the mule, the ass, the seal, and some kinds of pigs. Of deer those that are called Achainae appear to have gall in their tail, but what is so called does resemble gall in colour, though it is not so completely fluid, and the organ internally resembles a spleen.

However, all deer have maggots living inside the head, and the habitat of these creatures is in the hollow underneath the root of the tongue and in the neighbourhood of the vertebra to which the head is attached. These creatures are as large as the largest grubs; they grow altogether in a cluster, and they are usually about twenty in number.[10]

Deer then, as has been observed, are without a gall-bladder; their gut, however, is so bitter that even hounds refuse to eat it unless the animal is 506b1 exceptionally fat. With the elephant also the liver is unfurnished with a gall-bladder, but when the animal is cut in the region where the organ is found in animals furnished with it, there oozes out a fluid resembling gall, in greater or less quantities. Of animals that take in sea-water and are furnished with a lung, the dolphin is unprovided with a gall-bladder. Birds and fishes all have the organ, as also oviparous quadrupeds, all to a greater or a lesser extent. But of fishes some have the organ close to the liver, as the dog-fishes, the sheat-fish, the angel-fish, the

[8]Reading καρδίᾳ ἴδιόν τι. [9]Dittmeyer excises this paragraph.
[10]Dittmeyer excises this paragraph.

smooth skate, the torpedo, and the lanky fishes, the eel, the pipe-fish, and the hammer-headed shark. The callionymus, also, has the gall-bladder close to the liver, and in no other fish does the organ attain so great a relative size. Other fishes have the organ close to the gut, attached to the liver by certain extremely fine ducts. The bonito has the gall-bladder stretched alongside the gut and equalling it in length, and often a double fold of it. Others have the organ in the region of the gut; in some cases far off, in others near; as the fishing-frog, the elops, the synagris, the muraena, and the sword-fish. Often animals of the same genus show this diversity of position; as, for instance, some congers are found with the organ attached close to the liver, and others with it detached from and below it. The case is much the same with birds: that is, some have the gall-bladder close to the stomach, and others close to the gut, as the pigeon, the raven, the quail, the swallow, and the sparrow; some have it near at once to the liver and to the stomach as the aegocephalus; others have it near at once to the liver and the gut, as the falcon and the kite.

16 · Again, all viviparous quadrupeds are furnished with kidneys and a bladder. Of the ovipara that are not quadrupedal there is no instance of an animal, whether fish or bird, provided with these organs. Of the ovipara that are quadrupedal, the turtle alone is provided with these organs of a magnitude to correspond with the other organs of the animal. In the turtle the kidney resembles the same organ in the ox; that is to say, it looks like one single organ composed of a number of small ones. [The bison also resembles the ox in all its internal parts.][11]

17 · With all animals that are furnished with these parts, the parts are similarly situated, and with the exception of man, the heart is in the middle; in man, however, as has been observed, the heart is placed a little to the left-hand side. In all animals the pointed end of the heart turns frontwards; only in fish it would at first sight seem otherwise, for the pointed end is turned not towards the breast, but towards the head and the mouth. And the apex is attached to a tube just where the right and left gills meet together. There are other ducts extending from the heart to each of the gills, greater in the greater fish, lesser in the lesser; but in the large fishes the duct at the pointed end of the heart is a tube, white-coloured and exceedingly thick.

Fishes in some few cases have a gullet, as the conger and the eel; and in these the organ is small.

In fishes that are furnished with an undivided liver, the organ lies entirely on the right side; where the liver is cloven from the root, the larger half of the organ is on the right side; for in some fishes the two parts are detached from one another, without any coalescence at the root, as is the case with the dog-fish. And there is also a species of hare in what is named the Fig district, near Lake Bolbe, and

[11]Dittmeyer excises the bracketed sentence.

elsewhere, which might be taken to have two livers owing to the length of the connecting ducts, similar to the structure in the lung of birds.

The spleen in all cases is by nature on the left-hand side, and the kidneys also lie in the same position in all creatures that possess them. There have been known instances of quadrupeds under dissection, where the spleen was on the right hand and the liver on the left; but all such cases are regarded as monstrosities.

In all animals the wind-pipe extends to the lung, and the manner how, we shall discuss hereafter; and the gullet, in all that have the organ, extends through the diaphragm into the stomach. For, as has been observed, most fishes have no gullet, but the stomach is united directly with the mouth, so that in some cases when big fish are pursuing little ones, the stomach tumbles forward into the mouth.

All the afore-mentioned animals have a stomach, and one similarly situated, that is to say, situated directly under the midriff; and they have a gut connected therewith and closing at the outlet of the food at what is termed the rectum. However, animals present diversities in the structure of their stomachs. In the first place, of the viviparous quadrupeds, such of the horned animals as are not furnished with teeth in both jaws are furnished with four such chambers. These animals are those that are said to chew the cud. In these animals the gullet extends from the mouth downwards along the lung, from the midriff to the big stomach; and this stomach is rough inside and partitioned. And connected with it near to the entry of the gullet is what from its appearance is termed the hair-net; for outside it is like the stomach, but inside it resembles a knotted hair-net; and the hair-net is a great deal smaller than the stomach. Connected with this is the many-plies, rough inside and laminated, and of about the same size as the hair-net. Next after this comes what is called the abomasum, larger and longer than the many-plies, furnished inside with numerous folds, large and smooth. After all this comes the gut.

Such is the stomach of those quadrupeds that are horned and do not have teeth in both jaws; and these animals differ one from another in the shape and size of the parts, and in the fact of the gullet reaching the stomach centrally in some cases and sideways in others. Animals that are furnished equally with teeth in both jaws have one stomach; as man, the pig, the dog, the bear, the lion, the wolf. The stoat has all its internal organs similar to the wolf's.

All these, then have a single stomach, and after that the gut; but the stomach in some is comparatively large, as in the pig and bear, and the stomach of the pig has a few smooth folds; others have a much smaller stomach, not much bigger than the gut, as the lion, the dog, and man. In the other animals the shape of the stomach varies in the direction of one or other of those already mentioned; that is, the stomach in some animals resembles that of the pig; in others that of the dog, alike with the larger animals and the smaller ones. In all these animals diversities occur in regard to the size, the shape, the thickness or the thinness of the stomach, and also in regard to the place where the gullet opens into it.[12]

There is also a difference in the nature of the gut of the two groups of animals

[12]Reading *κατὰ τοῦ στομάχου τὴν θέσιν καὶ σύντρησιν.*

above mentioned (those which have teeth in both jaws and those which do not) in size, in thickness, and in foldings.

The intestines in those animals which do not have teeth in both jaws are in all cases the larger, for the animals themselves are larger than those in the other category; for few of them are small, and no single one of the horned animals is very small. And some possess appendages to the gut, but no animal that does not have teeth in both jaws has a straight gut.

The elephant has a constricted gut, so that the animal appears to have four stomachs; in it the food is found, but there is no distinct and separate receptacle. Its viscera resemble those of the pig, only that the liver is four times the size of that of 508a1
the ox, and the other viscera in like proportion, while the spleen is comparatively small.

Much the same may be said of the stomach and the gut in oviparous quadrupeds, as in the land tortoise, the turtle, the lizard, both crocodiles, and in fact, in all animals of the like kind; that is to say, their stomach is one and simple, resembling in some cases that of the pig and in other cases that of the dog.

The serpent genus is similar and in almost all respects furnished similarly to the lizards among oviparous land animals, if one were to increase their length and remove their feet. That is to say, the serpent is coated with the tessellations, and resembles the lizard in its back and belly; but it has no testicles, but, like fishes, has two ducts converging into one, and an ovary long and bifurcate. The rest of its internal organs are identical with those of the lizard, except that, owing to the narrowness and length of the animal, the viscera are correspondingly narrow and elongated, so that they are apt to escape recognition from the similarities in shape. Thus, the windpipe of the creature is exceptionally long, and the gullet is longer still, and the windpipe commences so close to the mouth that the tongue appears to be underneath it; and the windpipe seems to project over the tongue, owing to the fact that the tongue draws back into a sheath and does not remain in its place as in other animals. The tongue, moreover, is thin and long and black, and can be protruded to a great distance. And both serpents and lizards have this altogether exceptional property in the tongue, that it is forked at the end, and this property is the more marked in the serpent, for the tips of its tongue are as thin as hairs. The seal, also, has a split tongue.

The stomach of the serpent is more like a more spacious gut, resembling the stomach of the dog; then comes the gut, long, narrow, and single to the end. The heart is situated close to the pharynx, small and kidney-shaped; and for this reason the organ might in some cases appear not to have the pointed end turned towards the breast. Then comes the lung, single, and articulated with a fibrous passage, very long, and quite detached from the heart. The liver is long and simple; the spleen is short and round: as in the case in both respects with the lizard. Its gall resembles that of the fish; the water-snakes have it beside the liver, and the other snakes have 508b1
it usually beside the gut. These creatures are all saw-toothed. Their ribs are as numerous as the days of the month; in other words, they are thirty in number.

Some affirm that the same phenomenon is observable with serpents as with swallow-chicks: they say that if you prick out a serpent's eyes they will grow again. And further, the tails of lizards and of serpents, if they be cut off, will grow again.[13]

With fishes the properties of the gut and stomach are similar; that is, they have a stomach single and simple, but variable in shape. For in some cases the stomach is gut-shaped,[14] as with the scarus—which appears to be the only fish that chews the cud. And the whole length of the gut is simple, and if it has a reduplication it loosens out again into a simple form.

An exceptional property in fishes and in birds for the most part is the being furnished with gut-appendages. Birds have them low down and few in number. Fishes have them high up about the stomach, and sometimes numerous, as in the goby, the burbot,[15] the perch, the scorpaena, the citharus, the red mullet, and the sparus; the grey mullet has several of them on one side of the belly, and on the other side only one. Some fish possess these appendages but only in small numbers, as the hepatus and the glaucus; and they are few also in the dorado. These fishes differ also from one another, for in the dorado one individual has many and another few. Some fishes are entirely without the part, as the majority of the selachians. As for all the rest, some of them have a few and some a great many. And in all fish the gut-appendages are found close up to the stomach.

In regard to their internal parts birds differ from other animals and from one another. Some birds, for instance, have a crop in front of the stomach, as the cock, the cushat, the pigeon, and the partridge; and the crop consists of a large hollow skin, into which the food first enters and where it lies undigested. Just where the crop leaves the gullet it is somewhat narrow; by and by it broadens out but where it communicates with the stomach it narrows down again. The stomach in most birds is fleshy and hard, and inside is a strong skin which comes away from the fleshy part. Other birds have no crop, but instead of it a gullet wide and roomy, either all
509a1 the way or in the part leading to the stomach, as with the daw, the raven, and the carrion-crow. The quail also has the gullet widened out at the lower extremity, and in the aegocephalus and the owl the organ is slightly broader at the bottom. The duck, the goose, the gull, the catarrhactes, and the great bustard have the gullet wide and roomy from one end to the other, and the same applies to a great many other birds. In some birds there is a portion of the stomach that resembles a crop, as in the kestrel. In the case of small birds like the swallow and the sparrow neither the gullet nor the crop is wide, but the stomach is long. Some few have neither a crop nor a dilated gullet, but the latter is exceedingly long, as in long-necked birds, such as the porphyrio; and in the case of all these birds the excrement is unusually moist. The quail is exceptional in regard to these organs, as compared with other birds; for it has a crop, and at the same time its gullet is wide and spacious in front of the stomach, and the crop is at some distance, relatively to its size, from the gullet at that part.

[13]Dittmeyer excises this paragraph.
[14]Reading ἐντεροειδῆ.
[15]Reading γαλῆ.

Further, in most birds, the gut is thin, and simple, when loosened out. The gut-appendages in birds, as has been observed, are few in number, and are not situated high up, as in fishes, but low down towards the extremity of the gut. Not all birds have them, but most do such as the cock, the partridge, the duck, the night-raven, the localus,[16] the ascalaphus, the goose, the swan, the great bustard, and the owl. Some of the little birds also have these appendages, but very small ones, as in the sparrow.

BOOK III

1 · Now that we have stated the magnitudes, the properties, and the relative differences of the other internal organs, it remains for us to treat of the organs that contribute to generation. These organs in the female are in all cases internal; in the male they present numerous diversities.

In the blooded animals some males are altogether devoid of testicles, and some have the organ but situated internally; and of those males that have the organ internally situated, some have it close to the loin in the neighbourhood of the kidney and others close to the belly. Other males have the organ situated externally. In the case of these last, the penis is in some cases attached to the belly, whilst in others it is loosely suspended, as is the case also with the testicles; and, in the cases where the penis is attached to the belly, the attachment varies accordingly as the animal urinates forwards or backwards.

No fish is furnished with testicles, nor any other creature that has gills, nor any serpent whatever: nor, in short, any animal devoid of feet, save such only as are viviparous within themselves. Birds are furnished with testicles, but these are internally situated, close to the loin. The case is similar with oviparous quadrupeds, such as the lizard, the tortoise and the crocodile; and among the viviparous animals this peculiarity is found in the hedgehog. Others among those creatures that have the organ internally situated have it close to the belly, as in the case with the dolphin amongst animals devoid of feet, and with the elephant among viviparous quadrupeds. In other cases these organs are externally conspicuous.

We have already alluded to the diversities observed in the attachment of these organs to the belly and the adjacent region: in some cases the testicles are connected closely at the back and do not hang free, as in the pig, and in others they are freely suspended, as in man.

Fishes, then, are devoid of testicles, as has been stated, and serpents also. They are furnished, however, with two ducts connected with the midriff and running on to either side of the backbone, coalescing into a single duct above the outlet of the residuum, and by 'above' the outlet I mean the region near to the spine. These ducts in the rutting season get filled with the genital fluid, and, if the ducts be squeezed, the sperm oozes out white in colour. As to the differences observed in male fishes of diverse species, the reader should consult the *Anatomies*, and the subject will be

[16] Dittmeyer excises the bird.

hereafter more accurately discussed when we describe the specific character in each case.

The males of oviparous animals, whether biped or quadruped, are in all cases furnished with testicles close to the loin underneath the midriff. With some animals the organ is whitish, in others somewhat of a sallow hue; in all cases it is enveloped with minute and delicate veins. From each of the two testicles extends a duct, and, as in the case of fishes, the two ducts coalesce into one above the outlet of the residuum. This constitutes the penis, which in the case of small ovipara is inconspicuous; but in the case of the larger ovipara, as in the goose and the like, the organ becomes quite visible just after copulation.

The ducts both in fishes and in these animals are attached to the loin under the stomach between the gut and the great vein, from which ducts extend, one to each of the two testicles. And just as with fishes the genital fluid is found in the ducts, and the ducts become plainly visible at the rutting season and in some instances become invisible after the season is passed, so also is it with the testicles of birds; before copulation the organ is small in some birds and quite invisible in others, but during copulation the organ is greatly enlarged. This phenomenon is remarkably illustrated in the ring-dove and the partridge, so much so that some people are actually of opinion that these birds are devoid of testicles in the winter-time.

Of male animals that have their testicles placed frontwards, some have them inside, close to the belly, as the dolphin; some have them outside, exposed to view, close to the lower extremity of the belly. These animals resemble one another thus far in respect to this organ; but they differ from one another in the fact, that some of them have their testicles situated separately by themselves, while others, which have the organ situated externally, have them enveloped in what is termed the scrotum.[1]

In all viviparous animals furnished with feet the following properties are observed in the testicles themselves. From the aorta there extend vein-like ducts to the head of each of the testicles, and another two from the kidneys; these two are supplied with blood, while the two from the aorta are devoid of it. From the head of the testicle alongside of the testicle itself is a duct, thicker and more sinewy that the others, that bends back again at the end of the testicle to its head; and from the head of each of the two testicles the two ducts extend until they coalesce in front at the penis. The duct that bends back again and that which is in contact with the testicle are enveloped in one and the same membrane, so that, until you draw aside the membrane, they seem to be a single duct. Further, the duct in contact with the testicle has its moist content qualified by blood, but to a comparatively lesser extent than in the case of the ducts higher up which are connected with the aorta;[2] in the ducts that bend back towards the tube of the penis, the liquid is white-coloured. There also runs a duct from the bladder, opening into the upper part of the tube, around which lies, sheath-wise, what is called the penis.

All this may be studied by the light of the accompanying diagram; wherein the letter A marks the starting-point of the ducts that extend from the aorta; the letters

[1]Dittmeyer excises this paragraph.
[2]Dittmeyer excises 'which . . . aorta'.

KK mark the heads of the testicles and the ducts descending to them; the ducts extending from these along the testicles are marked ΩΩ; the ducts turning back, in which is the white fluid, are marked *BB*; the penis Δ; the bladder *E*; and the testicles ΨΨ.

If the testicles themselves are cut off or removed, the ducts draw upwards by contraction. Moreover, when male animals are young, people sometimes destroy the testicles by rubbing; sometimes they castrate them at a later period. And I may here add, that a bull has been known to serve a cow immediately after castration, and actually to impregnate her.

So much then for the properties of testicles in animals.

In animals furnished with a womb, the womb is not in all cases the same in form or endowed with the same properties, but both in the vivipara and the ovipara great diversities present themselves. In all creatures that have the womb close to the genitals, the womb is forked and one fork lies to the right-hand side and the other to the left; its commencement, however, is single, and so is the orifice, resembling in the case of the most numerous and largest animals a tube composed of much flesh and gristle. Of these parts one is termed the *hystera* or *delphys,* whence is derived ἀδελφός, and the other part, the tube or orifice, is termed *metra.* In all biped or quadruped vivipara the womb is in all cases below the midriff, as in man, the dog, the pig, the horse, and the ox; the same is the case also in all horned animals. At the extremity of the so-called horns, the wombs of most animals have a convolution.

In the case of those ovipara that lay eggs externally, the wombs are not in all cases similarly situated. Thus the wombs of birds are close to the midriff, and the wombs of fishes down below, just like the wombs of biped and quadruped vivipara, only that, in the case of the fish, the wombs are delicately formed, membranous, and elongated; so much so that in extremely small fish, each of the two bifurcated parts looks like a single egg, and those fishes whose egg is described as crumbling would appear to have inside them a pair of eggs, whereas in reality each of the two sides consists not of one but of many eggs, and this accounts for their breaking up into so many particles.

The womb of birds has the lower and tubular portion fleshy and firm, and the part close to the midriff membranous and exceedingly fine: so fine that the eggs might seem to be outside the womb altogether. In the larger birds the membrane is more distinctly visible, and, if inflated through the tube, lifts and swells out; in the smaller birds all these parts are more indistinct.

The properties of the womb are similar in oviparous quadrupeds, as the tortoise, the lizard, the frog and the like; for the tube below is single and fleshy, and the cleft portion with the eggs is at the top close to the midriff. With animals devoid of feet that are internally oviparous and viviparous externally, as is the case with the dogfish and the other so-called Selachians (and by this title we designate such creatures destitute of feet and furnished with gills as are viviparous), with these animals the womb is bifurcate, and beginning down below[3] it extends as far as the midriff, as in the case of birds. There is[4] also a narrow part between the two forks

[3]Transferring κάτωθεν ἀρξαμένη from line 8.
[4]Reading ἔστι for ἔτι.

running up as far as the midriff,[5] and the eggs are engendered here and[6] above at the origin of the midriff; afterwards they pass into the wider space and turn from eggs into young animals. However, the differences in respect to the wombs of these fishes as compared with one another and with fishes in general, would be more accurately studied in their various forms in the *Anatomies*.

The members of the serpent genus also present divergencies either when compared with the above-mentioned creatures or with one another. Serpents as a rule are oviparous, the viper being the only viviparous member of the genus though it is first internally oviparous; and owing to this peculiarity the properties of the womb in the viper are similar to those of the womb in the selachians. The womb of the serpent is long, in keeping with the body, and starting below from a single duct extends continuously on both sides of the spine, so as to give the impression of thus being a separate duct on each side of the spine, until it reaches the midriff, where the eggs are engendered in a row; and these eggs are laid not one by one, but all strung together. [And all animals that are viviparous both internally and externally have the womb situated above the stomach, and all the ovipara underneath, near to the loin. Animals that are viviparous externally and internally oviparous present an intermediate arrangement; for the underneath portion of the womb, in which the eggs are, is placed near to the loin, but the part about the orifice is above the gut.][7]

Further, there is the following diversity observable in wombs as compared with one another: namely that the females of horned animals which do not have teeth in both jaws are furnished with cotyledons in the womb when they are pregnant, and such is the case, among animals with teeth in both jaws, with the hare, the mouse, and the bat; whereas all other animals that have teeth in both jaws, and are viviparous and furnished with feet, have the womb quite smooth, and in their case the attachment of the embryo is to the womb itself and not to any cotyledon.

The parts, then, in animals that are not uniform, both parts external and parts internal, have the properties above assigned to them.

511b1 2 · In sanguineous animals the uniform part most universally found is the blood, and its habitat the vein; next in degree of universality, their analogues, lymph and fibre, and, that which chiefly constitutes the body of animals, flesh and whatsoever in the several parts is analogous to flesh; then bone, and parts that are analogous to bone, as fish-bone and gristle; and then, again, skin, membrane, sinew, hair, nails, and whatever corresponds to these; and, furthermore, fat, suet, and the excretions—dung, phlegm, yellow bile, and black bile.

Now, as the nature of blood and the nature of the veins have all the appearance of being fundamental, we must discuss their properties first of all, and all the more as some previous writers have treated them very unsatisfactorily. And the cause of the ignorance is the extreme difficulty experienced in the way of observation. For in the dead bodies of animals the nature of the chief veins is undiscoverable, owing to the fact that they in particular collapse at once when the blood leaves them; for the

[5]Reading στενή for τείνει.
[6]Retaining καί.
[7]Dittmeyer excises this paragraph.

blood pours out of them in a stream, like liquid out of a vessel, since there is no blood separately situated by itself, except a little in the heart, but it is all lodged in the veins. In *living* animals it is impossible to inspect these parts, for of their very nature they are internal. For this reason those who have carried on their investigations on dead and dissected bodies have failed to discover the chief sources of the veins, while those who have narrowly inspected bodies of living men reduced to extreme attenuation have arrived at conclusions regarding the origin of the veins from the manifestations then visible externally. Syennesis, the physician of Cyprus, writes as follows:—

'The big veins run thus:—from the eye, across the eyebrow, along the back, past the lung, in under the breasts; one from right to left, and the other from left to right; that from the left, through the liver to the kidney and the testicle, that from the right, to the spleen and kidney and testicle, and thence to the penis'.

Diogenes of Apollonia writes thus:—

'The veins in man are as follows:—There are two veins pre-eminent in magnitude. These extend through the belly along the backbone, one to right, one to left; either one to the leg on its own side, and upwards to the head, past the collar bones, through the throat. From these, veins extend all over the body, from that on 512a1
the right hand to the right side and from that on the left hand to the left side; the most important ones, two in number, to the heart in the region of the backbone; others a little higher up through the chest in underneath the armpit, each to the hand on its own side, one being termed the splenetic, and the other the hepatitic. Each of the pair splits at its extremity; the one branches in the direction of the thumb and the other in the direction of the palm; and from these run off a number of minute veins branching off to the fingers and to all parts of the hand. Other veins, more minute, extend from the main veins; from that on the right towards the liver, from that on the left towards the spleen and the kidneys. The veins that run to the legs split at the juncture of the legs with the trunk and extend right down the thigh. The largest of these goes down the thigh at the back of it, and can be discerned as a big one; the second one runs inside the thigh, not quite as big as the one just mentioned. After this they pass on along the knee to the shin and the foot, like those which lead towards the hands[8] and arrive at the sole of the foot, and from thence continue to the toes. Moreover, many delicate veins separate off from the great veins towards the stomach and the ribs.

'The veins that run through the throat to the head can be discerned in the neck as large ones; and from each one of the two, where it terminates, there branch off a number of veins to the head those from the right side towards the left, and those from the left side towards the right; and the two veins terminate near to the ears. There is another vein in the neck running along the big vein on either side, slightly less in size than it, and with these the greater part of the veins in the head are connected. They run through the throat inside; and from either one of the two there extend veins in underneath the shoulder blade and towards the hands; and these appear alongside the splenetic and hepatitic veins as another pair of veins smaller in

[8]Reading πόδα, καθάπερ αἱ.

size. When there is a pain near the surface of the body, the physician lances these two latter veins; but when the pain is in the region of the stomach he lances the splenetic and hepatitic veins. And from these, other veins depart to run below the breasts.

512b1 'There is also another pair running on each side through the spinal marrow to the testicles, thin and delicate. There is, further, a pair running beneath the skin through the flesh to the kidneys, and these with men terminate at the testicle, and with women at the womb. These are termed the spermatic veins.[9] The veins that leave the stomach are comparatively broad just as they leave; but they become thinner, until they change over from right to left and from left to right.

'Blood is thickest when it is imbibed by the fleshy parts; when it is transmitted to the regions above-mentioned, it becomes thin, warm, and frothy'.

3 · Such are the accounts given by Syennesis and Diogenes. Polybus writes to the following effect:—

'There are four pairs of veins. The first extends from the back of the head, through the neck on the outside, past the backbone on either side, until it reaches the loins and passes on to the legs, after which it goes on through the shins to the outer side of the ankles and on to the feet. And it is on this account that surgeons, for pains in the back and loin, bleed in the ham and in the outer side of the ankle. Another pair of veins runs from the head, past the ears, through the neck: they are termed the jugular veins. This pair goes on inside along the backbone, past the muscles of the loins, on to the testicles, and onwards to the thighs, and through the inside of the hams and through the shins down to the inside of the ankles and to the feet; and for this reason, surgeons, for pains in the muscles of the loins and in the testicles, bleed on the hams and the inner side of the ankles. The third pair extends from the temples, through the neck, in underneath the shoulder-blades, into the lung; the one running from right to left in underneath the breast and on to the spleen and the kidney; the other from left to right from the lung in underneath the breast and into the liver and the kidney; and both terminate in the rectum. The fourth pair 513a1 extend from the front part of the head and the eyes in underneath the neck and the collar-bones; from thence they stretch on through the upper part of the upper arms to the elbows and then through the fore-arms on to the wrists and the jointings of the fingers, and also through the lower part of the upper-arms to the armpits, and so on, keeping above the ribs, until one of the pair reaches the spleen and the other reaches the liver; and after this they both pass over the stomach and terminate at the penis'.

That, pretty well, is what others have said. There are also some writers on nature who have not dealt in such precise terms with the veins, but who all alike agree in assigning the head and the brain as the starting-point of the veins. And in this opinion they are mistaken.

The investigation of such a subject, as has been remarked, is one fraught with difficulties; but, if any one is keenly interested in the matter, he will get an adequate

[9] This sentence has been transposed from line 8, where in the MSS it follows 'left to right'.

grasp of it only if he studies strangled animals which have been previously emaciated.

The nature of the veins is as follows. There are two veins in the thorax by the backbone, and lying to its inner side; and of these two the larger one is situated to the front, and the lesser one is to the rear of it; and the larger is situated rather to the right-hand side of the body, and the lesser one to the left; and by some this vein is termed the aorta, from the fact that even in dead bodies they have observed the sinewy part of it. These have their origins in the heart, for they traverse the other viscera, in whatever direction they happen to run, without in any way losing their distinctive characteristic as veins, whereas the heart is as it were a part of them (and that too more in respect to the frontward and larger one of the two), owing to the fact that these two veins are above and below, with the heart lying midway.

The heart in all animals has cavities inside it. In the case of the very small animals the largest of the chambers is scarcely discernible; the second larger is scarcely discernible in animals of medium size; but in the largest animals all three chambers are distinctly seen. In the heart then (with its pointed end directed frontwards, as has been observed) the largest of the three chambers is on the right-hand side and highest up; the least one is on the left-hand side; and the medium-sized one lies between the other two; and the largest one of the three chambers is a great deal larger than either of the two others. All three, however, are connected with passages leading in the direction of the lung, but all these communications are indistinctly discernible by reason of their minuteness, except one.

The great vein, then, is attached to the biggest of the three chambers, the one that lies uppermost and on the right-hand side; it then extends right through the chamber, coming out as a vein again; just as though the cavity were a part of the vessel, in which the blood forms a lake. The aorta is attached to the middle chamber; but the arrangement is dissimilar, and it is connected with it by a much narrower pipe.

The vein then passes through the heart and a passage runs from the heart into the aorta. The great vein looks as though made of membrane or skin, while the aorta is narrower than it, and is very sinewy; and as it stretches away to the head and to the lower parts it becomes exceedingly narrow and sinewy.

First of all, then, upwards from the heart there stretches a part of the great vein towards the lung and the attachment of the aorta, a large undivided vessel. But there split off from it two parts; one towards the lung and the other towards the backbone and the last vertebra of the neck.

The vein that extends to the lung, as the lung itself is duplicate, divides at first into two; and then extends along by every pipe and every perforation, greater along the greater ones, lesser along the less, so that it is impossible to discern a single part wherein there is not both perforation and vein; for the extremities are indistinguishable from their minuteness, and the whole lung appears to be filled with blood. The passages from the vein lie above the tubes that extend from the windpipe. And the vein which extends to the vertebra of the neck and the backbone, stretches back again along the backbone; as Homer represents in the lines:—

He cut through all that vein
which runs along the back right to the neck.[10]

From this vessel there extend small veins past each rib and each vertebra; and at the vertebra above the kidneys the vessel bifurcates. And in the above way the parts branch off from the great blood-vessel.

But up above all these, from that part which is connected with the heart, the entire vein branches off in two directions. The one set extend to the sides and to the collar-bones, and then pass on through the armpits, in men to the arms, in 514a1 quadrupeds to the forelegs, in birds to the wings, and in fishes to the upper fins. The origins of these veins, where they first branch off, are called the jugular veins; and where they branch off to the neck they run alongside the windpipe; and, occasionally, if these veins are pressed externally, men, though not actually choked, become insensible, shut their eyes, and fall to the ground. Extending in the way described and keeping the windpipe in between them, they pass on until they reach the ears at the junction of the lower jaw with the skull. Hence again they branch off into four veins, of which one bends back and descends through the neck and the shoulder, and meets the previous branching off of the vein at the bend of the arm, while the rest of it terminates at the hand and fingers.

Each vein of the other pair stretches from the region of the ear to the brain, and branches off in a number of fine and delicate veins into the so-called meninx which surrounds the brain. The brain itself in all animals is destitute of blood, and no vein, great or small terminates there. But of the remaining veins that branch off from the last-mentioned vein some encircle the head, others end their courses in the organs of sense and at the teeth in exceedingly fine small veins.

4 · And in like manner the parts of the lesser vein, designated the aorta, branch off, accompanying the branches from the big vein; only that, in regard to the aorta, the passages are less in size, and the branches very considerably less than are those of the great vein. So much for the veins as observed in the regions above the heart.

The part of the great vein that lies underneath the heart extends, freely suspended, right through the midriff, and is united both to the aorta and the backbone by slack membranous passages. From it one vein, short and wide, extends through the liver, and from it a number of minute veins branch off into the liver and disappear. From the vein that passes through the liver two branches separate off, of which one terminates in the diaphragm or so-called midriff, and the other runs up 514b1 again through the armpit into the right arm and unites with the other veins at the inside of the bend of the arm; and that is why when the surgeon opens this vein, the patient is relieved of certain pains in the liver; and from the left-hand side of it there extends a short but thick vein to the spleen and the little veins branching off it disappear in that organ. Another part branches off from the left-hand side of the great vein, and ascends in the same way into the left arm; only that in the one case it is the vein that traverses the liver, while in this case it is distinct from the vein that runs into the spleen.

[10] *Iliad* XIII 546.

Again, other veins branch off from the big vein; one to the omentum, and another to the pancreas, from which vein run a number of veins through the mesentery. All these veins terminate in a single large vein, which extends along the entire gut and stomach to the oesophagus; about these parts many veins branch off.

As far as the kidneys, each of the two remaining undivided, the aorta and the big vein extend; and here they get more closely attached to the backbone, and branch off, each of the two, into a Λ shape, and the big vein gets to the rear of the aorta. But the chief attachment of the aorta to the backbone takes place in the region of the heart; and the attachment is effected by means of minute and sinewy vessels. The aorta, just as it draws off from the heart, is a tube of considerable volume, but, as it advances in its course, it gets narrower and more sinewy. And from the aorta there extend veins to the mesentery just like the veins from the big vein, only that they are considerably less in magnitude; they are, indeed, narrow and fibrous, and they end in delicate and complex fibre-like veinlets.

There is no vessel that runs from the aorta into the liver or the spleen.

From each of the two great blood-vessels there extend branches to each of the two flanks, and both branches fasten on to the bone. Vessels also extend to the kidneys from the big vein and the aorta; only that they do not open into the cavity but into the body of the kidney. From the aorta run two other ducts to the bladder, firm and continuous; and there are other ducts from the hollow of the kidneys, in no way communicating with the big vein. From the centre of each of the two kidneys springs a hollow sinewy vein, running along the backbone right through the narrow parts; by and by each of the two veins first disappears in its own flank, and soon 515a1
afterwards reappears stretching in the direction of the flank.[11] The extremities of these attach to the bladder,[12] and also in the male to the penis and in the female to the womb. From the big vein no vein extends to the womb, but the organ is connected with the aorta by veins numerous and closely packed.

Furthermore, from the aorta and the great vein at the points of branching there come other veins. Some of these run first to the groins—large hollow veins—and then pass on down through the legs and terminate in the feet and toes. And, again, another set run through the groins and the thighs, from right to left and from left to right, and unite in the hams with the other veins.

In the above description we have thrown light upon the course of the veins and their points of departure.

In all sanguineous animals the case stands as here set forth in regard to the points of departure and the chief veins. But the description does not hold equally good for the entire vein-system in all these animals. For, in point of fact, the parts are not identically situated in them all, nor do all animals have the same parts. Furthermore, things are not equally clear in all cases—they are clearest in the case of animals of considerable magnitude and supplied abundantly with blood. For in little animals and those scantily supplied with blood, either from natural causes or from a prevalence of fat in the body, it is less easy to discover the arrangement; for

[11]Dittmeyer excises lines 34 ('. . . and there are other ducts . . .') to 2 ('. . . flank.').
[12]Dittmeyer excises 'the bladder and also'.

in the latter of these creatures the passages get clogged, like water-channels choked with mud; and the others have a few minute fibres instead of veins. But in all cases the big vein is plainly discernible, even in creatures of insignificant size.

5 · The sinews of animals are arranged as follows. For these also the point of origin is the heart; for the heart has sinews within itself in the largest of its three chambers, and the aorta is a sinew-like vein; in fact, at its extremity it is actually a sinew, for it is there no longer hollow, and is stretched like the sinews where they terminate at the jointings of the bones. Nevertheless, the sinews do not proceed in unbroken sequence from one point of origin, as do the blood-vessels.

For the veins have the shape of the entire body, like a sketch of a mannikin; in such a way that the whole frame seems to be filled up with little veins in very attenuated subjects—for the space occupied by flesh in fat individuals is filled with little veins in thin ones—whereas the sinews are distributed about the joints and the flexures of the bones. Now, if the sinews were continuous, this continuity would be discernible in attenuated specimens.

In the ham, or the part which controls the act of jumping, is an important system of sinews; and another sinew, a double one, is that called the tendon, and others are those brought into play when a great effort of physical strength is required; that is to say, the epitonos and the shoulder-sinews. Other sinews, devoid of specific designation, are situated in the region of the flexures of the bones; for all the bones that are attached to one another are bound together by sinews, and a great quantity of sinews are placed in the neighbourhood of all the bones. But in the head there is no sinew; but the head is held together by the sutures of the bones.

Sinew is fissile lengthwise, but crosswise it is not easily broken, but admits of a considerable amount of tension. Around the sinews a liquid mucus is developed, white and glutinous, and they are sustained by it and appear to be composed of it. Now, vein may be cauterized, but sinew, when cauterized, is completely destroyed; and, if sinews be cut asunder, the severed parts will not again cohere. A feeling of numbness is incidental only to parts of the frame where sinew is situated.

There is a very extensive system of sinews connected severally with the feet, the hands, the ribs, the shoulder-blades, the neck, and the arms.

All animals supplied with blood are furnished with sinews; but in the case of animals that have no flexures to their limbs, but are destitute of feet and hands, the sinews are fine and inconspicuous; and so the sinews in the fish are chiefly discernible.

6 · Fibres are intermediate between sinew and vein. Some of them are supplied with fluid, the lymph; and they pass from sinew to vein and from vein to sinew. There is another kind of fibre that is found in blood, but not in the blood of all animals alike. If this fibre be left in the blood, the blood will coagulate; if it be removed, the blood does not coagulate. While, however, this fibrous matter is found in the blood of the great majority of animals, it is not found in the blood of the deer, the roe, the antelope, and some other animals; and so the blood of these animals does

not coagulate to the extent observed in the blood of other animals. The blood of the deer coagulates to about the same extent as that of the hare: that is to say, the blood in either case coagulates, but not into a stiff substance, like the blood of ordinary animals, but only into a flaccid consistency like that of milk which is not subjected to the action of rennet. The blood of the antelope admits of a firmer consistency in coagulation; for in this respect it resembles, or only comes a little short of, the blood of sheep. Such are the properties of vein, sinew, and fibrous tissue. 516^{a}1

7 · The bones in animals are all connected with one single bone, and are continuous with one another, like the veins and there is no instance of a bone standing apart by itself.

In all animals furnished with bones, the backbone is the point of origin. The spine is composed of vertebrae, and it extends from the head down to the loins. The vertebrae are all perforated, and, above, the bony portion of the head is connected with the topmost vertebrae, and is designated the skull. And the serrated lines on the skull are termed sutures.

The skull is not formed alike in all animals. In some animals the skull consists of one single bone, as in the case of the dog; in others it is composite in structure, as in man; and in the human species the suture is circular in the female, while in the male it is made up of three separate sutures, uniting above in three-corner fashion; and instances have been known of a man's skull being devoid of suture altogether. The skull is composed not of four bones, but of six; two of these are in the region of the ears, small in comparison with the other four. From the skull extend the jaws, constituted of bone. [Animals in general move the lower jaw; the river-crocodile is the only animal that moves the upper one.][13] In the jaws is the tooth-system; and the teeth are constituted of bone, and are partly perforated, partly not; and this is the only kind of bone which it is impossible to grave with a graving tool.

On the upper part of the course of the backbone[14] are the collar-bones and the ribs. The chest rests on ribs; and these ribs meet together, whereas the others do not; for no animal has bone in the region of the stomach. Then come the shoulder-bones, or blade-bones, and the arm-bones connected with these, and the bones in the hands connected with the bones of the arms. With animals that have forelegs, the bones of the foreleg resemble those of the arm in man.

At the lower end of the backbone, after the haunch-bone, comes the hip-socket; then the leg-bones, those in the thighs and those in the shins, which are termed limb-bones, a part of which is the ankle, while a part of the same is the so-called 516^{b}1
plectrum in those creatures that have an ankle;[15] and connected with these bones are the bones in the feet.

Now, with all animals that are supplied with blood and furnished with feet, and are at the same time viviparous, the bones do not differ greatly one from another, but only in the way of relative hardness, softness, or magnitude. Again, in

[13]Dittmeyer excises these sentences: see 492^{b}23.
[14]Reading ἄνω δὲ τῆς ῥάχεως ᾗ περαίνει.
[15]Dittmeyer excises 'while a part of the same . . . ankle'.

one and the same animal certain bones are supplied with marrow, while others are destitute of it. Some animals might appear to have no marrow whatsoever in their bones—e.g. the lion—since they have marrow only in small amount, poor and thin, and in very few bones; for marrow is found in the thigh and arm-bones. The bones of the lion are exceptionally hard; so hard, in fact, that if they are rubbed against one another they emit sparks like flint-stones. The dolphin has bones, and not fish-spine.

Of the other animals supplied with blood, some differ but little, as is the case with birds; others have systems analogous, as fishes; for viviparous fishes, such as the Selachia, are gristle-spined, while the ovipara have a spine which corresponds to the backbone in quadrupeds. This exceptional property has been observed in fishes, that in some of them there are found delicate spines scattered here and there throughout the fleshy parts. The serpent is similarly constructed to the fish; in other words, his backbone is spinous. With oviparous quadrupeds, the skeleton of the larger ones is more osseous; of the smaller ones, more spinous. But all sanguineous animals have a backbone of either one kind or other: that is, composed either of bone or of spine.

The other portions of the skeleton are found in some animals and not found in others, but the presence or the absence of this and that part carries with it, as a matter of course, the presence or the absence of the bones. For animals that are destitute of arms and legs cannot be furnished with limb-bones; and in like manner with animals that have the same parts, but yet have them unlike in form; for in these animals the bones differ in the way of excess or defect, or in the way of analogy. So much for the osseous systems in animals.

8 · Gristle is of the same nature as bone, but differs from it in the way of excess or defect. And just like bone, cartilage also, if cut, does not grow again. In terrestrial viviparous sanguinea the gristle formations are unperforated, and there is no marrow in them as there is in bones; in the selachia, however—for they are gristle-spined—there is found[16] in region of the backbone, a gristle-like substance analogous to bone, and in this there is a liquid resembling marrow. In viviparous animals furnished with feet, gristle formations are found in the region of the ears, in the nostrils, and around certain extremities of the bones.

9 · Furthermore, there are parts of other kinds, neither identical with, nor altogether diverse from, the parts above enumerated: such as nails, hooves, claws, and horns; and also, beaks, such as birds are furnished with—all in the several animals that are furnished therewith. All these parts are flexible and fissile; but bone is neither flexible nor fissile, but frangible.

And the colours of horns and nails and claw and hoof follow the colour of the skin and the hair. For according as the skin of an animal is black, or white, or of medium hue, so are the horns, the claws, or the hooves, as the case may be, of hue to

[16]Omitting αὐτῶν ἐν τοῖς πλατέσι.

match. And it is the same with nails. The teeth, however, follow after the bones. Thus in black men, such as the Aethiopians and the like, the teeth and bones are white, but the nails are black, like the whole of the skin.

Horns in general are hollow at their point of attachment to the bone which juts out from the head inside the horn, but they have a solid portion at the tip, and they are simple in structure. In the case of the stag alone of all animals the horns are solid throughout, and ramify into branches. And, whereas no other animal is known to shed its horns, the deer sheds its horns annually, unless it has been castrated; and with regard to the effects of castration in animals we shall speak hereafter. Horns attach rather to the skin than to the bone; which will account for the fact that there are found in Phrygia and elsewhere cattle that can move their horns as freely as their ears.

Of animals furnished with nails—and all animals have nails that have toes, and toes that have feet,[17] except the elephant; and the elephant has toes undivided and slightly articulated, but has no nails whatsoever—of animals furnished with nails, some are straight-nailed, like man; others are crooked-nailed, as the lion 517b1
among animals that walk, and the eagle among animals that fly.

10 · The following are the properties of hair and of parts analogous to hair, and of skin. All viviparous animals furnished with feet have hair; all oviparous animals furnished with feet have horn-like tessellates; fishes, and fishes only, have scales—that is, such oviparous fishes as have the crumbling egg. For the lanky fishes, the conger has no such egg, nor the muraena, and the eel has no egg at all.

The hair differs in the way of thickness and fineness, and of length, according to the locality of the part in which it is found, and according to the quality of skin on which it grows. For, as a general rule, the thicker the hide, the harder and the thicker is the hair; and the hair is inclined to grow in abundance and to a great length in localities of the bodies hollow and moist, if the localities be fitted for the growth of hair at all. The facts are similar in the case of animals coated with scales or with tessellates. With soft-haired animals the hair gets harder with good feeding, and with bristly animals it gets softer and scantier from the same cause. Hair differs in quality also according to the heat or coldness of the locality: just as the hair in man is hard in warm places and soft in cold ones. Again, straight hair is inclined to be soft, and curly hair to be bristly.

11 · Hair is naturally fissile, and in this respect it differs in degree in diverse animals. In some animals the hair goes on gradually hardening into bristle until it no longer resembles hair but spine, as in the case of the hedgehog. And in like manner with the nails; for in some animals the nail differs as regards hardness in no way from bone.

[17] Dittmeyer excises 'and toes that have feet'.

Of all animals man has the most delicate skin: that is, if we take into consideration his relative size. In the skin of all animals there is a mucous liquid, scanty in some animals and plentiful in others, as, for instance, in the hide of the ox; for men manufacture glue out of it. (In some places glue is manufactured from fishes also.)[18] The skin, when cut, is in itself devoid of sensation; and this is especially the case with the skin on the head, owing to there being no flesh between it and the skull. And wherever the skin is quite by itself, if it be cut asunder, it does not grow together again, as is seen in the thin part of the jaw, in the prepuce, and the eyelid. In all animals the skin is one of the parts that extends continuous and unbroken, and it comes to a stop only where the natural ducts pour out their contents, and at the mouth and nails.

All sanguineous animals, then, have skin; but not all such animals have hair, save only under the circumstances described above. The hair changes its colour as animals grow old, and in man it turns white. With animals, in general, the change takes place, but not very obviously except in the case of the horse. Hair turns grey from the point backwards to the roots. But, in the majority of cases, grey hairs are white from the beginning; and this is a proof that greyness of hair does not, as some believe to be the case, imply withering; for no part is brought into existence in a withered condition.

In the eruptive malady called the white-sickness all the hairs get grey; and instances have been known where the hair became grey while the patients were ill of the malady, whereas the grey hairs shed off and black ones replaced them on their recovery. [Hair is more apt to turn grey when it is kept covered than when exposed to the action of the outer air.][19] In men, the hair over the temples is the first to turn grey, and the hair in the front grows grey sooner than the hair at the back; and the hair on the pubes is the last to change colour.

Some hairs are congenital, others grow after the maturity of the animal; but this occurs in man only. The congenital hairs are on the head, the eyelids, and the eyebrows; of the later growths the hairs on the pubes are the first to come, then those under the armpits, and, thirdly, those on the chin; for the regions where congenital growths and the subsequent growths are found are equal in number. The hair on the head grows scanty and sheds out to a greater extent and sooner than all the rest. But this remark applies only to hair in front; for no man ever gets bald at the back of his head. Smoothness on the top of the head is termed baldness, but smoothness on the eyebrows is called *anaphalanthiasis*; and neither of these conditions of baldness supervenes in a man until he has entered upon sexual activity. For no boy ever gets bald, no woman, and no castrated man. In fact, if a man be castrated before reaching puberty, the later growths of hair never come at all; and, if the operation take place subsequently, the after-growths, and these only, shed off, except that on the pubes.

Women do not grow hairs on the chin; except that a scanty beard grows on some women after the monthly periods have stopped; and a similar phenomenon is observed at times in priestesses in Caria, but these cases are looked upon as

[18]Dittmeyer excises this sentence.
[19]Dittmeyer excises this sentence.

518b1 portentous with regard to coming events. The other after-growths are found in women, but more scanty and sparse. Men and women are at times born incapable of the after-growths; and of them, those who are destitute even of the growth upon the pubes are constitutionally impotent.

Hair as a rule grows more or less in length as the wearer grows in age; chiefly the hair on the head, then that in the beard, and fine hair grows longest of all. With some people as they grow old the eyebrows grow thicker, to such an extent that they have to be cut off; and this growth is owing to the fact that the eyebrows are situated at a conjuncture of bones, and these bones, as age comes on, draw apart and exude a gradual increase of moisture. The eyelashes do not grow in size, but they shed when the wearer enters on sexual activity, and shed all the quicker as this activity is the more powerful; and these are the last hairs to grow grey.

Hairs if plucked out before maturity grow again; but they do not grow again if plucked out afterwards. Every hair is supplied with a mucous moisture at its root, and immediately after being plucked out it can lift light articles if it touch them with this mucus.

Animals that admit of diversity of colour in the hair admit of a similar diversity to start with in the skin and in the cuticle of the tongue.

In some cases the upper lip and the chin is thickly covered with hair, and in other cases these parts are smooth and the cheeks are hairy; and smooth-chinned men are less inclined to baldness.

The hair is inclined to grow in certain diseases, especially in consumption, and in old age, and after death; and under these circumstances the hair hardens, and the same phenomenon is observable in respect of the nails.

In the case of men of strong sexual passions the congenital hairs shed the sooner, while the hairs of the aftergrowths are the quicker to come. When men are afflicted with varicose veins they are less inclined to take on baldness; and if they be bald when they become thus afflicted, some get their hair again.

If a hair be cut, it does not grow at the point of section; but it gets longer by growing upward from below. In fishes the scales grow harder and thicker, and when the animal gets emaciated or is growing old the scales grow harder. In quadrupeds as they grow old the hair in some and the wool in others gets deeper but scantier in amount: and the hooves or claws get larger in size; and the same is the case with the beaks of birds. The claws also increase in size, as do also the nails.

519a1 12 · With regard to winged animals, such as birds, no creature is liable to change of colour by reason of age, excepting the crane. The wings of this bird are ash-coloured at first, but as it grows old the wings get black. Again, owing to special climatic influences, as when unusual frost prevails, a change is sometimes observed to take place in birds whose plumage is of one uniform colour; thus, birds that have dark or black plumage turn white, as the raven, the sparrow, and the swallow; but no case has been known of a change of colour from white to black. [Further, most birds change the colour of their plumage at different seasons of the year, so much so that a man ignorant of their habits might be mistaken as to their identity.][20]

[20]Dittmeyer excises this sentence.

Some animals change the colour of their hair with a change in their drinking-water, for the same species of animal is found white in one district and black in another. And in regard to the commerce of the sexes, water in many places is of such peculiar quality that rams, if they have intercourse with the female after drinking it, beget black lambs, as is the case with the water of the Psychrus, a river in the district of Assyritis in the Chalcidic Peninsula, on the coast of Thrace; and in Antandria there are two rivers of which one makes the lambs white and the other black. The river Scamander also has the reputation of making lambs yellow, and that is the reason, they say, why Homer designates it the Yellow River instead of the Scamander.[21]

Animals as a general rule have no hair on their internal surfaces, and, in regard to their extremities, they have hair on the upper, but not on the lower side.

The hare is the only animal to have hair inside its mouth and underneath its feet. Further, the moustache-whale[22] instead of teeth has hairs in its mouth resembling pigs' bristles.

Hairs after being cut grow at the bottom but not at the top; if feathers be cut off, they grow neither at top nor bottom, but shed and fall out. Further, the bee's wing will not grow again after being plucked off, nor will the wing of any creature that has undivided wings. Neither will the sting grow again if the bee lose it, but the creature will die of the loss.

13 · In all sanguineous animals membranes are found. And membrane resembles a thin close-textured skin, but its qualities are different, as it admits neither of cleavage nor of extension. Membrane envelops each one of the bones and each one of the viscera, both in the larger and the smaller animals; though in the smaller animals the membranes are indiscernible from their extreme tenuity and minuteness. The largest of all the membranes are the two that surround the brain, and of these two the one that lines the bony skull is stronger and thicker than the one that envelops the brain; next in order of magnitude comes the membrane that encloses the heart. If membrane be bared and cut asunder it will not grow together again, and the bone thus stripped of its membrane mortifies.

14 · The omentum is membrane. All sanguineous animals are furnished with this organ; but in some animals it is supplied with fat, and in others it is devoid of it. The omentum has both its starting-point and its attachment, with ambidental vivipara, in the centre of the stomach, where the stomach has a kind of suture; in non-ambidental vivipara it has its starting-point and attachment in the chief of the stomachs.

15 · The bladder also is of the nature of membrane, but of membrane peculiar in kind, for it is extensile. The organ is not common to all animals, but,

[21]Dittmeyer excises the passage on the effects of water on procreation.
[22]Reading *μυστακόκητος*.

while it is found in all the vivipara, the tortoise is the only oviparous animal that is furnished therewith. The bladder if cut asunder will not grow together again, unless the section be just at the commencement of the urethra: except indeed in very rare cases, for instances of healing have been known to occur. After death, the organ passes no liquid excretion; but in life it passes at times dry excretion also, which turns into stones in the case of sufferers from that malady. Indeed, instances have been known of concretions in the bladder indistinguishable from cockle-shells.

Such are the properties, then, of vein, sinew and skin, of fibre and membrane, of hair, nail, claw and hoof, of horns, of teeth, of beak, of gristle, of bones, and of parts that are analogous to these.

16 · Flesh, and that which is by nature akin to it in sanguineous animals, is in all cases situated in between the skin and the bone, or the substance analogous to bone; for just as spine is a counterpart of bone, so is the flesh-like substance to flesh, in the case of animals that have bones and spine.

Flesh can be divided asunder in any direction, not lengthwise only as is the case with sinew and vein. When animals are subjected to emaciation the flesh disappears, and the creatures become a mass of veins and fibres; when they are over fed, fat takes the place of flesh. Where the flesh is abundant in an animal, its veins are somewhat small and the blood abnormally red; the viscera also and the stomach are diminutive; whereas with animals whose veins are large the blood is somewhat black, the viscera and the stomach are large, and the flesh is somewhat scanty. And animals with small stomachs are disposed to take on flesh.

17 · Again, fat and suet differ from one another. Suet is frangible in all directions and congeals if subjected to extreme cold, whereas fat can melt but cannot congeal; and soups made of the flesh of animals supplied with fat do not congeal, as is found with horse-flesh and pork; but soups made from the flesh of animals supplied with suet do coagulate, as is seen with mutton and goat's flesh. Further, fat and suet differ as to their localities; for fat is found between the skin and flesh, but suet is found only at the limit of the fleshy parts. Also, in animals supplied with fat the omentum is supplied with fat, and it is supplied with suet in animals supplied with suet. Moreover, ambidental animals are supplied with fat, and non-ambidentals with suet.

Of the viscera the liver in some animals becomes fatty, as, among fishes, is the case with the selachia, by the melting of whose livers an oil is manufactured. The selachia themselves have no free fat at all in connexion with the flesh or with the stomach. The suet in fish is fatty, and does not congeal. All animals are furnished with fat, either intermingled with their flesh, or apart. Such as have no free fat are less fat than others in stomach and omentum, as the eel; for it has only a scanty supply of suet about the omentum. Most animals take on fat in the belly, especially such animals as are little in motion.

The brains of animals supplied with fat are oily, as in the pig; of animals supplied with suet, dry. But it is about the kidneys more than any other viscera that animals are inclined to take on fat; and the right kidney is always less supplied with fat, and, be the two kidneys ever so fat, there is always a space devoid of fat in between the two. Animals supplied with suet are specially apt to have it about the kidneys, and especially the sheep; for this animal is apt to die from its kidneys being entirely enveloped. Fat about the kidney is induced by overfeeding, as is found at Leontini in Sicily; and consequently in this district they defer driving out sheep to pasture until the day is well on, to reduce the amount they eat.

18 · The part around the pupil of the eye is fatty in all animals, and this part resembles suet in all animals that possess such a part and that are not furnished with hard eyes.

Fat animals, whether male or female, are poor breeders. Animals are disposed to take on fat more when old than when young, and especially when they have attained their full breadth and their full length and are beginning to grow depth-ways.

19 · And now to proceed to the consideration of the blood. In sanguineous animals blood is the most universal and the most indispensable part; and it is not an acquired part, but it belongs to all animals that are not moribund. All blood is contained in a vascular system, to wit, the veins, and is found nowhere else, excepting in the heart. Blood is not sensitive to touch in any animal, any more than the excretions of the stomach; and the case is similar with the brain and the marrow. When flesh is lacerated, blood exudes, if the animal be alive and unless the flesh be gangrened. Blood in a healthy condition is naturally sweet to the taste, and red in colour; blood that deteriorates from natural decay or from disease is more or less black. Blood at its best, before it undergoes deterioration from either natural decay or disease, is neither very thick nor very thin. In the living animal it is always liquid and warm, but, on issuing from the body, it coagulates in all cases except in the case of the deer, the roe, and the like animals; for, as a general rule, blood coagulates unless the fibres be extracted. Bull's blood is the quickest to coagulate.

Animals that are internally and externally viviparous are more abundantly supplied with blood than the sanguineous ovipara. Animals that are in good condition, either from natural causes or from their health having been attended to, have the blood neither too abundant—as it is in creatures that have recently taken a drink—nor again very scanty, as is the case with animals when exceedingly fat. For animals in this condition have pure blood, but very little of it, and the fatter an animal gets the less becomes its supply of blood; for whatsoever is fat is destitute of blood.

A fat substance is incorruptible, but blood and all things containing it corrupt rapidly, and this property characterizes especially all parts connected with the bones. Blood is finest and purest in man; and thickest and blackest in the bull and the ass, of all vivipara. In the lower and the higher parts of the body blood is thicker and blacker.

Blood palpitates in the veins of all animals alike all over their bodies, and blood is the only liquid that permeates the entire frames of living animals, without exception and at all times, as long as life lasts. Blood is developed first of all in the heart of animals before the body is differentiated as a whole. If blood be removed or if it escape in any considerable quantity, animals fall into a faint; if it be removed in an exceedingly large quantity they die. If the blood get exceedingly liquid, animals fall sick; for the blood then turns into something like ichor, and gets so thin that it at times has been known to exude through the pores like sweat. In some cases blood, when issuing from the veins, does not coagulate at all, or only here and there. Whilst animals are sleeping the blood is less abundantly supplied near the exterior surfaces, so that, if the sleeping creature be pricked with a pin, the blood does not issue as copiously. Blood is developed out of ichor by concoction, and fat in like manner out of blood. If the blood get diseased, haemorrhoids may ensue in the nostril or at the anus, or the veins may become varicose. Blood, if it corrupt in the body, has a tendency to turn into pus, and pus may turn into a solid concretion.

Blood in the female differs from that in the male, for, supposing the male and female to be on a par as regards age and health, the blood in the female is thicker and blacker than in the male; and with the female there is less on the surface and more internally. Of all female animals the female in man is the most richly supplied with blood, and of all animals the menstruous discharges are the most copious in woman. The blood of these discharges under disease turns into flux. Women are less subject to other diseases. Women are seldom afflicted with varicose veins, with haemorrhoids, or with bleeding at the nose, and, if any of these maladies supervene, the menses are imperfectly discharged.

Blood differs in quantity and appearance according to age; in very young animals it resembles ichor and is abundant, in the old it is thick and black and scarce, and in middle-aged animals its qualities are intermediate. In old animals the 521b1
blood coagulates rapidly, even blood at the surface of the body; but this is not the case with young animals. Ichor is unconcocted blood: either blood that has not yet been concocted, or that has become fluid again.

20 · We now proceed to marrow; for this is one of the liquids found in certain sanguineous animals. All the natural liquids of the body are contained in vessels: as blood in veins, marrow in bones [and other moistures in membranous structures of the skin or gut].[23]

In young animals the marrow is exceedingly sanguineous, but, as animals grow old, it becomes fatty in animals supplied with fat, and suet-like in animals with suet. All bones, however, are not supplied with marrow, but only the hollow ones, and not all of these. For of the bones in the lion some contain no marrow at all, and some are only scantily supplied therewith; and that accounts, as was previously observed, for the statement made by certain writers that the lion is marrowless. In the bones of pigs it is found in small quantities; and in the bones of certain animals of this species it is not found at all.

[23]Dittmeyer excises this clause.

These liquids, then, are nearly always congenital in animals, but milk and sperm come at a later time. Of these latter, that which, whensoever it is present, is secreted in all cases ready-made, is the milk; sperm, on the other hand, is not like that in all cases, but in some only, as in the case of what are designated *thori* in fishes.

Whatever animals have milk, have it in their breasts. All animals have breasts that are internally and externally viviparous, as for instance all animals that have hair, as man and the horse; and the cetaceans, as the dolphin, the porpoise, and the whale—for these animals have breasts and are supplied with milk. Animals that are oviparous or only externally viviparous have neither breasts nor milk, as the fish and the bird.

All milk is composed of a watery serum called whey, and a consistent substance called curd; and the thicker the milk, the more abundant the curd. The milk, then, of non-ambidentals coagulates, and that is why cheese is made of the milk of such animals under domestication; but the milk of ambidentals does not coagulate, nor their fat either, and the milk is thin and sweet. Now the camel's milk is the thinnest, and that of the horse next after it, and that of the ass next again, but cow's milk is the thickest. Milk does not coagulate under the influence of cold, but rather runs to whey; but under the influence of heat it coagulates and thickens. As a general rule milk only comes to animals in pregnancy. When the animal is pregnant milk is found, but at first—and then again later—it is unfit for use. In the case of female animals not pregnant a small quantity of milk has been procured by the employment of special food, and cases have been actually known where women advanced in years on being submitted to the process of milking have produced milk, and in some cases have produced it in sufficient quantities to enable them to suckle an infant.

The people that live on and about Mount Oeta take such she-goats as decline the male and rub their udders hard with nettles to cause pain; hereupon they milk the animals, procuring at first a liquid resembling blood, then a liquid mixed with purulent matter, and eventually milk, as freely as from females submitting to the male.

As a general rule, milk is not found in the male of man or of any other animal, though from time to time it has been found in a male; for instance, once in Lemnos a he-goat was milked by its dugs (for it has two dugs close to the penis), and was milked to such effect that cheese was made of the produce, and the same phenomenon was repeated in a male of its own begetting. Such occurrences, however, are regarded as portents, and in point of fact when the Lemnian owner of the animal inquired of the oracle, the god informed him that the portent foreshadowed the acquisition of a fortune. With some men, after puberty, a little milk can be produced by squeezing the breasts; cases have been known where on their being subjected to a prolonged milking process a considerable quantity of milk has been educed.

In milk there is a fatty element, which in clotted milk gets to resemble oil. Goat's milk is mixed with sheep's milk in Sicily, and wherever sheep's milk is fat.

The best milk for clotting is not only that where the curd is most abundant, but that also where it is driest.

Now some animals produce more than enough milk to rear their young, and this is useful for cheese-making and for storage. This is especially the case with the sheep and the goat, and next in degree with the cow. Mare's milk and milk of the she-ass are mixed in with Phrygian cheese. And there is more curd in cow's milk than in goat's milk; for graziers tell us that from nine gallons of goat's milk they can get nineteen cheeses at an obol apiece, and from the same amount of cow's milk, thirty. Other animals give only enough of milk to rear their young, and no superfluous amount and none fitted for cheese-making, as is the case with all animals that have more than two breasts; for with none of such animals is milk produced in superabundance or used for the manufacture of cheese.

The juice of the fig and rennet are employed to curdle milk. The fig-juice is first squeezed out into wool; the wool is then rinsed into a little milk, and if this be mixed with other milk it curdles it. Rennet is a kind of milk; for it is found in the stomach of the animal while it is yet suckling.

21 · Rennet then consists of milk with an admixture of fire,[24] which comes from the natural heat of the animal, as the milk is concocted. All ruminating animals produce rennet, and, of ambidentals, the hare. Rennet improves in quality the longer it is kept; and this sort, and also hare's rennet, is good for diarrhoea, and the best of all rennet is that of the young deer.

In milk-producing animals the comparative amount of the yield varies with the size of the animal and the diversities of pasturage. For instance, there are in Phasis small cattle that in all cases give a copious supply of milk, and the large cows in Epirus yield each one daily some nine gallons of milk, and half of this from each pair of teats, and the milker has to stand erect, stooping forward a little, as otherwise, if he were seated, he would be unable to reach up to the teats. But, with the exception of the ass, all the quadrupeds in Epirus are of large size, and the cattle and the dogs are the largest. Now large animals require abundant pasture, and this country supplies just such pasturage, and also supplies pasture grounds to suit the diverse seasons of the year. The cattle are particularly large, and likewise the sheep of the so-called Pyrrhic breed, the name being given in honour of King Pyrrhus.

Some pasture quenches milk, as lucerne, and that especially in ruminants; other feeding renders it copious, as cytisus and vetch; but cytisus in flower is not recommended, as it has burning properties, and vetch is not good for pregnant cattle, as it causes increased difficulty in parturition. However, beasts that can eat plentifully, as they are benefited thereby in regard to pregnancy, so also being well nourished produce milk in plenty. Some of the plants that cause flatulence bring milk, as for instance, a large feed of beans with the ewe, the she-goat, the cow, and the young she-goat; for this feeding makes them drop their udders. And the pointing

[24]Reading πῦρ ὅ ἐκ τῆς.

of the udder to the ground before parturition is a sign of there being plenty of milk.

Milk remains for a long time in the female, if she be kept from the male and be properly fed, and, of quadrupeds, this is especially true of the ewe; for the ewe can be milked for eight months. As a general rule, ruminating animals give milk in abundance, and milk fitted for cheese manufacture. In the neighbourhood of Torone cows run dry for a few days before calving, and have milk all the rest of the time. In women, milk of a livid colour is better than white for nursing purposes; and dark women give healthier milk than fair ones. Milk that is richest in curd is the most nutritious, but milk with a scanty supply of curd is the more wholesome for children.

22 · All sanguineous animals eject sperm. As to what, and how, it contributes to generation, these questions will be discussed in another treatise. Taking the size of his body into account, man emits more sperm than any other animal. In hairy-coated animals the sperm is sticky, but in other animals it is not so. It is white in all cases, and Herodotus is under a misapprehension when he states that the Aethiopians eject black sperm.[25]

Sperm issues from the body white and consistent, if it be healthy, and after quitting the body becomes thin and black. In frosty weather it does not coagulate, but gets exceedingly thin and watery both in colour and consistency; but it coagulates and thickens under the influence of heat. If it be long in the womb before issuing out, it comes more than usually thick; and sometimes it comes out dry and compact. Fertile sperm sinks in water; infertile sperm dissolves away. There is no truth in what Ctesias has written about the sperm of the elephant.

BOOK IV

1 · We have now treated, in regard to blooded animals, of the parts they have in common and of the parts peculiar to this genus or that, both the uniform and the
523b1 non-uniform parts, both the external and the internal. We now proceed to treat of animals devoid of blood. These animals are divided into several genera.

One genus consists of so-called molluscs: these are animals that, being devoid of blood, have flesh-like substance outside, and any hard structure they may happen to have, inside—in this respect resembling the red-blooded animals,—such as the genus of the cuttlefish.

Another genus is that of the crustaceans. These are animals that have their hard structure outside, and their soft or flesh-like substance inside, and the hard substance belonging to them has to be crushed rather than shattered; and to this genus belongs the crayfish and the crab.

[25]See Herodotus III 101.

A third genus is that of the testaceans. These are animals that have their hard substance outside and their flesh-like substance within, and their hard substance can be shattered but not crushed; and to this genus belong the snail and the oyster.

The fourth genus is that of insects; and this genus comprehends numerous and dissimilar species. Insects are creatures that, as the name implies, have nicks either on the belly or on the back, or on both belly and back, and have no one part distinctly osseous and no one part distinctly fleshy, but are something intermediate between bone and flesh; that is to say, their body is hard all through, inside and outside. Some insects are wingless, such as the *iulus* and the centipede; some are winged, as the bee, the cockchafer, and the wasp; and the same genus is in some cases both winged and wingless, as the ant and the glow-worm.

In molluscs the external parts are as follows: in the first place, the so-called feet; secondly, and attached to these, the head; thirdly, the sac, containing the internal parts, and incorrectly designated by some writers the head; and, fourthly, fins round about the sac. In all molluscs the head is found to be between the feet and the belly. All molluscs are furnished with eight feet, and in all cases these feet are severally furnished with a double row of suckers, with the exception of one single species of octopus. The cuttlefish, the small calamary and the large calamary have an exceptional organ in a pair of long tentacles, having at their extremities a portion rendered rough by the presence of two rows of suckers; and with these they apprehend their food and draw it into their mouths, and in stormy weather they cling by them to a rock like anchors and ride out the storm. They swim by the aid of 524a1
the fins[1] that they have about the sac. In all cases their feet are furnished with suckers.

The octopus uses his feelers either as feet or hands; with the two which stand over his mouth he draws in food, and the last of his feelers he employs in the act of copulation—it is extremely sharp, is exceptional as being of a whitish colour, and at its extremity is bifurcate (it is like that on the rachis, and by rachis is meant the smooth surface on the far side from the suckers).

In front of the sac and over the feelers they have a hollow tube, by means of which they discharge any sea-water that they may have taken into the sac of the body in the act of receiving food by the mouth. They can shift the tube from side to side, and by means of it they discharge their ink.

Stretching out its feet, it swims obliquely in the direction of the so-called head, and by this mode of swimming it can see in front, for its eyes are at the top, and in this attitude it has its mouth at the rear. The head, while the creature is alive, is hard, and looks as though it were inflated. It apprehends and retains objects by means of the under-surface of its arms, and the membrane in between its feet is kept at full tension; if the animal get on to the sand it can no longer retain its hold.

There is a difference between the octopus and the molluscs above mentioned: the sac of the octopus is small, and his feet are long, whereas in the others the sac is large and the feet short; so short, in fact, that they cannot walk on them. Compared

[1]Reading τοῖς δὲ πτερυγίοις ἅ.

with one another, the calamary is long-shaped and the cuttlefish flat-shaped; and of the calamaries the so-called teuthus is much bigger than the teuthis; for teuthi have been found as much as five ells long. Some cuttlefish attain a length of two ells, and the feelers of the octopus are sometimes as long, or even longer. The species teuthus is not a numerous one; the teuthus differs from the teuthis in shape; that is, the sharp extremity of the teuthus is broader and, further, the encircling fin goes all round the sac, whereas it is in part lacking in the teuthis; both animals are sea-creatures.

In all cases the head comes after the feet, in the middle of the feet that are
524b1 called feelers. There is here situated a mouth, and two teeth in the mouth; and above these two large eyes, and between the eyes a small cartilage enclosing a small brain; and within the mouth it has a minute organ of a fleshy nature, and this it uses as a tongue—for none of them has a tongue. Next after this, on the outside, is what looks like a sac; the flesh of which it is made is divisible, not in long straight strips, but in rings; and all molluscs have a cuticle around this flesh. Next after or at the back of the mouth comes a long and narrow oesophagus, and close after that a crop, large and spherical, like that of a bird; then comes the stomach, like the fourth stomach in ruminants; and the shape of it resembles the spiral convolution in the trumpet-shell; from the stomach there goes back again, in the direction of the mouth, a thin gut, and the gut is thicker than the oesophagus.

Molluscs have no viscera, but they have what is called a mytis, and on it the ink-sac; in the cuttlefish this vessel is the largest, and this juice is most abundant. All molluscs, when frightened, discharge such a juice, but the discharge is most copious in the cuttlefish. The mytis, then, is situated under the mouth, and the oesophagus runs through it; and down below at the point to which the gut extends is the ink-sac which is enveloped in one and the same membrane as the gut; and it discharges both the ink and the excreta by the same orifice. The animals have also certain hair-like growths in their bodies.

In the cuttlefish, the teuthis, and the teuthus the hard parts are within, towards the back of the body; those parts are called in one the sepium, and in the other the 'sword'. They differ from one another; for the sepium is hard and flat, being a substance intermediate between bone and spine, with (in part) a crumbling, spongy texture, but in the teuthis the part is thin and somewhat gristly. These parts differ from one another in shape, as do also the sacs of the animals. The octopus has nothing hard of this kind in its interior, but it has a gristly substance round the head, which, if the animal grows old, becomes hard.

The females differ from the males. The males have a duct in under the oesophagus, extending from the brain to the lower portion of the sac, and there is an organ to which it attaches, resembling a breast; in the female there are two of these
525a1 organs, situated higher up; with both sexes there are underneath these organs certain red formations. The egg of the octopus is single, uneven on its surface, and of large size; the fluid substance within is all uniform in colour, smooth, and in colour white; the mass of the egg is so great as to fill a vessel larger than the creature's head. The cuttlefish has two sacs, and inside them a number of eggs, like white

hailstones. For the disposition of these parts I must refer to my anatomical diagrams.

The males of all these animals differ from the females and the difference is most marked in the cuttlefish; for the back of the sac, which is blacker than the belly, is rougher in the male than in the female, and in the male the back is striped, and the rump is more sharply pointed.

There are several species of the octopus. One keeps close to the surface, and is the largest of them all, and near the shore the size is larger than in deep water; and there are others, small, variegated in colour, which are not articles of food. There are two others, one called the *heledone,* which differs in the length of its legs and in having one row of suckers—all the rest of the molluscs having two,—and the other called the *bolitaina* or the *ozolis.*

There are two others found in shells. One of them is called by some the *nautilus* or the *pontilus* (it is a sort of octopus);[2] and the shell of this creature is something like a separate valve of a deep scallop-shell.[3] This lives very often near to the shore, and is apt to be thrown up high and dry on the beach; and when its shell falls away it is caught or dies on the land. These polypods are small, and are shaped like the *bolitaina.* There is another that is placed within a shell like a snail; it never comes out of the shell, but lives inside it like the snail, and from time to time protrudes its feelers.

So much for molluscs.

2 · With regard to the crustaceans, one species is that of the crayfish, and a second, resembling the first, is that of the lobster; the lobster differing from the crayfish in having large claws, and in a few other respects as well. Another species is that of the carid, and another is that of the crab, and there are many kinds both of 525b1
carid and of crab.

Of carids there are the prawns, the squillae, and the little kind, (the little kind do not develop into a larger kind).

Of the crab, the varieties are indefinite and incalculable. The largest of all crabs is one called *maia,* a second variety is the *pagurus* and the crab of Heracleotis, and a third variety is the fresh-water crab; the other varieties are smaller in size and have no special designations. In Phoenicia there are found on the beach certain crabs that are called 'horses' from their running with such speed that it is difficult to overtake them; these crabs, when opened, are found empty, because of insufficiency of nutriment. [There is another variety, small like the crab, but resembling in shape the lobster.][4]

All these animals, as has been stated, have their hard and shelly part outside, where the skin is in other animals, and the fleshy part inside; and the belly is more or less laminated, and the female here deposits her spawn.

The crayfishes have five feet on either side, including the claws at the end; and

[2]Dittmeyer excises 'or the *pontilus* . . . octopus)'.
[3]Reading *συμφυῆς*.
[4]Dittmeyer excises.

in like manner the crabs have ten feet in all, including the claws. Of the carids, the prawns have five feet on either side, which are sharp-pointed—those towards the head; and five others on either side in the region of the belly, with their extremities flat; they are devoid of flaps on the under side, but on the back they resemble the crayfish. It is very different with the squilla; it has four front legs which are flat on either side, then three thin ones close behind on either side, and the rest of the body is for the most part devoid of feet. Of all these animals the feet bend out obliquely, as is the case with insects; and the claws, where claws are found, turn inwards. The crayfish has a tail, and five fins on it; and the prawn has a tail and four fins; the squilla also has fins at the tail on either side. In the case of both the middle part of the tail is spinous: only that in the squilla the part is flattened and in the prawn it is sharp-pointed. Of all animals of this genus the crab is the only one devoid of a rump; and, while the body of the carid and the crayfish is elongated, that of the crab is rotund.

In the crayfish the male differs from the female: in the female the first foot is bifurcate, in the male it is undivided; the belly-fins in the female are large and overlapping on the neck, while in the male they are smaller and do not overlap; and, further, on the last feet of the male there are spur-like projections, large and sharp, which in the female are small and smooth. Both male and female have two antennae in front of the eyes, large and rough, and other antennae underneath, small and smooth. The eyes of all these creatures are hard, and can move either to the inner or to the outer side. The eyes of most crabs can do the same, to an even greater degree.

The lobster is all over grey-coloured, with a mottling of black. Its under feet, up to the big feet, are eight in number; then come the big feet, far larger and flatter at the tips than the same organs in the crayfish; and these are irregular: the right claw has the extreme flat surface long and thin, while the left claw has the corresponding surface thick and round. Each of the two claws, divided at the end like a pair of jaws, has both below and above a set of teeth: only that in the right claw they are small and saw-shaped, while in the left claw those at the apex are saw-shaped and those within are molar-shaped, these latter being, in the under part, four teeth close together, and in the upper part three teeth, not close together. Both right and left claws have the upper part mobile, and bring it to bear against the lower one, and both are curved, being thereby naturally adapted for apprehension and constriction. Above the two large claws come two others, covered with hair, a little underneath the mouth; and underneath these the gill-like formations in the region of the mouth, hairy and numerous. These organs the animal keeps in perpetual motion; and the two hairy feet it bends and draws in towards its mouth. The feet near the mouth are furnished also with delicate appendages. Like the crayfish, the lobster has two teeth, and above these teeth are its antennae, long, but shorter and finer by far than those of the crayfish, and then four other antennae similar in shape, but shorter and finer than the others. Over these antennae come the eyes, small and short, not large like the eyes of the crayfish. Over the eyes is a peaky rough projection like a forehead, larger than the same part in the crayfish; in fact, the frontal part is more pointed and the thorax is much broader in the lobster than in the crayfish, and the body in general is smoother and more full of flesh. Of the eight feet, four are bifurcate at the extremities, and four are undivided. The region of the so-called neck is outwardly divided into five divisions, and sixthly comes the flattened portion at the end, and this portion has five flaps; and the inner parts, into which the female drops her spawn, are four in number and hairy, and on each of the aforesaid parts is a spine turned outwards, short and straight. The body in general and the region of the thorax in particular are smooth, not rough as in the crayfish; but on the large claws the outer portion has larger spines. There is no apparent difference between the male and female; for they both have one claw, whichever it may be, larger than the other, and neither male nor female is ever found with both claws of the same size.

All crustaceans take in water close by the mouth. The crab discharges it, closing up, as it does so, a small portion of the same, and the crayfish discharges it by way of the gills; and the gill-shaped organs in the crayfish are very numerous.

The following properties are common to all crustaceans: they have in all cases two teeth (for the front teeth in the crayfish are two in number), and in all cases there is in the mouth a small fleshy structure serving for a tongue; and the stomach is close to the mouth (except that the crayfish has a little oesophagus in front of the stomach),[5] and there is a straight gut attached to it. This gut, in the crayfish and its congeners, and in the carids, extends in a straight line to the tail, and terminates where the animal discharges the residuum, and where the female deposits her eggs; in the crab it terminates where the flap is situated, and in the centre of the flap. And in all these animals the eggs are deposited outside.[6] Further, the female has the place for the eggs running along the gut. And, again, all these animals have an organ, larger or smaller, termed the *mytis* or poppy.

We must now proceed to review their several differentiae.

The crayfish then, as has been said, has two teeth, large and hollow, in which is 527a1
contained a juice resembling the mytis, and in between the teeth is a fleshy substance, shaped like a tongue. After the mouth comes a short oesophagus, and then a membranous stomach attached to the oesophagus, and at the orifice of the stomach are three teeth, two facing one another and a third standing by itself underneath. Coming off obliquely from the stomach is a gut, simple and of equal thickness throughout the entire length of the body until it reaches the anal vent.

These are all common properties of the crayfish, the carid, and the crab; for the crab too has two teeth.[7]

Again, the crayfish has a duct attached all the way from the chest to the anal vent; and this duct serves as the ovary in the female, and as the seminal duct in the male. This passage is attached to the concave surface of the flesh in such a way that the flesh is in between; for the gut is related to the convexity and this duct to the concavity, pretty much as is observed in quadrupeds. And the duct is identical in both the sexes; that is to say, the duct in both is thin and white, and charged with a sallow-coloured moisture, and is attached to the chest.

[5]Dittmeyer excises the parenthetical sentence. [6]Omitting ᾗ.
[7]Dittmeyer excises this paragraph.

These are the properties of the egg and of the convolutes in the carid as well.

The male differs from the female in regard to its flesh, in having in connexion with the chest two separate and distinct white substances, resembling in colour and conformation the tentacles of the cuttlefish, and they are convoluted like the 'poppy' of the trumpet-shell. These organs have their starting-point in cotyledons which are situated under the hindmost feet; and hereabouts the flesh is red and blood-coloured, but is slippery to the touch and in so far unlike flesh. Off from the convolute[8] organ at the chest branches another coil about as thick as twine; and underneath there are two granular seminal bodies in juxtaposition with the gut. These are the organs of the male. The female has red-coloured eggs, which are adjacent to the stomach and to each side of the gut all along to the fleshy parts, being enveloped in a thin membrane.

Such are the parts, internal and external, of these animals.

527b1 3 · The inner parts of sanguineous animals happen to have specific designations; for these animals have in all cases the inner viscera, but this is not the case with the bloodless animals, but what they have in common with red-blooded animals is the stomach, the oesophagus, and the gut.[9]

With regard to the crab, it has already been stated that it has claws and feet, and their position has been set forth; furthermore, for the most part they have the right claw bigger and stronger than the left. It has also been stated that in general the eyes of the crab look sideways. Further, the trunk of the crab's body is single and undivided, including its head[10] and any other part it may possess. Some crabs have eyes placed sideways on the upper part, immediately under the back, and standing a long way apart, and some have their eyes in the centre and close together, like the crabs of Heracleotis and the *maia*. The mouth lies underneath the eyes, and inside it there are two teeth, as is the case with the crayfish, only that in the crab the teeth are not rounded but long; and over the teeth are two lids, and in between them are structures such as the crayfish has beside its teeth. The crab takes in water by the mouth, using the lids as a strainer,[11] and discharges the water by two passages above the mouth, closing by means of the lids the way by which it entered; and the two passage-ways are just underneath the eyes. [When it has taken in water it closes its mouth by means of both lids, and ejects the water in the way above described.][12] Next after the teeth comes the oesophagus, very short, so short in fact that the stomach seems to come straightway after the mouth. Next after the oesophagus comes the stomach, which is bifurcated, to the centre of which is attached a simple and delicate gut; and the gut terminates outwards, at the lid, as has been previously stated. [Between the lids the crab has parts like those near the teeth in the crayfish.][13] Inside the trunk is a sallow juice and some few little bodies, long and

[8]Reading *ἀπὸ τοῦ . . . κηρυκώδους*.
[9]Dittmeyer excises this paragraph. [10]Reading *ἥ τε κεφαλή*.
[11]Reading *ἀπηθῶν τοῖς ἐπικαλύμμασιν*.
[12]Dittmeyer excises this sentence.
[13]Dittmeyer excises.

white, and others spotted red. The male differs from the female in size and breadth, and in respect of the lid; for this is larger in the female and stands out further, and is more hairy, as is the case also with the female in the crayfish.

So much, then, for the organs of the crustacea.

4 · With the testaceans such as the land-snails and the sea-snails, and all the shellfish and also with the sea-urchin genus, the fleshy part, in such as have flesh, is 528a1
similarly situated to the fleshy part in the crustaceans; in other words, it is inside the animal, and the shell is outside, and there is no hard substance in the interior. As compared with one another the testaceans present many diversities, both in regard to their shells and to the flesh within. Some of them have no flesh at all, as the sea-urchin; others have flesh, but it is inside and wholly hidden, except for the head, as in the land-snails, and the so-called *cocalia,* and, among sea animals, in the purple murex, the trumpet-shell, the sea-snail, and the spiral-shaped testaceans in general. Of the rest, some are bivalved and some univalved; and by bivalves I mean such as are enclosed within two shells, and by univalved such as are enclosed within a single shell, and in these last the fleshy part is exposed, as in the case of the limpet. Of the bivalves, some can open out, like the scallop and the mussel; for all such shells are grown together on one side and are separate on the other, so as to open and shut. Other bivalves are closed on both sides alike, like the razor-fish. Some testaceans there are, that are entirely enveloped in shell and expose no portion of their flesh outside, as the ascidians.

Again, in regard to the shells themselves, the testaceans present differences when compared with one another. Some are smooth-shelled, like the razor-fish, the mussel, and some clams, viz. those which some call milk-shells, while others are rough-shelled, such as the pool-oyster, the pinna, and certain species of clam, and the trumpet-shells; and of these some are ribbed, such as the scallop and a certain kind of clam, and some are devoid of ribs, as the pinna and another species of clam. Testaceans also differ from one another in regard to the thickness or thinness of their shell, both as regards the shell in its entirety and as regards specific parts of the shell, for instance, the lips; for some have thin-lipped shells, like the mussel, and others have thick-lipped shells, like the pool-oyster. Some also are capable of motion, like the scallop, and indeed some aver that scallops can actually fly, owing to the circumstance that they often jump right out of the apparatus by means of which they are caught; others are incapable of motion and are attached fast to some external object, as is the case with the pinna. All the spiral-shaped testaceans can move and creep, and even the limpet relaxes its hold to go in quest of food. Common 528b1
to these and to all hard-shelled creatures is the smoothness of the inside of the shell. In the case of the univalves and the bivalves, the fleshy substance adheres to the shell so tenaciously that it can only be removed by an effort; in the case of those that are spiral-shaped, it is more loosely attached. And a peculiarity of all of these is the spiral twist of the shell in the part farthest away from the head; they are also furnished from birth with an operculum. And, further, all spiral-shaped testaceans have their shells on the right-hand side, and move not in the direction of the spire,

but the opposite way.[14] Such are the diversities observed in the external parts of these animals.

The internal structure is almost the same in all these creatures, and in the spiral-shaped ones especially; for it is in size that these latter differ from one another, and in excess or defect of their characteristics. And there is not much difference between most of the univalves and bivalves; but while they differ from one another but slightly, they differ considerably from such as are incapable of motion. And this will be illustrated more satisfactorily hereafter.

The spiral-shaped testaceans are all similarly constructed, but differ from one another, as has been said, in the way of excess or defect (for the larger species have larger and more conspicuous parts, and the smaller have smaller and less conspicuous), and, furthermore, in relative hardness or softness, and in other such properties. All of them have the flesh that extrudes from the mouth of the shell, hard and stiff; some more, and some less. From the middle of this protrudes the head and two horns, and these horns are large in the large species, but exceedingly minute in the smaller ones. The head protrudes from them all in the same way; and, if the animal be alarmed, the head draws in again. Some of these creatures have a mouth and teeth, as the snail; teeth sharp, and small, and delicate. They have also a proboscis just like that of the fly; and the proboscis is tongue-shaped. The trumpet-shell and the purple murex have this organ firm and solid; and just as the horse-fly and the gadfly can pierce the skin of a quadruped, so is this proboscis proportionately stronger in these testaceans; for they bore right through the shells
529a1 of their prey. The stomach follows close upon the mouth, and this organ in the snail resembles a bird's crop. Underneath come two white firm formations, like breasts; and similar formations are found in the cuttlefish also, only that they are of a firmer consistency in the cuttle-fish. After the stomach comes an oesophagus, simple and long, extending to the poppy, which is in the innermost recess of the shell. These are clear in the case of the purple murex and the trumpet-shell, within the whorl of the shell. What comes next to the oesophagus is the gut; in fact, the gut is continuous with the oesophagus,[15] and runs its whole length uncomplicated to the outlet of the residuum. The gut has its point of origin in the region of the coil of the poppy, and is wider hereabouts [for the poppy is for the most part a sort of excretion in all testaceans];[16] it then takes a bend and runs up again towards the fleshy part, and terminates by the side of the head, where the animal discharges its residuum; and this holds good in the case of all spiral-shaped testaceans, whether terrestrial or marine. From the stomach there is drawn in a parallel direction with the oesophagus, in the larger snails, a long white duct enveloped in a membrane, resembling in colour the breast-like formations higher up; and in it are nicks, as in the egg-mass of the crayfish, except that it is white in colour whereas the egg is red. This formation has no outlet nor duct, but is enveloped in a thin membrane with a narrow cavity in its interior. And from the gut downward extend black and rough

[14]This sentence is excised by Dittmeyer.
[15]Dittmeyer excises this clause.
[16]Dittmeyer excises.

formations, in close connexion, something like the formations in the tortoise, only not so black. Marine snails, also, have these formations, and the white ones, only that the formations are smaller in the smaller species.

The univalves and bivalves are in some respects similar in construction, and in some respects dissimilar, to the spiral testaceans. They all have a head and horns, and a mouth, and the organ resembling a tongue; but these organs, in the smaller species, are indiscernible owing to the minuteness of these animals, and some are indiscernible even when the animals are dead or motionless. They all have the poppy, but not all in the same place, nor of equal size, nor similarly open to observation; thus, the limpets have this organ deep down in the bottom of the shell, and the bivalves at the hinge connecting the two valves. They also have in all cases the hairy growths in a circular form, as in the scallops. And, with regard to the so-called egg, in those that have it, when they have it, it is situated in one of the semi-circles of the periphery, as is the case with the white formation in the snail; for this white formation in the snail corresponds to the so-called egg. But all these parts, as has been stated, are clear in the larger species, while in the small ones they are almost or altogether indiscernible. Hence they are most plainly visible in the large scallops; and these are the bivalves that have one valve flat-shaped, like the lid of a pot. The outlet of the excretion is in sea-creatures[17] on one side; for there is a passage whereby the excretion passes out. [And the poppy, as has been stated, is an excretion in all these animals—an excretion enveloped in a membrane.][18] The so-called egg has no outlet in any of these creatures, but is merely an excrescence in the fleshy mass; and it is not situated in the same region with the gut, but the egg is situated on the right-hand side, and the gut on the left. Such are the relations of the anal vent in most of these animals; but in the case of the wild limpet (called by some the sea-ear), the residuum issues beneath the shell; for the shell is perforated. In this particular limpet the stomach is seen coming after the mouth, and the egg-shaped formations are discernible. But for the relative positions of these parts you are referred to the *Anatomies*.

The so-called hermit crab is in a way intermediate between the crustaceans and the testaceans. In its nature it resembles the crayfish kind, and it is born simple of itself, but by its habit of introducing itself into a shell and living there it resembles the testaceans, and so appears to partake of the characters of both kinds. In shape, to put it simply, it resembles a spider, only that the part below the head and thorax is larger in this creature than in the spider. It has two thin red horns, and underneath these horns two long eyes, not retreating inwards, nor turning sideways like the eyes of the crab, but protruding straight out; and underneath these eyes the mouth, and round about the mouth several hair-like growths, and next after these two bifurcate legs, whereby it draws in objects towards itself, and two other legs on either side, and a third small pair. All below the thorax is soft, and when opened is found to be sallow-coloured within. From the mouth there runs a single passage right on to the stomach, but the passage for the excretions is not discernible. The

[17]Reading θαλαττίοις for ἄλλοις.
[18]Excised by Dittmeyer.

legs and the thorax are hard, but not so hard as those of the crab. It does not adhere to its shell like the purple murex and the trumpet-shell, but can easily be loosened. It is longer when found in spiral shells than when found in the shell of the neritae.

The[19] animal found in the shell of the neritae is a separate species, like the other in most respects; but of its bifurcate feet or claws, the right-hand one is small and the left-hand one is large, and it progresses chiefly by the aid of this latter one. In the shells[20] of these animals, and in certain others, there is found a parasite whose mode of attachment is similar. The particular one which we have just described is named the *cyllarus*.

The nerites has a smooth large round shell, and resembles the trumpet-shell in shape, only the poppy is, in its case, not black but red. It clings with great force near the middle. In calm weather, then, they go free afield, but when the wind blows the hermit-crabs take shelter against the rocks: the neritae themselves cling fast like limpets; and the same is the case with the haemorrhoid and all others of the like kind. And they cling to the rock, when they turn back their operculum; for this operculum seems like a lid; in fact this structure represents the one part, in those with spiral shells, of that which in the bivalves is a duplicate shell. The interior of the animal is fleshy, and the mouth is inside. And it is the same with the haemorrhoid, the purple murex, and all suchlike animals.

Such of the crabs as have the left foot the bigger of the two are found in the neritae, but not in spiral shells. There are some snail-shells which have inside them creatures resembling those little lobsters that are also found in fresh water. These creatures, however, differ in having the part inside the shell soft. But as to their characters, you are referred to the *Anatomies*.

5 · The urchins are devoid of flesh, and this is a character peculiar to them; and while they are in all cases empty and devoid of any flesh within,[21] they are in all cases furnished with the black formations. There are several species of the urchin,
530b1 and one of these is that which is made use of for food; this is the kind in which are found the so-called eggs, large and edible, in the larger and smaller specimens alike; for even when as yet very small they are provided with them. There are two other species, the *spatangus*, and the so-called *bryssus;* these are sea-creatures and scarce. Further, there are the 'mother-urchins', the largest in size of all the species. In addition to these there is another species, small in size, but furnished with large hard spines; it lives in the sea at a depth of several fathoms; and is used by some people as a specific for cases of strangury. In the neighbourhood of Torone there are sea-urchins of a white colour, shells, spines, eggs and all, and that are longer than the ordinary sea-urchin. The spine in this species is not large nor strong, but rather limp; and the black formations in connexion with the mouth are more than usually numerous, and communicate with the external duct, but not with one another; in point of fact, the animal is in a manner divided up by them. The edible urchin moves

[19]Dittmeyer excises this paragraph and the next.

[20]Reading κόγχαις.

[21]Dittmeyer excises 'and this is a character . . . flesh within'.

with greatest freedom and most often; and this is indicated by the fact that these urchins have always something or other on their spines.

All urchins are supplied with eggs, but in some of the species the eggs are exceedingly small and unfit for food. The urchin has what we may call its head and its mouth down below, and a place for the issue of the residuum up above; [and this same property is common to all spiral-shells and to limpets].[22] For the food on which the creature lives lies down below; consequently the mouth is near the food, and the excretion is above, near to the back of the shell. The urchin has five hollow teeth inside, and in the middle of these teeth a fleshy substance serving the office of a tongue. Next to this comes the oesophagus, and then the stomach, divided into five parts, and filled with excretion, all the five parts uniting at the anal vent, where the shell is perforated. Underneath the stomach, in another membrane, are the so-called eggs, identical in number in all cases, and that number is always an odd number, to wit five. Up above, the black formations are attached to the starting-point of the teeth, and they are bitter to the taste, and unfit for food. A similar or at least an analogous formation is found in many animals; as, for instance, in the tortoise, the toad, the frog, the spiral shells and in the molluscs; but the formation varies here and there in colour, and in all cases is altogether uneatable, or more or less unpalatable. In reality the body[23] of the urchin is continuous from one end to the other, but to outward appearance it is not so, but looks like a lantern with its surrounding skin missing. The urchin uses its spines as feet; for it rests its weight on these, and then by moving them shifts from place to place.

6 · The so-called ascidian has of all these animals the most remarkable characteristics. It is the only mollusc that has its entire body concealed within its shell, and the shell is a substance intermediate between hide and shell, so that it cuts like a piece of hard leather. It is attached to rocks by its shell, and is provided with two passages placed at a distance from one another, very minute and hard to see, whereby it admits and discharges the sea-water; for it has no visible excretion—just as of shell fish in general some resemble the urchin in this matter of excretion, and others are provided with the so-called mecon. If the animal be opened, it is found to have, in the first place, a sinewy membrane running round inside the shell-like substance, and within this membrane is the flesh-like substance of the ascidian, not resembling that in other molluscs; but this flesh is the same in all ascidia. And this substance is attached in two places to the membrane and the skin, obliquely; and at the point of attachment the space is narrowed at each side, where the fleshy substance stretches towards the passages that lead outwards through the shell; and here it discharges and admits food and liquid matter, just as it would if one of the passages were a mouth and the other an anal vent; and one of the passages is somewhat wider than the other one. Inside it has a pair of cavities, one on either side, a small partition separating them; and one of these two cavities contains the liquid. The creature has no other part whether instrumental or sensory, nor, as was

[22]Dittmeyer excises.
[23]Reading σῶμα.

said in the case of the others, is it furnished with any organ connected with excretion. The colour of the ascidian is in some cases sallow, and in other cases red.

There is, furthermore, the genus of the sea-anemones, peculiar in its way. The sea-anemone clings to rocks like certain of the testaceans, but at times relaxes its
531b1 hold. It has no shell, but its entire body is fleshy. It has the faculty of perception, and, if you put your hand to it, it will seize and cling to it, as the octopus would do with its feelers, and in such a way as to make the flesh of your hand swell up. Its mouth is in the centre of its body, and it lives adhering to the rock as an oyster to its shell. Just as it clings to your hand, so it does to little fish and to anything edible that comes in its way; and it feeds upon sea-urchins and scallops. Another species of the sea-anemone roams freely abroad. The sea-anemone appears to be devoid altogether of excretion, and in this respect it resembles a plant. Of sea-anemones there are two species, the lesser and more edible, and the large hard ones, such as are found in the neighbourhood of Chalcis. In winter time their flesh is firm, and accordingly they are sought after as articles of food, but in summer weather they go off, for they become thin and watery, and if you catch at them they break at once into bits, and cannot be taken off the rocks entire; and being oppressed by the heat they tend to slip back into the crevices of the rocks.

So much for the external and the internal parts of molluscs, crustaceans, and testaceans.

7 · We now proceed to treat of insects in like manner. This genus comprises many species, and, though several kinds are clearly related to one another, these are not classified under one common designation, as in the case of the bee, the hornet, the wasp, and all such insects, and again as in the case of those that have their wings in a sheath, like the cockchafer, the stag-beetle, the blister-beetle, and the like.

Insects have three parts common to them all; the head, the trunk containing the stomach, and a third part in between these two, corresponding to what in other creatures embraces chest and back. In the majority of insects this intermediate part is single; but in the long and many-footed insects it has practically the same number of segments as of nicks.

All insects when cut in two continue to live, excepting such as are extremely cold, or such as from their minute size chill rapidly; though wasps continue living after severance. In conjunction with the middle portion either the head or the
532a1 stomach can live, but the head cannot live by itself. Insects that are long in shape and many-footed can live for a long while after being cut in two, and the severed portions can move in either direction: they can move either in the direction of the section or in the direction of the tail, as is observed in the millipedes.

All insects have eyes, but no other organ of sense discernible, except that some insects have a kind of a tongue corresponding to a similar organ common to all testaceans; and by this organ such insects taste and imbibe their food. In some insects this organ is soft; in other insects it is firm; as it is in the purple-fish. In the horsefly and the gadfly this organ is hard, and indeed it is hard in most insects. In point of fact, such insects as have no sting in the rear use this organ as a weapon (and such insects as are provided with this organ are unprovided with teeth, with the exception of a few insects); the fly by a touch can draw blood with this organ, and the gnat can prick with it.

Certain insects are furnished with stings. Some insects have the sting inside, as the bee and the wasp, others outside, as the scorpion; and this is the only insect furnished with a long tail. And, further, the scorpion is furnished with claws, as is also the creature resembling a scorpion found within the pages of books.

In addition to their other organs, flying insects are furnished with wings. Some insects are double-winged, as the fly; others are furnished with four wings, as the bee; and no insect with only two wings has a sting in the rear. Again, some winged insects have a sheath for their wings, as the cockchafer; whereas in others the wings are unsheathed, as in the bee. But in the case of all alike, flight is in no way modified by the rump, and the wing is devoid of quill-structure or division of any kind.

Again, some insects have antennae in front of their eyes, as the butterfly and the stag-beetle. Of those that have the power of jumping, some have the hinder legs the longer; and others have 'paddles' which bend backwards like the hind-legs of quadrupeds. All insects have the belly different from the back; as, in fact, is the case with all animals. The flesh of an insect's body is neither shell-like nor is it flesh-like in the way of the internal substance of shell-covered animals; but it is something intermediate in quality. That is why they have neither spine, nor bone, nor anything 532b1
like sepia-bone, nor enveloping shell; but their body by its hardness is its own protection and requires no extraneous support. However, insects have a skin; but the skin is exceedingly thin. These and such-like are the external parts of insects.

Internally, next after the mouth, comes a gut, in the majority of cases straight and simple down to the outlet of the residuum; but in a few cases the gut is coiled. No insect is provided with any viscera, or is supplied with fat; and these statements apply to all animals devoid of blood. Some have a stomach also, and attached to this the rest of the gut, either simple or convoluted as in the case of the grasshopper.

The cicada, alone of such creatures (and, in fact, alone of all creatures), is unprovided with a mouth, but it is provided with the tongue-like formation found in insects furnished with frontward stings; and this formation in the cicada is long, continuous, and devoid of any split; and by the aid of this the creature feeds on dew, and on dew only, and in its stomach no excretion is ever found. Of the cicada there are several kinds, and they differ from one another in relative magnitude, and in this respect that the chirper is provided with a cleft under the *hypozoma* and has in it a membrane quite discernible, while the cicadelle does not.

Furthermore, there are some strange creatures to be found in the sea, which from their rarity we are unable to classify. Some experienced fishermen affirm that they have at times seen in the sea animals like sticks, black, rounded, and of the same thickness throughout; and others resembling shields, red in colour, and furnished with fins packed close together; and others resembling the male organ in shape and size, with a pair of fins in the place of the testicles, and they aver that on one occasion a creature of this description was brought up on the end of a nightline.

So much then for the parts, external and internal, exceptional and common, of all animals.

8 · We now proceed to treat of the senses; for there are diversities in animals with regard to the senses, seeing that some animals have the use of all the senses, and others the use of a limited number of them. The total number of the senses (for we have no experience of any special sense not here included), is five: sight, hearing, smell, taste, and touch.

Man, then, and all vivipara that have feet, and, further, all red-blooded ovipara, plainly have the use of all the five senses, except where some isolated species has been subjected to mutilation, as in the case of the mole. For this animal is deprived of sight; it has no eyes visible, but if the skin—a thick one—be stripped off the head, about the place in the exterior where eyes usually are, the eyes are found inside in a stunted condition, furnished with all the parts found in ordinary eyes; that is to say, we find there the black part, the part inside it called the pupil, and the fatty part surrounding it; but all these parts are smaller than the same parts in visible eyes. There is no external sign of the existence of these organs owing to the thickness of the skin, so that it would seem that its nature was stunted in the course of development; [for extending from the brain at its junction with the marrow are two strong sinewy ducts running past the sockets of the eyes, and terminating at the upper eye teeth].[24] All the other animals have a perception of colour and of sound, and the senses of smell and taste; the fifth sense, that, namely, of touch, is common to all animals whatsoever.

In some animals the organs of sense are plainly discernible; and this is especially the case with the eyes. For animals have a special locality for the eyes, and also a special locality for hearing: that is to say, some animals have ears, while others have the passage for sound discernible. It is the same with the sense of smell; that is to say, some animals have nostrils, and others have the passages for smell, such as birds. It is the same also with the organ of taste, the tongue. Of aquatic red-blooded animals, fishes possess the organ of taste, namely the tongue, but it is in an imperfect form, in other words it is osseous and undetached. In some fish the palate is fleshy, as in the fresh-water carp, so that by an inattentive observer it might be mistaken for a tongue.

There is no doubt but that fishes have the sense of taste, for a great number of them delight in special flavours; and fishes freely take the hook if it be baited with a piece of flesh from a tunny or from any fat fish, obviously enjoying the taste and the eating of bait of this kind. Fishes have no visible organs for hearing or for smell; for what might appear to indicate an organ for smell in the region of the nostril has no communication with the brain—in some cases these are blind alleys, and in other cases lead only to the gills; but for all this fishes undoubtedly hear and smell. For they are observed to run away from any loud noise, such as would be made by the rowing of a galley, so as to become easy of capture in their holes; for though a sound be very slight in the open air, it has a loud and alarming resonance to creatures that

[24]Excised by Dittmeyer.

hear under water. And this is shown in the capture of the dolphin; for when the hunters have enclosed a shoal with their canoes, they set up from inside the canoes a loud splashing in the water, and by so doing induce the creatures to run in a shoal high and dry up on the beach, and so capture them while stupefied with the noise. And yet, for all this, the dolphin has no organ of hearing discernible. Furthermore, when engaged in their craft, fishermen are particularly careful to make no noise with oar or net; and after they have spied a shoal, they let down their nets at a spot so far off that they count upon no noise being likely to reach the shoal, occasioned either by oar or by the surging of their boats through the water; and the crews are strictly enjoined to preserve silence until the shoal has been surrounded. And, at times, when they want the fish to crowd together, they adopt the stratagem of the dolphin-hunter; in other words they clatter stones together, that the fish may, in their fright, gather close into one spot, and so they envelop them within their nets. [Before surrounding them, then, they preserve silence, as was said; but, after hemming the shoal in, they call on every man to shout aloud and make any kind of noise; for on hearing the noise and hubbub the fish are sure to tumble into the nets from sheer fright.] [25] Further, when fishermen see a shoal of fish feeding at a distance, disporting themselves in calm bright weather on the surface of the water, if they are anxious to descry the size of the fish and to learn what kind of a fish it is, they may succeed in coming upon the shoal whilst yet basking at the surface if they sail up without the slightest noise, but if any man make a noise previously, the shoal will be seen to scurry away in alarm. Again, there is a small river-fish called the *cottus;* this creature burrows under a rock, and fishers hunt it by clattering stones against the rock, and the fish bewildered at the noise, darts out of its hiding-place. From these facts it is quite obvious that fishes can hear; and indeed some people, from living near the sea and frequently witnessing such phenomena, affirm that of all living creatures the fish is the quickest of hearing. And of all fishes the quickest of hearing are the mullet, the basse, the *salpe,* the *chromis* and such like. Other fishes are less quick of hearing, and thus are more apt to be found living at the bottom of the sea.

The case is similar in regard to the sense of smell. Thus, as a rule, fishes will not touch a bait that is not fresh, neither are they all caught by one and the same bait, but by special ones which they distinguish by their sense of smell; for some fishes are attracted by malodorous baits, as the saupe, for instance, is attracted by excrement. Again, a number of fishes live in caves; and accordingly fishermen, when they want to entice them out, smear the mouth of a cave with strong-smelling pickles, and the fish are soon attracted to the smell. And the eel is caught in a similar way; for the fisherman lays down an earthen pot that has held pickles, after inserting a strainer in its neck. As a general rule, fishes are more quickly attracted by savoury smells. For this reason, fishermen roast the fleshy parts of the cuttlefish and use it as bait on account of its smell; for fish are peculiarly attracted by it; they also bake the octopus and bait their weels with it, entirely, as they say, on account of its smell. Furthermore, gregarious fishes, if fish-washings or bilge-water be thrown

[25] Excised by Dittmeyer.

overboard, are observed to scud off to a distance, from apparent dislike of the smell. 534b1 And it is asserted that they can at once detect by smell the presence of their own blood; and this faculty is manifested by their hurrying off to a great distance whenever fish-blood is spilt in the sea. And, as a general rule, if you bait your weel with a stinking bait, the fish refuse to enter the weel or even to draw near; but if you bait the weel with a fresh and savoury bait, they come at once from long distances and swim into it. [And all this is particularly manifest in the dolphin; for, as was stated, it has no visible organ of hearing, and yet it is captured when stupefied with noise; and so, while it has no visible organ for smell, it has the sense of smell remarkably keen.][26] It is manifest, then, that the animals above mentioned are in possession of all the five senses.

All other animals may, with very few exceptions, be comprehended within four genera: to wit, molluscs, crustaceans, testaceans, and insects. Of these, the mollusc, the crustacean, and the insect have all the senses; for they have both[27] smell and taste. As for insects, both winged and wingless, they can detect the presence of scented objects afar off, as for instance bees and cnipes detect the presence of honey at a distance; and they do so recognizing it by smell. Many insects are killed by the smell of brimstone; ants leave their ant-hills if powdered origanum and brimstone is scattered round them; and most insects may be banished with burnt hart's horn, or better still by the burning of the gum styrax. The cuttle-fish, the octopus, and the crayfish may be caught by bait. The octopus, in fact, clings so tightly to the rocks that it cannot be pulled off, but remains attached even when being cut; and yet, if you apply fleabane to the creature, it drops off at the very smell of it. The facts are 535a1 similar in regard to taste. For the food that insects go in quest of is of diverse kinds, and they do not all delight in the same flavours; for instance, the bee never settles on anything rotten, but on things sweet; and the gnat settles only on acid substances and not on sweet. The sense of touch, as has been remarked, is common to all animals. Testaceans have the senses of smell and taste—as is plain from the use of baits, e.g. in the case of the purple-fish; for this creature is enticed by putrefying baits, which it perceives and is attracted to from a great distance. The proof that it possesses a sense of taste is the same; for whenever an animal is attracted to a thing by perceiving its smell, it is sure to like the taste of it. Further, all animals furnished with a mouth derive pleasure or pain from the touch of sapid juices.

With regard to sight and hearing, we cannot make statements with thorough confidence or on clear evidence. However, the razor-fish, if you make a noise, appears to burrow in the sand, and to hide himself deeper when he hears the approach of the iron rod (for the animal juts a little out of its hole, while the greater part of the body remains within),—and scallops, if you present your finger near their open valves, close them tight again as though they could see what you were doing. Furthermore, when fishermen are laying bait for neritae, they always get to leeward of them, and never speak a word while so engaged, believing that the animal can smell and hear; and they assure us that, if any one speaks aloud, the

[26] Excised by Dittmeyer.
[27] Reading καὶ γὰρ ἔχει καὶ ὄσφρησιν.

creature makes efforts to escape. With regard to testaceans, of the walking species the urchin appears to have the least developed sense of smell; and, of the stationary species, the ascidian and the barnacle.

So much for the organs of sense in the general run of animals. We now proceed to treat of voice.

9 · Voice and sound are different from one another; and language differs from voice and sound. The fact is that no animal can give utterance to voice except by the action of the pharynx, and consequently such animals as are devoid of lung have no voice; and language is the articulation of voice by the tongue. Thus, the voice and larynx can emit vowel sounds; consonantal sounds are made by the tongue and the lips; and out of these language is composed. Consequently, animals that have no tongue at all or that have a tongue not freely detached, have no language; although they may be enabled to make sounds by other organs than the tongue.

Insects, for instance, have no voice and no language, but they can emit sound by internal air, though not by the emission of air; for no insects are capable of respiration. But some of them make a humming noise, like the bee and the other winged insects; and others are said to sing, as the cicada. And all these latter insects make their sounds by means of the membrane that is underneath the hypozoma—those insects, that is to say, whose body is thus divided; as for instance, one species of cicada, which makes the sound by means of the friction of the air. Flies and bees, and the like, produce their special noise by opening and shutting their wings in the act of flying; for the noise made is by the friction of the internal air. The noise made by grasshoppers is produced by rubbing with their 'paddles'.

No mollusc or crustacean can produce any natural voice or sound. Fishes can produce no voice, for they have no lungs, nor windpipe and pharynx; but they emit certain sounds and squeaks, which is what is called their 'voice', as the gurnard, and the sciaena (for these fishes make a grunting kind of noise) and the *caprus* in the river Achelous, and the *chalcis* and the cuckoo-fish; for the chalcis makes a sort of piping sound, and the cuckoo-fish makes a sound greatly like the cry of the cuckoo, and is named from the circumstance. The apparent voice in all these fishes is a sound caused in some cases by a rubbing motion of their gills, which are prickly, or in other cases by internal parts about their bellies; for they all have air inside them, by rubbing and moving which they produce the sounds. Some of the selachia seem to squeak.

But in these cases the term 'voice' is inappropriate; the more correct expression would be 'sound'. For the scallop, when it goes along supporting itself on the water, which is called 'flying', makes a whizzing sound; and so does the sea-swallow; for this fish flies in the air, clean out of the water, being furnished with fins broad and long. Just then as in the flight of birds the sound made by their wings is not voice, so is it in the case of all these other creatures.

The dolphin, when taken out of the water, gives a squeak and moans in the air, but these noises do not resemble those above mentioned. For this creature has a voice, for it is furnished with a lung and a windpipe; but its tongue is not loose, nor has it lips, so as to give utterance to an articulate sound.

Of animals which are furnished with tongue and lung, the oviparous quadrupeds[28] produce a voice, but a feeble one; in some cases, a shrill piping sound, like the serpent; in others, a thin faint cry;[29] in others, a low hiss, like the tortoise. The formation of the tongue in the frog is exceptional. The front part of the tongue, which in other animals is detached, is tightly fixed in the frog as it is in all fishes; but the part towards the pharynx is freely detached and folded and it is with this that it makes its peculiar croak. The croaking that goes on in the water is the call of the males to the females at rutting time; for all animals have a special cry for mating and copulation as is observed in the case of goats, swine, and sheep. [The frog makes its croaking noise by putting its under jaw on a level with the surface of the water and extending its upper jaw. The tension is so great that the upper jaw becomes transparent, and the animal's eyes shine through the jaw like lamps; for the commerce of the sexes takes place usually in the night time.][30]

Birds can utter voiced sounds; and such of them can articulate best as have the tongue flat, and also such as have thin delicate tongues. In some cases, the male and the female utter the same note; in other cases, different notes. The smaller birds are more vocal and given to chirping than the larger ones; but in the pairing season every species of bird becomes particularly vocal. Some of them call when fighting, as the quail, others cry when challenging to combat, as the partridge, or when victorious, as the cock. In some cases males and females sing alike, as is observed in the nightingale, only that the female stops singing when brooding or rearing her young; in other birds, the males sing alone; in fact, with fowls and quails, the female does not sing.

536b1 Viviparous quadrupeds utter voiced sounds of different kinds, but they have no language. In fact, this is peculiar to man. For while whatever has language has voice, not everything that has voice has language. Men that are born deaf are in all cases also dumb; that is, they can make vocal sounds, but they cannot speak. Children, just as they have no control over other parts, so have no control, at first, over the tongue; but it is so far imperfect, and only detaches itself by degrees, so that in the interval children for the most part lisp and stutter.

Vocal sounds and modes of language differ according to locality. Vocal sounds are characterized chiefly by their pitch, whether high or low, and the kinds of sound do not differ within the same genus; but articulate sound, that one might reasonably designate language, differs both in various animals, and also in the same species according to diversity of locality; as for instance, some partridges cackle, and some make a shrill twittering noise. Of little birds, some sing a different note from the parent birds, if they have been removed from the nest and have heard other birds singing; and a mother-nightingale has been observed to give lessons in singing to a young bird, thus suggesting that language is not natural in the same way as voice but can be artificially trained. Men have the same voice, but they differ from one another in language.

[28] Omitting Dittmeyer's ⟨ἢ ἄποδα⟩.
[29] Dittmeyer excises this clause.
[30] Excised by Dittmeyer.

The elephant makes a vocal sound of a wind-like sort by the mouth alone, unaided by the trunk, just like the sound of a man panting or sighing; but, if it employ the trunk as well, the sound produced is like that of a hoarse trumpet.

10 · With regard to the sleeping and waking of animals, all creatures that are red-blooded and provided with legs give sensible proof that they go to sleep and that they waken up from sleep; for all animals that are furnished with eyelids shut them up when they go to sleep. Furthermore, it would appear that not only do men dream, but horses also, and dogs, and oxen, and sheep, and goats, and all viviparous quadrupeds; and dogs show their dreaming by barking in their sleep. With regard to oviparous animals we cannot be sure that they dream, but most undoubtedly they sleep. And the same may be said of water animals, such as fishes, molluscs, crustaceans, to wit crayfish and the like. These animals sleep without 537a1
doubt, although their sleep is of very short duration. The proof of their sleeping cannot be got from the condition of their eyes—for none of these creatures are furnished with eyelids—but can be obtained only from their motionless repose.

[Apart from the irritation caused by lice and what are called fleas, fish are met with in a state so motionless that one might easily catch them by hand; and, as a matter of fact, these little creatures, if the fish remain long in one position, will attack them in myriads and devour them. For they are found in the depths of the sea, and are so numerous that they devour any bait made of fish's flesh if it be left long on the ground at the bottom; and fishermen often draw up a sort of ball of them, all clinging on to the bait.][31]

But it is from the following facts that we may more reasonably infer that fishes sleep. Very often it is possible to take a fish off its guard so far as to catch hold of it or to give it a blow unawares; and all the while the fish is quite still but for a slight motion of the tail. And it is quite obvious that the animal is sleeping, from its movements if any disturbance be made during its repose; for it moves just as you would expect in a creature suddenly awakened. Further, owing to their being asleep, fish may be captured by torchlight. The watchmen in the tunny-fishery often take advantage of the fish being asleep to envelop them in a circle of nets; and it is quite obvious that they were thus sleeping by their lying still and allowing the glistening under-parts of their bodies to become visible, while the capture is taking place. They sleep in the night-time more than during the day; and so soundly at night that you may cast the net without making them stir. Fish, as a general rule, sleep close to the ground, or to the sand or to a stone at the bottom, or after concealing themselves under a rock or the ground. Flat fish go to sleep in the sand; and they can be distinguished by the outlines of their shapes in the sand, and are caught in this position by being speared with pronged instruments. The basse, the gilthead, the mullet, and fish of the like sort are often caught in the daytime by the prong owing to their having been surprised when sleeping; for it is scarcely probable that such fish could be pronged while awake. The selachia sleep at times so soundly that they

[31] Excised by Dittmeyer.

may be caught by hand. The dolphin and the whale, and all such as are furnished with a blow-hole, sleep with the blow-hole over the surface of the water, and breathe through the blow-hole while they keep up a quiet flapping of their fins; indeed, some have actually heard the dolphin snoring.

Molluscs sleep like fishes, and crustaceans also. It is plain also that insects sleep; for there can be no mistaking their condition of motionless repose. In the bee the fact of its being asleep is very obvious; for at night-time bees are at rest and cease to hum. But the fact that insects sleep may be very well seen in the case of common everyday creatures; for not only do they rest at night-time from dimness of vision (for all hard-eyed creatures see but indistinctly), but even if a lighted candle be presented they continue sleeping quite as soundly.

Of all animals man is most given to dreaming. Children and infants do not dream, but in most cases dreaming comes on at the age of four or five years. Instances have been known of men and women that have never dreamed at all; in cases of this kind, it has been observed that when a dream occurs in advanced life it is followed by bodily change leading to death for some and to debility for others.

So much then for sensation and for the phenomena of sleeping and awakening.

11 · Some animals are divided into male and female, but others are not so divided, but can only be said in a comparative way to bring forth young and to be pregnant. In animals that live confined to one spot there is no duality of sex; nor is there such, in fact, in any testaceans. In molluscs and in crustaceans we find male and female: and, indeed, in all animals furnished with feet and blood, whether biped or quadruped; in short, in all such as by copulation engender either live young or egg or grub. In the several genera, with however certain exceptions, there either absolutely is or absolutely is not a duality of sex. Thus, in quadrupeds the duality is universal, while the absence of such duality is universal in testaceans, and of these creatures, as with plants, some individuals are fruitful and some are not.

But among insects and fishes, some cases are found wholly devoid of this duality of sex. For instance, the eel is neither male nor female, and can engender nothing. In fact, those who assert that eels are at times found with hair-like or worm-like or seaweed-like objects within them, make only random assertions from not having carefully noticed the locality of such attachments. For no animal of this kind is ever viviparous unless previously oviparous; and none was ever yet seen with an egg. And animals that are viviparous have their young in the womb and closely attached, and not in the belly; for, if the embryo were kept in the belly, it would be subjected to the process of digestion like ordinary food. When people rest duality of sex in the eel on the assertion that the head of the male is bigger and longer, and the head of the female smaller and more snubbed, they are taking diversity of species for diversity of sex.

There are certain fish that are named capon-fish, and fish of this description are found in fresh water, as the carp and the *balagrus*. This sort of fish never has either roe or milt; but they are hard and fat all over, and are furnished with a small gut; and these fish are regarded as of excellent quality.

Again, just as in testaceans and in plants there is what bears and engenders, but not what impregnates, so is it, among fishes, with the *psetta,* the *erythrinus,* and the *channe;* for these fish are in all cases found furnished with eggs.

As a general rule, in red-blooded animals furnished with feet and not oviparous, the male is larger and longer-lived than the female (except with the mule, where the female is longer-lived and bigger than the male); whereas in oviparous and vermiparous creatures, as in fishes and in insects, the female is larger than the male; as for instance, with the serpent, the venom-spider, the gecko, and the frog. The same difference in size of the sexes is found in fishes, as, for instance, in the smaller selachia, in the greater part of the gregarious species, and in all that live in and about rocks. The fact that the female is longer-lived than the male is clear from the fact that female fishes are caught older than males. Furthermore, in all animals the upper and front parts are better, stronger, and more thoroughly equipped in the male than in the female, whereas the hinder and underparts are more delicate than those of the females. And this statement is applicable to man and to all vivipara that have feet. Again, the female is less muscular and less compactly jointed, and more thin and delicate in the hair—that is, where hair is found; and, where there is no hair, less strongly furnished in some analogous substance. And the female is more flaccid in texture of flesh, and more knock-kneed, and the shin-bones are thinner; and the feet are more delicate in such animals as are furnished with feet. And with regard to voice, the female in all animals that are vocal has a thinner and sharper voice than the male; except with cattle, for the lowing of the cow has a deeper note than that of the bull. With regard to organs of defence and offence, such as teeth, tusks, horns, spurs, and the like, these in some species the male possesses and the female does not; as, for instance, the hind has no horns, and where the cock-bird has a spur the hen is entirely destitute of the organ; and in like manner the sow is devoid of tusks. In other species such organs are found in both sexes, but are more perfectly developed in the male; as, for instance, the horn of the bull is more powerful than the horn of the cow.

BOOK V

1 · As to the parts internal and external that all animals are furnished with, and further as to the senses, to voice, and sleep, and the duality of sex, all these topics have now been touched upon. It now remains for us to discuss, duly and in order, their several modes of propagation.

These modes are many and diverse, and in some respects are like, and in other respects are unlike to one another. As the genera have already been divided, we must attempt to follow the same divisions in our present argument; only that whereas in the former case we started with a consideration of the parts of man, in the present case it behoves us to treat of man last of all because he involves most discussion. We shall commence, then, with testaceans, and then proceed to crustaceans, and then to the other genera in due order; and these other genera are molluscs, and insects, then fishes viviparous and fishes oviparous, and next birds; and afterwards we shall treat of animals provided with feet, both such as are oviparous and such as are viviparous; and we may observe that some quadrupeds are viviparous, but that the only viviparous biped is man.

Now there is one property that animals are found to have in common with plants. For some plants are generated from the seed of plants, whilst other plants are self-generated through the formation of some principle similar to a seed; and of these some derive their nutriment from the ground, whilst others grow inside other plants, as is mentioned in my treatise on *Plants*. So with animals some spring from parent animals according to their kind, whilst others grow spontaneously and not from kindred stock; and of these some come from putrefying earth or vegetable matter, as is the case with a number of insects, while others are spontaneously generated in the inside of animals out of the secretions of their several organs.

In animals where generation takes place from animals of the same kind, wherever there is duality of sex generation is due to copulation. In the group of fishes, however, there are some that are neither male nor female, and these, while they are identical generically with other fish, differ from them specifically; but there are others that stand altogether isolated and apart by themselves. Other fishes there are that are always female and never male, and from them are produced eggs like the wind-eggs in birds. Such eggs in birds are all unfruitful; but it is their nature to be independently capable of generation up to the egg-stage, unless indeed there 539b1 be some other mode than the one familiar to us of intercourse with the male; but concerning these topics we shall treat more precisely later on. In the case of certain fishes, however, after they have spontaneously generated eggs, these eggs develop into living animals; only that in certain of these cases development is spontaneous, and in others is not independent of the male; and the method of proceeding in regard to these matters will be set forth by and by, for the method is somewhat like to the method followed in the case of birds. But whenever creatures are spontaneously generated, either in other animals, in the soil, or on plants, or in the parts of these, and when such are generated male and female, then from the copulation of such spontaneously generated males and females there is generated a something—a something never identical in shape with the parents, but a something imperfect. For instance, the issue of copulation in lice is nits; in flies, grubs; in fleas, grubs egg-like in shape; and from these issues the parent-species is never reproduced, nor is any animal produced at all, but the like things only.

First, then, we must proceed to treat of copulation in regard to such animals as copulate; and then after this to treat in due order of other matters, both the exceptional and those of general occurrence.

2 · Those animals, then, copulate in which there is a duality of sex, and the modes of covering in such animals are not in all cases similar nor analogous. For the

red-blooded animals that are viviparous and furnished with feet have in all cases organs adapted for procreation, but the sexes do not in all cases come together in like manner. Thus, retromingent animals copulate with a rearward presentment, as is the case with the lion, the hare, and the lynx; though in the case of the hare, the female often first mounts the male.

The case is similar in most other such animals; that is to say, the majority of quadrupeds copulate as best they can, the male mounting the female; and this is the only method of copulating adopted by birds, though there are certain diversities of method observed even in birds. For in some cases the female squats on the ground and the male mounts on top of her, as is the case with the bustard, and the domestic fowl; in other cases, the male mounts without the female squatting, as with the crane; for, with these birds, the male mounts on to the back of the female and covers her, and like the cock-sparrow consumes but very little time in the operation. Of quadrupeds, bears perform the operation lying prone on one another, in the same way as other quadrupeds do while standing up; that is to say, with the belly of the male pressed to the back of the female. Hedgehogs copulate erect, belly to belly.

With regard to large-sized vivipara, the hind only very rarely allows the stag to complete the act and the same is the case with the cow as regards the bull, owing to the rigidity of the penis of the bull. In point of fact, the females elicit the sperm in the act of withdrawing from underneath him; and this phenomenon has been observed in the case of the hind, domesticated, of course. Covering with the wolf is the same as with the dog. Cats do not copulate with a rearward presentment, but the male stands erect and the female puts herself underneath him; and the female cat is naturally lecherous, and wheedles the male on to sexual commerce, and caterwauls during the operation. Camels copulate with the female in a sitting posture, and the male straddles over and covers her, not with the hinder presentment but like the other quadrupeds, and they pass the whole day long in the operation; when thus engaged they retire to lonely spots, and none but their keeper dare approach them. And the penis of the camel is so sinewy that bow-strings are manufactured out of it. Elephants, also, copulate in lonely places, and especially by river-sides in their usual haunts; the female squats down, and straddles with her legs, and the male mounts and covers her. The seal covers like all retromingent animals, and in this species the copulation extends over a lengthened time, as is the case with the dog and bitch; and the penis in the male seal is exceptionally large.

3 · Oviparous quadrupeds cover one another in the same way. That is to say, in some cases the male mounts the female precisely as in the viviparous animals, as is observed in both the land and the sea tortoise. . . .[1] And these creatures have an organ in which the ducts converge, and with which they perform the act of copulation, as is also observed in the toad,[2] the frog, and all other animals of the same group.[3]

[1]There is a lacuna in the text at this point.
[2]Reading φρῦνοι for τρυγόνες.
[3]Dittmeyer excises 'as is also . . . group'.

4 · Long animals devoid of feet, like serpents and muraenae, intertwine in coition, belly to belly. And, in fact, serpents coil round one another so tightly as to present the appearance of a single serpent with a pair of heads. The same mode is followed by the saurians; that is to say, they coil round one another in the act of coition.

5 · All fishes, with the exception of the flat selachians, lie side by side, and copulate belly to belly. Fishes, however, that are flat and furnished with tails—as the ray, the sting-ray and the like—copulate not only in this way, but also, where the tail from its thickness is no impediment, by mounting of the male upon the female, belly to back. But the angel-fish, and other like fishes where the tail is large, copulate only by rubbing against one another sideways, belly to belly. Some men assure us that they have seen some of the selachia copulating hindways, like dog and bitch. In all the selachian species the female is larger than the male; and the same is the case with other fishes for the most part. And among selachia are included, besides those already named, the ox-fish, the lamia, the aetos, the torpedo, the fishing-frog, and all the dogfish. Selachia, then, of all kinds, have in many instances been observed copulating in the way above mentioned; for in all viviparous animals the process of copulation is of longer duration than in the ovipara.

It is the same with the dolphin and with all cetaceans; that is to say, they come side by side, male and female, and copulate, and the act extends over a time which is neither short nor very long.

Again, in selachian fishes the male, in some species, differs from the female in the fact that he is furnished with two appendages hanging down from about the exit of the residuum, and that the female is not so furnished—this is observed in e.g. the dog-fish.

Now neither fishes nor any animals devoid of feet are furnished with testicles, but male serpents and male fishes have a pair of ducts which fill with milt at the rutting season, and discharge, in all cases, a milk-like juice. These ducts unite, as in birds; for birds have their testicles in their interior, and so have all ovipara that are furnished with feet. And this union of the ducts is so far continued[4] and of such extension as to enter the receptive organ in the female.

In viviparous animals furnished with feet there is outwardly one and the same duct for the sperm and the liquid residuum; but there are separate ducts internally, as has been observed before in the differentiation of the organs. And with such animals as are not viviparous the same passage serves externally for the discharge also of the solid residuum; although, internally, there are two passages near to one another. And these remarks apply to both male and female; for these animals are unprovided with a bladder except in the case of the tortoise; and the she-tortoise, though furnished with a bladder, has only one passage; and tortoises belong to the ovipara.

In the case of oviparous fishes the process of coition is less open to observation. That is why most people suppose that the female becomes impregnated by

[4]Omitting ἔξω.

swallowing the milt of the male. And there can be no doubt that this proceeding is often witnessed; for at the rutting season the females follow the males and perform this operation, and strike the males with their mouths under the belly, and the males are thereby induced to part with the sperm sooner and more plentifully. And, further, at the spawning season the males go in pursuit of the females, and, as the female spawns, the males swallow the eggs; and the species is continued in existence by the spawn that survives this process. On the coast of Phoenicia they catch them by means of one another: that is to say, by using the male of the grey mullet as a decoy they collect and net the female, and by using the female, the male.

The repeated observation of this phenomenon has led to the notion that the process was equivalent to coition, but the fact is that a similar phenomenon is observable in quadrupeds. For at the rutting seasons both the males and the females spray, and the two sexes take to smelling each other's genitals.

[With partridges, if the female gets to leeward of the male, she becomes thereby impregnated. And often when they happen to be in heat she is affected in this way by the voice of the male, or by his breathing down on her as he flies overhead; and both the male and the female partridge keep the mouth wide open and protrude the tongue in the process of coition.][5]

The actual process of copulation on the part of oviparous fishes is seldom accurately observed, owing to the fact that, having come alongside, they very soon part. But, for all that, the process has been observed in these cases too to take place in the manner above described.

6 · Cephalopods, such as the octopus, the cuttlefish, and the calamary, have 541b1
sexual intercourse all in the same way; that is to say, they unite at the mouth, by an interlacing of their tentacles. When, then, the octopus rests its so-called head against the ground and spreads abroad its tentacles, the other fits into the outspreading of these tentacles, and the two then bring their suckers into mutual connexion.

Some assert that the male has a kind of penis in one of his tentacles, the one in which are the two largest suckers; and they further assert that the organ is sinewy in character, growing attached right up to the middle of the tentacle, which is admitted into the nostril of the female.

Now cuttlefish and calamaries swim about closely intertwined, with mouths and tentacles facing one another and fitting closely together; and they fit their so-called nostrils into one another, and the one sex swims backwards and the other frontwards during the operation. And the female lays its spawn by the so-called 'blow-hole'; and some declare that it is at this organ that the coition really takes place.

7 · Crustaceans copulate, as the crayfish, the lobster, the carid[6] and the like, just like the retromingent quadrupeds, when the one animal turns up its tail and the

[5] Dittmeyer excises this paragraph.
[6] Dittmeyer excises the lobster and the carid.

other puts his tail on the other's tail. Copulation takes place in the early spring, near to the shore; and, in fact, the process has often been observed in the case of all these animals. Sometimes it takes place about the time when the figs begin to ripen. Lobsters and carids copulate in like manner.

Crabs copulate at the front parts of one another, throwing their overlapping opercula to meet one another: first the smaller crab mounts the larger at the rear; after he has mounted, the larger one turns on one side. Now, the female differs in no respect from the male except in the circumstance that its operculum is larger, more elevated, and more hairy, and into this operculum it spawns its eggs and in the same neighbourhood is the outlet of the residuum. In the copulative process of these animals there is no protrusion of a member from one animal into the other.

542a1 8 · Insects copulate at the hinder end, and the smaller individuals mount the larger; and the smaller individual is the male. The female pushes from underneath her sexual organ into the body of the male above, not the male into the female, as in other creatures; and this organ in the case of some insects appears to be disproportionately large when compared to the size of the body, and that too in very minute creatures; in some insects the disproportion is not so striking. This phenomenon may be witnessed if any one will pull asunder flies that are copulating—but they are hard to separate; for the intercourse of the sexes in their case is of long duration, as may be observed with common everyday insects, such as the fly and the cantharis. They all copulate in the manner above described, the fly, the cantharis, the sphondyle, [the phalangium spider],[7] and any others of the kind that copulate at all. The phalangia—that is to say, such of the species as spin webs—perform the operation in the following way: the female takes hold of the suspended web at the middle and gives a pull, and the male gives a counter pull; this operation they repeat until they are drawn in together and interlaced at the hinder ends; for this mode of copulation suits them in consequence of the rotundity of their stomachs.

So much for the mode of sexual intercourse in all animals; but, for each kind of animal, there are definite seasons and ages for copulation.

Animals in general seem naturally disposed to this intercourse at about the same period of the year, and that is when winter is changing into summer. And this is the season of spring, in which almost all things that fly or walk or swim take to pairing. Some animals pair and breed in autumn also and in winter, as is the case with certain aquatic animals and certain birds. Man pairs and breeds at all seasons, as is the case also with domesticated animals, owing to the shelter and good feeding they enjoy: that is to say, with those whose period of gestation is also comparatively brief, as the sow and the bitch, and with those birds that breed frequently. Many animals time the season of intercourse with a view to the right nurture subsequently of their young. In the human species, the male is more under sexual excitement in
542b1 winter, and the female in summer.

[7]Excised by Dittmeyer.

With birds the far greater part, as has been said, pair and breed during the spring and early summer, with the exception of the halcyon.

The halcyon breeds at the season of the winter solstice. Accordingly, when this season is marked with calm weather, the name of 'halcyon days' is given to the seven days preceding, as to as many following, the solstice; as Simonides the poet says:—

> God lulls for fourteen days the winds to sleep
> In winter; and this temperate interlude
> Men call the Holy Season, when the deep
> Cradles the mother Halcyon and her brood.

And these days are calm, when southerly winds prevail at the solstice, northerly ones having been the accompaniment of the Pleiads. The halcyon is said to take seven days for building her nest, and the other seven for laying and hatching her eggs. In our country there are not always halcyon days about the time of the solstice, but in the Sicilian seas this season of calm is pretty regular. The bird lays about five eggs.

9 · The shearwater and the gull lay their eggs on rocks bordering on the sea, two or three at a time; but the gull lays in the summer, and the shearwater at the beginning of spring, just after the solstice, and it broods over its eggs as birds do in general. And neither of these birds resorts to a hiding-place.

The halcyon is the most rarely seen of all birds. It is seen only about the time of the setting of the Pleiads and the solstice. When ships are lying at anchor, it will hover about a vessel and then disappear in a moment, and Stesichorus alludes to this peculiarity. The nightingale also breeds at the beginning of summer, and lays five or six eggs; from autumn until spring it retires to a hiding-place.

Insects copulate and breed in winter also, when the weather is fine and south winds prevail; such, I mean, as do not hibernate, as the fly and the ant. The greater part of wild animals bring forth once and once only in the year, except in the case of animals like the hare, where the female can become superfoetally impregnated.

In like manner the great majority of fishes breed only once a year, like the shoal-fishes (or, in other words, such as are caught in nets), the tunny, the pelamys, 543a1 the grey mullet, the chalcis, the mackerel, the sciaena, the psetta and the like, with the exception of the basse; for this fish (alone amongst those mentioned) breeds twice a year, and the second brood is the weaker of the two. The trichias and the rock-fishes breed twice a year; the red mullet alone breeds thrice—this is inferred from the spawn; for the spawn of the fish may be seen in certain places at three different times of the year. The scorpaena breeds twice a year. The sargue breeds twice, in the spring and in the autumn. The saupe breeds once a year only, in the autumn. The female tunny breeds only once a year, but owing to the fact that the fish in some cases spawn early and in others late, it looks as though the fish bred twice over. The first spawning takes place in Posideon before the solstice, and the latter spawning in the spring. The male tunny differs from the female in being unprovided with the fin beneath the belly which is called *aphareus*.

10 · Of selachia, the angel-fish is the only one that breeds twice; for it breeds at the beginning of autumn, and at the setting of the Pleiads; and it is in better condition in the autumn. It engenders at a birth seven or eight young. Certain of the dog-fishes, for example the spotted dog, seem to breed twice a month, and this results from the circumstance that the eggs do not all reach maturity at the same time.

Some fishes breed at all seasons, as the muraena. This animal lays a great number of eggs at a time; and the young when hatched are very small but grow with great rapidity, like the young of the hippurus; for these fishes from being diminutive at the outset grow with exceptional rapidity to an exceptional size. But whereas the muraena breeds at all seasons, the hippurus breeds only in the spring. The smyrus differs from the muraena; for the muraena is mottled and weakly, whereas the smyrus is strong and of one uniform colour, and the colour resembles that of the pine-tree, and the animal has teeth inside and out. They say that in this case, as in other similar ones, the one is the male, and the other the female. They come out on to the land, and are frequently caught.

Fishes, then, as a general rule, attain their full growth with great rapidity, but this is especially the case, among small fishes, with the crow-fish: it spawns near the shore, in weedy and tangled spots.The sea-perch, too, is small at first, and rapidly attains a great size. The pelamys and the tunny breed in the Euxine, and nowhere else. The mullet, the gilt-head, and the basse, breed best where rivers run into the sea. The orcys, the mackerel, and many other species spawn in the open sea.

11 · Fish for the most part breed during the three months of Munichion, Thargelion and Scirrophorion. Some few breed in autumn: as, for instance, the saupe and the sargus, and such others of this sort as breed shortly before the autumn equinox; likewise the electric ray and the angel-fish. Other fishes breed even in winter and in summer, as was previously observed: as, for instance, in winter-time the basse, the grey mullet, and the pipe-fish; and in summer time, in the month of Hecatombaion, the female tunny, about the time of the summer solstice; and the tunny lays a sac-like enclosure in which are contained a number of small eggs. The shoal-fishes breed in summer.

Of the grey mullets, the chelon begins to be in roe in Posideon; as also the sargue, and the myxon, and the cephalus; and their period of gestation is thirty days. And some of the grey mullet species are not produced from copulation, but grow from mud and sand.

As a general rule, then, fishes are in roe in the springtime; while some, as has been said, are so in summer, in autumn, or in winter. But it does not occur in the same way for all—neither in general nor among members of the same genus—as it does for most of those that breed in the spring; and, further, conception in these variant seasons is not so prolific. And, indeed, we must bear this in mind, that just as with plants and quadrupeds diversity of locality has much to do not only with general physical health but also with the comparative frequency of sexual intercourse and generation, so also with regard to fishes locality of itself has much to do not only in regard to the size and vigour of the creature, but also in regard to its parturition and its copulations, causing the same species to breed oftener in one place and seldomer in another.

12 · The cephalopods also breed in spring. Of the marine cephalopods one of the first to breed is the cuttlefish. It spawns at all times of the day and its period of gestation is fifteen days. After the female has laid her eggs, the male comes and discharges the milt over the eggs, and the eggs thereupon harden. And they go about in pairs; and the male is more mottled and more black on the back than the female.

The octopus pairs in winter and breeds in spring, lying hidden for about two months. Its spawn is shaped like a vine-tendril, and resembles the fruit of the white poplar; the creature is extraordinarily prolific, for the number of individuals that come from the spawn is something incalculable. The male differs from the female in the fact that its head is longer, and that the organ called by the fishermen its penis, in the tentacle, is white. The female, after laying her eggs, broods over them, and in consequence gets out of condition, by reason of not going in quest of food during the hatching period.

The purple murex breeds about spring-time, and the trumpet-shell at the close of the winter. And, as a general rule, the testaceans are found to be furnished with their so-called eggs in springtime and in autumn, with the exception of the edible urchin; for this animal has the so-called eggs in most abundance in these seasons, but at no season is unfurnished with them; and it is furnished with them in especial abundance in warm weather or when a full moon is in the sky—except for the sea-urchin found in the Pyrrhaean Straits, for this urchin is at its best in the winter; and these urchins are small but full of eggs.

Snails are found by observation to become in all cases impregnated about the same season.

13 · Of birds the wild species, as has been stated, as a general rule pair and breed only once a year. The swallow, however, and the blackbird breed twice. With regard to the blackbird, however, its first brood is killed by inclemency of weather (for it is the earliest of all birds to breed), but the second brood it usually succeeds in rearing.

Birds that are domesticated or that are capable of domestication breed frequently, just as the common pigeon breeds all through the summer, and as is seen in the fowl; for the cock and hen have intercourse, and the hen breeds, at all seasons except during the days about the winter solstice.

[Of the pigeon family there are many kinds; for the common pigeon is not identical with the rock-pigeon: the rock-pigeon is smaller than the common pigeon, and is less easily domesticated; it is also black, and small, red-footed and rough-footed; and in consequence of these peculiarities it is neglected by the pigeon-fancier. The largest of all the pigeon species is the ring-dove; and the next in size is the stock-dove; and the stock-dove is a little larger than the common pigeon.

The smallest of all the species is the turtle-dove. Pigeons breed and hatch at all seasons, if they are furnished with a sunny place and all requisites; unless they are so furnished, they breed only in the summer. The spring brood is the best, or the autumn brood. The summer brood and those produced in hot periods are the worst.][8]

14 · Further, animals differ from one another in regard to the time of life that is best adapted for sexual intercourse.

To begin with, in most animals the secretion of the seminal fluid and its generative capacity are not phenomena simultaneously manifested, but manifested successively. Thus, in all animals, the earliest secretion of sperm is unfruitful, or if it be fruitful the issue is comparatively poor and small. And this phenomenon is especially observable in man, in viviparous quadrupeds, and in birds; for in the case of man and the quadruped the offspring is smaller, and in the case of the bird, the egg.

For animals that copulate, of one and the same species, the age for maturity is in most species tolerably uniform, unless it occurs prematurely by reason of abnormality, or is postponed by physical injury.

In man, then, maturity is indicated by a change of the tone of voice, by an increase in size and an alteration in appearance of the sexual organs, as also of the breasts; and above all, in the hair-growth at the pubes. Man begins to possess seminal fluid about the age of fourteen, and becomes generatively capable at about the age of twenty-one years.

In other animals there is no hair-growth at the pubes (for some animals have no hair at all, and others have none on the belly, or less on the belly than on the back), but still, in some animals the change of voice is quite obvious; and in some animals other organs give indication of the commencing secretion of the sperm and the onset of generative capacity. As a general rule the female is sharper-toned in
545a1 voice than the male, and the young animal than the elder; for the stag has a much deeper-toned bay than the hind. Moreover, the male cries chiefly at rutting time, and the female under terror and alarm; and the cry of the female is short, and that of the male prolonged. With dogs also, as they grow old, the tone of the bark gets deeper.

There is a difference observable also in the neighings of horses. That is to say, the female foal has a thin small neigh, and the male foal a small neigh, yet bigger and deeper-toned than that of the female, and a louder one as time goes on. And when they are two years old and take to breeding, the neighing of the stallion becomes loud and deep, and that of the mare louder and shriller than heretofore; and this change usually goes on until they reach the age of twenty years; and after this time the neighing in both sexes becomes weaker.

As a rule, then, as was stated, the voice of the male differs from the voice of the female, in animals where the voice admits of a prolonged sound, in the fact that the

[8]Dittmeyer excises this paragraph.

note in the male voice is deeper; not, however, in all animals, for the contrary holds good in the case of some, as for instance in cattle; for here the cow has a deeper note than the bull, and the calves a deeper note than the adults. And that is why gelded animals change their voice in the opposite direction; for male animals that undergo this process assume the characters of the female.

The following are the ages at which various animals become capacitated for sexual commerce. The ewe and the she-goat are sexually mature when one year old, and the she-goat more definitely so; the ram and the he-goat are sexually mature at the same age. The progeny of very young individuals among these animals differs from that of others; for the males improve in the course of the second year, when they become fully mature.[9] The boar and the sow are capable of intercourse when eight months old, and the female brings forth when one year old, the difference corresponding to her period of gestation. The boar is capable of generation when eight months old, but, with a sire under a year in age, the litter is apt to be a poor one. The ages, however, are not invariable; now and then the boar and the sow are capable of intercourse when four months old, and are capable of producing a litter which can be reared when six months old; but at times the boar begins to be capable of intercourse when ten months. He continues sexually mature until he is three years old. The dog and the bitch are, as a rule, sexually capable and sexually receptive when a year old, and sometimes when eight months old; but this is more common with the dog than with the bitch. The period of gestation with the bitch is sixty days, or sixty-one, or sixty-two, or sixty-three at the utmost; the period is never under sixty days, or, if it is, the litter comes to no good. The bitch, after delivering a litter, submits to the male in six months, but not before. The horse and the mare are, at the earliest, sexually capable and sexually mature when two years old; the issue, however, of parents of this age is small and poor. As a general rule these animals are sexually capable when three years old, and they grow better for breeding purposes until they reach twenty years. The stallion is sexually capable up to the age of thirty-three years, and the mare up to forty, so that, in point of fact, the animals are sexually capable all their lives long; for the stallion, as a rule, lives for about thirty-five years, and the mare for over forty; although a horse has been known to live to the age of seventy-five. The ass and the she-ass are sexually capable when thirty months old; but, as a rule, they are not generatively mature until they are three years old, or three years and a half. An instance has been known of a she-ass bearing and bringing forth a foal when only a year old. A cow has been known to calve when only a year old, and the calf grew as big as might be expected, but no more. So much for the dates at which these animals attain to generative capacity. In the human species, the male is generative, at the longest, up to seventy years, and the female up to fifty; but such extended periods are rare, for few produce children at those ages. As a rule, the male is generative up to the age of sixty-five, and to the age of forty-five the female is capable of conception.

The ewe bears up to eight years, and, if she be carefully tended, up to eleven years; in fact, the ram and the ewe are sexually capable pretty well all their lives

[9]The text of this sentence is uncertain.

long. He-goats, if they be fat, are less serviceable for breeding; and this is the reason why they say of a vine when it stops bearing that it is 'running the goat'. However, if an over-fat he-goat be thinned down, he becomes sexually capable and generative.

Rams single out the oldest ewes for copulation, and show no regard for the young ones. And, as has been stated, the issue of the younger ewes is poorer than that of the older ones.

The boar is good for breeding purposes until he is three years of age; but after that age his issue deteriorates, for after that age his vigour is on the decline. The boar normally mates after a good feed, and with the first sow it mounts; otherwise the copulation is slightly longer, and the litter is comparatively poor. The first litter of the sow is the fewest in number; at the second litter she is at her prime. The animal, as it grows old, continues to breed, but mates more slowly. When they reach fifteen years, they become unproductive, and are getting old. If a sow be highly fed, it is all the more eager for sexual commerce, whether old or young; but, if it be over-fattened in pregnancy, it gives the less milk after parturition. With regard to the age of the parents, the litter is the best when they are in their prime; but with regard to the seasons of the year, the litter is the best that comes at the beginning of winter; and the summer litter the poorest, consisting of animals small and thin and flaccid. The boar, if it be well fed, is sexually capable at all hours, night and day; but otherwise is peculiarly salacious early in the morning. As it grows old the sexual passion dies away, as we have already remarked. Very often a boar, when more or less impotent from age or debility, finds itself unable to accomplish the sexual commerce with due speed: then the sow, growing fatigued with the standing posture, will roll over on the ground, and the pair will conclude the operation side by side of one another. The sow is sure of conception if it drops its lugs in rutting time; if the ears do not thus drop, it may have to rut a second time before impregnation takes place.

Bitches do not submit to the male throughout their lives, but only until they reach a certain maturity of years. As a general rule, they are sexually receptive and conceptive until they are twelve years old; although cases have been known where dogs and bitches have been respectively procreative and conceptive to the ages of eighteen and even of twenty years. But age diminishes the capability of generation and of conception with these animals as with all others.

546b1 The female of the camel is retromingent, and submits to the male in the way above described; and the season for copulation in Arabia is about the month of Maemacterion. Its period of gestation is twelve months; and it is never delivered of more than one foal at a time. The female becomes sexually receptive and the male sexually capable at the age of three years. After parturition, an interval of a year elapses before the female is again receptive to the male.

The female elephant becomes sexually receptive when ten years old at the youngest, and when fifteen at the oldest; and the male is sexually capable when five years old, or six. The season for intercourse is spring. The male allows an interval of three years to elapse after commerce with a female; and, after it has once impregnated a female, it has no intercourse with her again. The period of gestation with the female is two years; and only one young animal is produced at a time, in other words it is uniparous. And the embryo is the size of a calf two or three months old.

15 · So much for the copulations of such animals as copulate. We now proceed to treat of generation both with respect to copulating and non-copulating animals, and we shall commence with discussing the subject of generation in the case of the testaceans.

The testacean is almost the only genus that throughout all its species is non-copulative.

The purple murices gather together to some one place in the spring-time, and deposit the so-called 'honey-comb'. This substance resembles the comb, only that it is not so neat; and looks as though a number of husks of white chick-peas were all stuck together. But none of these structures has any open passage, and the murex does not grow out of them, but these and all other testaceans grow out of mud and decaying matter. The substance is a sort of excretion of the trumpet-shell and the murex; for it is deposited by the trumpet-shell as well. Such, then, of the testaceans as deposit the honeycomb are generated like all other testaceans, but they certainly come in greater abundance in places where their congeners have been living previously. At the commencement of the process of depositing the honeycomb, they throw off a slippery mucus, and of this the husklike formations are composed. These formations, then, all melt and deposit their contents on the ground, and at this spot there are found on the ground a number of minute murices, and murices are caught at times with these animalculae upon them, some of which are too small to be differentiated in form. If the murices are caught before producing this honey-comb, they sometimes go through the process in fishing-creels, not here and there in the baskets, but gathering to some one spot all together, just as they do in the sea; and owing to the narrowness of their new quarters they cluster together like a bunch of grapes.

There are many species of the purple murex; and some are large, as those found off Sigeum and Lectum; others are small, as those found in the Euripus, and on the coast of Caria. And those that are found in bays are large and rough; in most of them the bloom is dark, in others it is reddish and small in size; some of the large ones weigh upwards of a mina apiece. But the specimens that are found along the coast and on the beaches are small-sized, and the bloom in their case is of a reddish hue. Further, as a general rule, in northern waters the bloom is blackish, and in southern waters of a reddish hue. The murex is caught in the spring-time when engaged in the construction of the honeycomb; but it is not caught at any time about the rising of the dog-star, for at that period it does not feed, but conceals itself and burrows. [The bloom of the animal is situated between the 'poppy' and the neck, and the co-attachment of these is an intimate one. In colour it looks like a white membrane, and this is what people extract; and if it be squeezed it stains your hand with the colour of the bloom. There is a kind of vein that runs through it, and this would appear to be in itself the bloom. And the rest of its substance is somewhat astringent.[10]] It is after the murex has constructed the honey-comb that the bloom is at its worst. Small specimens they break in pieces, shells and all, for it is no easy matter to extract the organ; but in dealing with the larger ones they first strip off the shell and then abstract the bloom. For this purpose the neck and poppy are separated, for the bloom lies in between them, above the so-called stomach; hence the necessity of separating them in abstracting the bloom. Fishermen are anxious always to break the animal in pieces while it is yet alive, for, if it die before the process is completed, it vomits out the bloom; and for this reason the fishermen keep the animals in creels, until they have collected a sufficient number and can attend to them at their leisure. Fishermen in past times used not to lower creels or attach them to the bait, so that very often the animal got dropped off in the pulling up; at present, however, they always attach a basket, so that if the animal fall off it is not lost. The animal is more inclined to slip off the bait if it be full inside; if it be empty it is actually difficult to shake it off. Such are the phenomena peculiar to the murex.

The trumpet-shell comes into existence in the same way and at the same season as the murex. Both animals also have opercula, as do all the stromboids, and this is congenital with them all; and they feed by protruding the so-called tongue underneath the operculum. The tongue of the murex is bigger than one's finger, and by means of it, it feeds, and perforates conchylia and the shells of its own kind. Both the murex and the trumpet-shell are long-lived. The murex lives for about six years; and the yearly increase is indicated by a distinct interval in the spiral convolution of the shell.

The mussel also constructs a honey-comb.[11]

With regard to the lagoon oysters, wherever you have slimy mud there you are sure to find them beginning to grow. Cockles and clams and razor-fishes and scallops grow in sandy places. The pinna grows straight up from the bottom in sandy and slimy places; [these creatures have inside them a pinna-guard, in some cases a small carid and in other cases a little crab; if the pinna be deprived of this pinna-guard it soon dies.][12]

As a general rule, then, all testaceans grow by spontaneous generation in mud, differing from one another according to the differences of the material; oysters growing in slime, and cockles and the other testaceans above mentioned on sandy bottoms; and in the hollows of the rocks the ascidian and the barnacle, and common sorts, such as the limpet and the nerites. All these animals grow with great rapidity, especially the murex and the scallop; for the murex and the scallop attain their full growth in a year. In some of the testaceans white crabs are found, very diminutive in size; they are most numerous in the trough-shaped mussel. In the pinna also is found the so-called pinna-guard. They are found also in the scallop and in the lagoon oyster; they never appear to grow in size. Fishermen declare that they come into

[10]Dittmeyer excises the bracketed sentences.
[11]Dittmeyer excises this sentence.
[12]Dittmeyer excises.

being at the same time as their hosts. Scallops burrow for a time in the sand, like the murex.

Shell-fish, then, grow in the way above mentioned; and some of them grow in shallow water, some on the seashore, some in muddy places, some on hard and stony 548a1
ground, and some in sandy places. Some shift about from place to place, others do not. Of those that keep to one spot the pinnae are rooted to the ground; the razor-fish and the clam keep to the same locality, but are not so rooted; but still, if forcibly removed they die.

[The star-fish is naturally so warm that whatever it lays hold of is found, when suddenly taken away from the animal, to be scorched. Fishermen say that the star-fish is a great pest in the Strait of Pyrrha. In shape it resembles a star as seen in a drawing. The so-called sea-lungs are generated spontaneously. The shells that painters use are a good deal thicker, and the bloom is outside the shell on the surface. These creatures are mostly found on the coast of Caria.][13]

The hermit-crab grows out of soil and slime, and finds its way into untenanted shells. As it grows it shifts to a larger shell, as for instance into the shell of the nerites, or of the strombus or the like, and very often into that of the small trumpet-shell. After entering a new shell, it carries it about, and begins to feed [again; and, by and by, as it grows, it shifts again into another larger one].[14]

16 · Moreover, the animals that are unfurnished with shells grow like the testaceans, as, for instance, the sea-anemones and the sponges in rocky caves.

Of the sea-anemone there are two species; and of these one species lives in hollows and never loosens its hold upon the rocks, and the other lives on smooth flat reefs, free and detached, and shifts its position from time to time. [Limpets also detach themselves, and shift from place to place.][15]

In the chambered cavities of sponges pinna-guards are found. And over the chambers there is a kind of spider's web, by the opening and closing of which they catch minute fishes; that is to say, they open the web to let the fish get in, and close it again to entrap them.

Of sponges there are three species; the first is of porous texture, the second is close-textured, the third, which is nicknamed 'the sponge of Achilles', is exception- 548b1
ally fine and close-textured and strong. This sponge is used as a lining to helmets and greaves, for the purpose of deadening the sound of the blow; and this is a very scarce species. Of the close-textured sponges such as are particularly hard and rough are nicknamed 'goats'.

Sponges grow either attached to a rock or on sea-beaches, and they get their nutriment in slime: a proof of this statement is the fact that when they are first secured they are found to be full of slime. This is characteristic of all living creatures that get their nutriment by close local attachment. And the close-textured

[13]Dittmeyer excises.
[14]Dittmeyer excises.
[15]Dittmeyer excises.

sponges are weaker than the more porous ones because their attachment extends over a smaller area.

It is said that the sponge is sensitive; and as a proof of this statement they say that if the sponge is made aware of an attempt being made to pluck it from its place of attachment it draws itself together, and it becomes a difficult task to detach it. It makes a similar movement in windy and boisterous weather with the object of tightening its hold. Some persons express doubts as to the truth of this assertion; as, for instance, the people of Torone.

The sponge breeds animals in itself—worms and other creatures—on which, if they be detached, the rock-fishes prey, as they prey also on the remaining stumps of the sponge; but, if the sponge be broken off, it grows again from the remaining stump and the place is soon as well covered as before.

The largest of all sponges are the loose-textured ones, and these are peculiarly abundant on the coast of Lycia. The softest are the close-textured sponges; for the so-called sponges of Achilles are harder than these. As a general rule, sponges that are found in deep calm waters are the softest; for windy and stormy weather has a tendency to harden them (as it has to harden all similar growing things), and to arrest their growth. And this accounts for the fact that the sponges found in the Hellespont are rough and close-textured; and, as a general rule, sponges found beyond or inside Cape Malea are, respectively, comparatively soft or comparatively hard. But the habitat of the sponge should not be too warm, for it has a tendency to decay, like all growing things. And this accounts for the fact that the sponge is at its best when found in deep water close to shore; for owing to the depth of the water they are well protected against both conditions.

Whilst they are still alive and before they are washed, they are blackish in colour. Their attachment is not made at one particular spot, nor is it made all over their bodies; for vacant pore-spaces intervene. There is a kind of membrane stretched over the under parts; [and the points of attachment are the more numerous.][16] On the top most of the pores are closed, but four or five are visible; and we are told by some that it is through these pores that the animal takes its food.

There is a particular species that is named the 'unwashable', from the circumstance that it cannot be cleaned. This species has the large pores, but all the rest of the body is close-textured; and, if it be dissected, it is found to be closer and more glutinous than the ordinary sponge, and the whole thing is something lung-like in consistency. And, on all hands, it is allowed that this species is sensitive and long-lived. They are distinguished in the sea from ordinary sponges from the circumstance that the ordinary sponges are white while the slime is in them,[17] but that these sponges are under any circumstances black.

And so much with regard to sponges and to generation in the testaceans.

17 · Of crustaceans, the female crayfish after copulation conceives and retains its eggs for about three months, during Scirrophorion, Hecatombaion, and

[16]Dittmeyer excises.
[17]Omitting μή.

Metageitnion; they then lay the eggs into the folds underneath the belly, and their eggs grow like grubs. This same phenomenon is observable in cephalopods also, and in such fishes as are oviparous; for in all these cases the egg continues to grow.

The egg of the crayfish is of a loose consistency, and is divided into eight parts; for corresponding to each of the flaps on the side there is a gristly formation to which the spawn is attached, and the entire structure resembles a cluster of grapes; for each gristly formation is split into several parts. This is obvious enough if you draw the parts asunder; but at first sight the whole appears to be one and indivisible. And the largest are not those nearest to the outlet but those in the middle, and the farthest off are the smallest. The size of the small eggs is that of a fig-seed; and they are not quite close to the outlet, but placed middleways; for at both ends, tailwards and trunkwards, there are two intervals; for it is thus that the flaps also grow. The side flaps, then, cannot close, but by placing the end flap on them the animal can close up all, and this end-flap serves them for a lid. And in the act of laying its eggs it seems to bring them towards the gristly formations by curving the flap of its tail, and then, squeezing the eggs forwards and maintaining a bent posture, it performs the act of laying. The gristly formations at these seasons increase in size and become receptive of the eggs; for the animal lays its eggs into these formations, just as the cuttlefish lays its eggs among twigs and driftwood.

It lays its eggs, then, in this manner, and after maturing them for about twenty days it rids itself of them all in one solid lump, as is quite plain from outside. And out of these eggs crayfish form in about fifteen days, and these are often caught less then a finger's breadth in length. The animal, then, lays its eggs before the middle of September, and after the middle of that month throws off its eggs in a lump. With the prawns the time for gestation is four months or thereabouts.

Crayfish are found in rough and rocky places, lobsters in smooth places, and neither are found in muddy ones; and this accounts for the fact that lobsters are found in the Hellespont and on the coast of Thasos, and crayfish in the neighbourhood of Sigeum and Mount Athos. Fishermen, accordingly, when they want to catch these various creatures out at sea, take bearings on the beach and elsewhere that tell them where the ground at the bottom is stony and where soft with slime. In winter and spring these animals keep in near to land, in summer they keep in deep water; thus at various times seeking respectively for warmth or coolness.

The so-called bear-crab lays its eggs at about the same time as the crayfish; and consequently in winter and in the spring-time, before laying their eggs, they are at their best, and after laying at their worst.

They cast their shell in the spring-time (just as serpents shed their slough), both directly after birth and in later life; this is true both of crabs and crayfish. And all crayfish are longlived.

18 · Cephalopods, after pairing and copulation, lay a white egg; and this spawn, as in the case of the testacean, gets granular in time. The octopus discharges into its hole, or into a potsherd or into any similar cavity, a structure resembling the

tendrils of a young vine or the fruit of the white poplar, as has been previously observed. The eggs, when the female has laid them, are clustered round the sides of 550a1 the hole. They are so numerous that, if they be removed, they suffice to fill a vessel much larger than the animal's body in which they were contained. Some fifty days later, the eggs burst and the little octopuses creep out, like little spiders, in great numbers; the characteristic form of their limbs is not yet to be discerned in detail, but their general outline is clear enough. And they are so small and helpless that the greater number perish; it is a fact that they have been seen so extremely minute as to be absolutely without organization, but nevertheless when touched they moved. The eggs of the cuttlefish look like big black myrtle-berries, and they are linked all together like a bunch of grapes, clustered round a centre, and are not easily sundered from one another; for the male exudes over them some moist mucus which constitutes the sticky gum. These eggs increase in size; and they are white at the outset, but black and larger after the sprinkling of the male seminal fluid.

When it has come into being the young cuttlefish is first distinctly formed inside out of the white substance, and when the egg bursts[18] it comes out. The inner part is formed as soon as the female lays the egg, something like a hail-stone; and out of this substance the young cuttlefish grows by a head-attachment, just as young birds grow by a belly-attachment. What is the exact nature of the navel-attachment has not yet been observed, except that as the young cuttlefish grows the white substance grows less and less in size, and at length, as happens with the yolk in the case of birds, the white substance in the case of the young cuttlefish disappears. In the case of the young cuttlefish, as in the case of other animals, the eyes at first seem very large. To illustrate this by way of a figure, let A represent the egg, B and C the eyes, and D the young cuttlefish.

The female cuttlefish gets pregnant in the spring-time, and lays its eggs after fifteen days of gestation; after the eggs are laid there comes in another fifteen days something like a bunch of grapes, and at the bursting of these the young cuttlefish issue forth. But if, when the young ones are fully formed, you sever the outer covering a moment too soon, the young creatures eject excrement, and their colour changes from white to red in their alarm.

550b1 Crustaceans, then, hatch their eggs by brooding over them underneath their bodies; but the octopus, the cuttlefish, and the like hatch their eggs wherever they may have laid them, and this statement is particularly applicable to the cuttlefish; in fact, its sac is often seen exposed to view close in to shore. The female octopus at times sits brooding over her eggs, and at other times squats in front of her hole, stretching out her tentacles.

The cuttlefish lays her spawn near to land in the neighbourhood of sea-weed or reeds or anything of the sort that has been cast up, such as brushwood, twigs, or stones; and fishermen place heaps of twigs here and there on purpose, and on to such heaps the female deposits a long continuous roe in shape like a curl of hair. It lays or spirts out the spawn with an effort, as though there were difficulty in the process.

[18] Reading τοῦ ᾠοῦ for τούτου.

The female calamary spawns at sea; and it emits the spawn, as does the cuttlefish, in the mass.

The calamary and the cuttlefish are short-lived, as, with few exceptions, they never see the year out; and the same statement is applicable to the octopus.

From one single egg comes one single cuttlefish; and this is likewise true of the young calamary.

The male calamary differs from the female; for if its gill-region be dilated and examined there are found two red formations resembling breasts, with which the male is unprovided. In the cuttlefish, apart from this distinction in the sexes, the male, as has been stated, is more mottled than the female.[19]

19 · With regard to insects, that the male is less than the female and that he mounts upon her back, and how he performs the act of copulation and the circumstance that he gives over reluctantly, all this has already been set forth; in most cases of insect copulation this process is speedily followed up by parturition.

All insects that copulate engender grubs, with the exception of a species of butterfly; and the female of this species lays a hard egg, resembling the seed of the safflower, with a juice inside it. But from the grub, the young animal does not grow out of a mere portion of it, as a young animal grows from a portion only of an egg, but the grub entire grows and the animal becomes differentiated out of it.

And of insects some are derived from congeners, as the venom-spider and the common-spider from the venom-spider and the common-spider, and so with the locust, the grasshopper, and the cicada. Other insects are not derived from living parentage, but are generated spontaneously: some out of dew falling on leaves, by nature in spring-time, but not seldom in winter too when there has been a stretch of fair weather and southerly winds; others grow in decaying mud or dung; others in timber, green or dry; some in the hair of animals; some in the flesh of animals; some in excrements: and some from excrement after it has been voided, and some from excrement yet within the living animal, like the intestinal worms. And of these worms there are three species: one named the flat-worm, another the round worm, and the third the ascarid. These intestinal worms do not in any case propagate their kind. The flat-worm, however, in an exceptional way, clings fast to the gut, and lays a thing like a melon-seed, by observing which indication the physician concludes that his patient is troubled with the worm.

The butterfly is generated from caterpillars which grow on green leaves, chiefly leaves of the raphanus, which some call cabbage. At first it is less than a grain of millet; it then grows into a small grub; and in three days it is a tiny caterpillar. After this it grows on and on, and becomes quiescent and changes its shape, and is now called a chrysalis. The outer shell is hard, and the chrysalis moves if you touch it. It attaches itself by cobweb-like filaments, and is unfurnished with mouth or any other apparent organ. After a little while the outer covering bursts

[19]Dittmeyer excises this paragraph.

asunder, and out flies the winged creature that we call the butterfly. At first, when it is a caterpillar, it feeds and ejects excrement; but when it turns into the chrysalis it neither feeds nor ejects excrement.

The same remarks are applicable to all such insects as are developed out of the grub, both such grubs as are derived from the copulation of living animals and such as are generated without copulation. For the grub of the bee, the hornet, and the wasp, whilst it is young, takes food and is seen to produce excrement; but when it has passed from the grub shape to its defined form and become what is termed a pupa, it ceases to take food and to void excrement, and remains tightly wrapped up and motionless until it has reached its full size, when it breaks the formation with which the cell is closed, and issues forth. The insects named the hypera and the penia are derived from similar caterpillars, which move in an undulatory way, progressing with one part and then pulling up the hinder parts by a bend of the body. The developed insect in each case takes its peculiar colour from the caterpillar.

From one particular large grub, which has as it were horns, and in other respects differs from grubs in general, there comes, by a metamorphosis of the grub, first a caterpillar, then the cocoon, then the *necydalus;* and the creature passes through all these transformations within six months. A class of women unwind and reel off the cocoons of these creatures,[20] and afterwards weave a fabric; a Coan woman of the name of Pamphila, daughter of Plateus, being credited with the first invention of the fabric. After the same fashion the stag-beetle comes from grubs that live in dry wood: at first the grub is motionless, but after a while the shell bursts and the stag-beetle issues forth.

From grubs on the beet comes the leekbane;[21] this creature is also winged. From the flat animalcule that skims over the surface of rivers comes the gadfly; and this accounts for the fact that gadflies most abound in the neighbourhood of waters on whose surface these animalcules are observed. From a certain small, black and hairy caterpillar comes first a wingless glow-worm; and this creature again suffers a metamorphosis, and transforms into a winged insect named the 'curl.'

Gnats grow from ascarids; and ascarids are engendered in the slime of wells, or in places where water containing an earthy deposit collects. This slime decays, and first turns white, then black, and finally blood-red; and at this stage there originate in it, as it were, little tiny bits of red weed, which at first wriggle about all clinging together, and finally break loose and swim in the water, and are hereupon known as ascarids. After a few days they stand straight up on the water motionless and hard, and by and by the husk breaks off and the gnats are seen sitting upon it, until the sun's heat or a puff of wind sets them in motion, when they fly away.

With all grubs and all animals that break out from the grub state, movement is due primarily to the heat of the sun or to wind.

Ascarids are more likely to be found, and grow with unusual rapidity, in places where there is a deposit of a mixed and heterogeneous kind, as in kitchens and in ploughed fields; for the contents of such places are disposed to rapid putrefaction.

[20]Omitting ἅ.
[21]The text is uncertain.

In autumn, also, owing to the drying up of moisture, they grow in unusual numbers.

The tick is generated from couch-grass. The cockchafer comes from a grub that is generated in the dung of the cow or the ass. The dung-beetle rolls a piece of dung into a ball, lies hidden within it during the winter, and gives birth therein to small grubs, from which grubs come new dung-beetles. Certain winged insects also come from the grubs that are found in pulse, in the same fashion as in the cases described.

Flies grow from grubs in the dung that farmers have gathered up into heaps; for those who are engaged in this work assiduously gather the remainder which has been mixed together, and this they term 'working-up' the manure. The grub is exceedingly minute to begin with; first—even at this stage—it assumes a reddish colour, and then from a quiescent state it takes on the power of motion, as though born to it; it then becomes a small motionless grub; it then moves again, and again relapses into immobility; it then comes out a perfect fly, and moves away under the influence of the sun's heat or of a puff of air. The horse-fly is engendered in timber. The budbane comes from a transformed grub; and this grub is engendered in cabbage-stalks. The cantharis comes from the caterpillars that are found on fig-trees or pear-trees or fir-trees—for on all these grubs are engendered—and also from caterpillars found on the dog-rose; and the cantharis takes eagerly to ill-scented substances, from the fact of its having been engendered in ill-scented woods. The conops comes from a grub that is engendered in the slime of vinegar.

And living animals are produced in substances that are usually supposed to be incapable of putrefaction; for instance, grubs are found in long-lying snow; and snow of this description gets reddish in colour, and hence the grub that is engendered in it is red and hairy. The grubs found in the snows of Media are large and white; and all such grubs are little disposed to motion. In Cyprus, in places where copper-ore is smelted, with heaps of the ore piled on day after day, an animal is engendered in the fire, somewhat larger than a large fly, furnished with wings, which can hop or crawl through the fire. And the grubs and these latter animals perish when you keep the one away from the fire and the other from the snow. Now the salamander is a clear case in point, to show us that animals do actually exist that fire cannot destroy; for this creature, so the story goes, not only walks through the fire but puts it out in doing so.

On the river Hypanis in the Cimmerian Bosphorus, about the time of the summer solstice, there are brought down towards the sea by the stream what look like little sacks rather bigger than grapes, out of which at their bursting issues a winged quadruped. The insect lives and flies about until the evening, but as the sun goes down it pines away, and dies at sunset having lived just one day, from which circumstance it is called the ephemeron.

As a rule, insects that come from caterpillars and grubs are held at first by cobwebs.[22]

Such is the mode of generation of the insects above enumerated.

[22] The three paragraphs from 552^{b}5 are excised by Dittmeyer.

20 · The wasps called ichneumons, less in size than the ordinary wasp, kill spiders and carry off the dead bodies to a wall or some such place with a hole in it; this hole they smear over with mud and lay their grubs inside it, and from the grubs come the hunter-wasps. Some of the coleoptera and of the small and nameless insects make small holes of mud on a wall or on a grave-stone, and there deposit their grubs.

With insects, as a general rule, the time of generation from its commencement to its completion comprises three or four weeks. With grubs and grub-like creatures the time is usually three weeks, and in the oviparous insects as a rule four. But, in the case of oviparous insects, the egg-formation comes at the close of seven days from copulation, and during the remaining three weeks the parent broods over and hatches its young; i.e. where this is the result of copulation, as in the case of the spider and its congeners. As a rule, the transformations take place in intervals of three or four days, corresponding to the lengths of interval at which the crises recur in fevers.

So much for the generation of insects. Their death is due to the shrivelling of their organs, just as the larger animals die of old age. Winged insects die in autumn from the shrinking of their wings. The horse-fly dies from dropsy in the eyes.[23]

21 · With regard to the generation of bees different hypotheses are in vogue. Some affirm that bees neither copulate nor give birth to young, but that they fetch their young. And some say that they fetch their young from the flower of the callyntrum; others assert that they bring them from the flower of the reed, others, from the flower of the olive. And it is stated as a proof that, when the olive harvest is most abundant, the swarms are most numerous. Others declare that they fetch the brood of the drones from one of the stuffs above mentioned, but that the working bees are engendered by the rulers of the hive.

Now of these rulers there are two kinds: the better kind is red in colour, the other is black and variegated; the ruler is double the size of the working bee. These rulers have the part below the waist half as large again, and they are called by some the 'mothers', from an idea that they generate the bees; and, as a proof they declare that the brood of the drones appears even when there is no ruler-bee in the hive, but that the bees do not appear in their absence. Others, again, assert that these insects copulate, and that the drones are male and the bees female.

The ordinary bee is generated in the cells of the comb, but the ruler-bees in cells down below attached to the comb, suspended from it, apart from the rest, six or seven in number, and growing in a way quite different from the mode of growth of the ordinary brood.

Bees are provided with a sting, but the drones are not so provided. The rulers are provided with stings, but they never use them; and this latter circumstance will account for the belief of some people that they have no stings at all.

[23]Dittmeyer excises the last two paragraphs of this chapter.

22 · Of bees there are various species. The best kind is a little round mottled insect; another is long, and resembles the hornet; a third is black and flat-bellied, and is nicknamed the 'robber'; a fourth kind is the drone, the largest of all, but stingless and inactive. And that is why some bee-masters place a net-work in front of the hives to keep the big drones out while it lets the bees go in.

Of the rulers there are, as has been stated, two kinds. In every hive there are more rulers than one; and a hive goes to ruin if there be too few rulers, not because of anarchy thereby ensuing, but, as we are told, because these creatures contribute in some way to the generation of the bees. A hive will go also to ruin if there be too large a number of rulers in it; for they divide into factions.

Whenever the spring-time is late coming, and when there is drought and mildew, then the progeny of the hive is small in number. But when the weather is dry they attend to the honey, and in rainy weather their attention is concentrated on the brood; and this will account for the coincidence of rich olive-harvests and abundant swarms.

The bees first work at the honeycomb, and then put the pupae in it: by the mouth, say those who hold the theory of their bringing them from elsewhere.[24] After putting in the pupae they put in the honey for subsistence, and this they do in the summer and autumn; and the autumn honey is the better of the two.

The honeycomb is made from flowers, and the materials for the wax they gather from the resinous gum of trees, while honey is what falls from the air, and is deposited chiefly at the risings of the constellations or when a rainbow is in the sky; and as a general rule there is no honey before the rising of the Pleiads. [The bee, then, makes the wax from flowers. The honey, however, it does not make, but merely gathers what is deposited out of the atmosphere; and as a proof of this statement we have the known fact that bee-keepers find the hives filled with honey within the space of one or two days. Furthermore, in autumn flowers are found, but honey, if it be withdrawn, is not replaced; now, after the withdrawal of the original honey, when no food or very little is in the hives, there would be a fresh stock of honey, if the bees made it from flowers.][25] Honey, if allowed to mature, gathers consistency; for at first it is like water and remains liquid for several days. If it be drawn off during these days it has no consistency; but it attains consistency in about twenty days. The taste of thyme-honey is discernible at once, from its peculiar sweetness and consistency.

The bee gathers from every flower that is furnished with a calyx, and from all other flowers that are sweet-tasted, without doing injury to any fruit; and the juices of the flowers it takes up with the organ that resembles a tongue and carries off to the hive.

Honey is taken from the hives on the appearance of the wild fig. They produce the best larvae at the time the honey is making. The bee carries wax and bees' bread round its legs, but vomits the honey into the cell. After depositing its young, it broods over it like a bird. The grub when it is small lies slantwise in the comb, but by

[24]Dittmeyer marks a lacuna at this point.
[25]Excised by Dittmeyer.

and by rises up straight by an effort of its own and takes food, and holds on so tightly to the honeycomb as actually to be squeezed against it.

The young of bees and of drones is white, and from the young come the grubs; and the grubs grow into bees and drones. The egg of the ruler is reddish in colour, and its substance is about as consistent as thick honey; and from the first it is about as big as the bee that is produced from it. From the young of the ruler there is no intermediate stage, it is said, of the grub, but the bee comes at once.

Whenever the bee lays an egg in the comb there is always a drop of honey set against it. The larva of the bee gets feet and wings as soon as the cell has been stopped up with wax, and when it arrives at its completed form it breaks its membrane and flies away. It ejects excrement in the grub state, but not afterwards; that is, not until it has got out of the encasing membrane, as we have already described. If you remove the heads from off the larvae before the coming of the wings, the bees will eat them up; and if you nip off the wings from a drone and let it go, the bees will bite off the wings from all the remaining drones.

The bee lives for six years as a rule, as an exception for seven years. If a swarm lasts for nine years, or ten, it is considered to have done well.

In Pontus are found bees exceedingly white in colour, and these bees produce their honey twice a month. (The bees in Themiscyra, on the banks of the river Thermodon, build honeycombs in the ground and in hives, and these honeycombs are furnished with very little wax but with honey of great consistency; and the honeycomb is smooth and level.) But this is not always the case with these bees, but only in the winter season; for in Pontus the ivy is abundant, and it flowers at this time of the year, and it is from the ivy-flower that they derive their honey. A white and very consistent honey is brought down to Amisus, which is deposited by bees on trees without the employment of honeycombs; and this kind of honey is produced in other districts in Pontus.

There are bees also that construct triple honeycombs in the ground; and these honeycombs supply honey but never contain grubs. But the honeycombs in these places are not all of this sort, nor do all the bees construct them.

23 · Anthrenae and wasps construct combs for their young. When they have no ruler, but are wandering about in search of one, the anthrene constructs its comb on some high place, and the wasp inside a hole. When the anthrene and the wasp have a ruler, they construct their combs underground. Their combs are in all cases hexagonal like the comb of the bee. They are composed, however, not of wax, but of a bark-like webbed fibre, and the comb of the anthrene is much neater than the comb of the wasp. Like the bee, they put their young just like a drop of liquid on to the side of the cell, and the egg clings to the wall of the cell. But eggs are not deposited in all the cells simultaneously; on the contrary, in some cells are creatures big enough to fly, in others are nymphae, and in others are mere grubs. As in the case of bees, excrement is observed only in the cells where the grubs are found. As long as the creatures are in the nymph condition they are motionless, and the cell is cemented over. In the comb of the anthrene there is found in the cell of the young a

drop of honey in front of it. The larvae of the anthrene and the wasp make their appearance not in the spring but in the autumn; and their growth is especially discernible in times of full moon. And the eggs and the grubs never rest at the bottom of the cells, but always cling on to the side wall.

24 · There is a kind of humble-bee that builds a pointed nest of clay against a stone or in some similar situation, besmearing the clay with something like spittle. And this is exceedingly thick and hard; in point of fact, one can hardly break it open with a spike. Here the insects lay their eggs, and white grubs are produced wrapped in a black membrane. Apart from the membrane there is found some wax in the honeycomb; and this wax is much yellower than that of the bee.

25 · Ants copulate and engender grubs; and these grubs do not attach themselves to anything, but grow on and on from small and rounded shapes until they become elongated and defined in shape: and they are engendered in springtime.

26 · The land-scorpion also lays a number of egg-shaped grubs, and broods over them. When the hatching is completed, the parent animal, as happens with the parent spider, is ejected and put to death by the young ones; for very often the young ones are about eleven in number.

27 · Spiders in all cases copulate in the way above mentioned, and generate at first small grubs. And these grubs metamorphose in their entirety, and not partially, into spiders; for the grubs are round-shaped at the outset. And the spider, when it lays its eggs, broods over them, and in three days they take definite shape.

All spiders lay their eggs in a web; but some spiders lay in a small and fine web, and others in a thick one; and some, as a rule, lay in a round-shaped case, and some are only partially enveloped in the web. The young grubs are not all developed at one and the same time into young spiders; but the moment the development takes place, the young spider makes a leap and begins to spin his web. The juice of the grub, if you squeeze it, is the same as the juice found in the spider when young; that is to say, it is thick and white.

The meadow spider lays its eggs at first into a web, one half of which is attached to itself and the other half is free; and on this the parent broods until the eggs are hatched. The phalangia lay their eggs in a sort of strong basket which they have woven, and brood over it until the eggs are hatched. The smooth spider is much less prolific than the phalangium. These phalangia, when they grow to full size, very often surround the mother and eject and kill her; and not seldom they kill the male as well, if they catch him; for he has the habit of co-operating with the mother in the hatching. The brood of a single phalangium is sometimes three hundred in number. The spider attains its full growth in about four weeks.

28 · Grasshoppers copulate in the same way as other insects; that is to say, with the lesser covering the larger, for the male is smaller than the female. The females first insert the hollow tube, which they have at their tails, in the ground, and then lay their eggs (the male is not furnished with this tube). The females lay their eggs all in a lump together, and in one spot, so that the entire lump of eggs resembles a honeycomb. After they have laid their eggs, the eggs assume the shape of oval grubs and are enveloped by a sort of thin clay, like a membrane; in this membrane-like formation they grow on to maturity. The larva is so soft that it collapses at a touch. The larva is not placed on the surface of the ground, but a little beneath the surface; and, when it reaches maturity, it comes out of its clayey investiture in the shape of a little black grasshopper; by and by, the skin integument strips off, and at once it grows larger and larger.

556a1 The grasshopper lays its eggs at the close of summer, and dies after laying them. The fact is that, at the time of laying the eggs, grubs are engendered in the region of the mother grasshopper's neck; and the male grasshoppers die about the same time. [In spring-time they come out of the ground; and no grasshoppers are found in mountainous land or in poor land, but only in flat and loamy land, for the fact is they lay their eggs in cracks of the soil.][26] During the winter their eggs remain in the ground; and with the coming of summer the last year's larva develops into the grasshopper.

29 · The locusts lay their eggs and die in like manner after laying them. Their eggs are subject to destruction by the autumn rains, when the rains are unusually heavy; but in seasons of drought the locusts are exceedingly numerous, from the absence of any destructive cause, since their destruction seems then to be a matter of accident and to depend on luck.

30 · Of the cicada there are two kinds; one, small in size, the first to come and the last to disappear; the other, large, that comes last and first disappears. Both in the small and the large species some are divided at the waist, to wit, the singing ones, and some are undivided; and these latter have no song. The large and singing cicada is by some designated the 'chirper', and the small cicada the cicadelle. And such of the latter as are divided at the waist can sing just a little.

The cicada is not found where there are no trees; and this accounts for the fact that in the district surrounding the city of Cyrene it is not found at all in the plain country, but is found in great numbers in the neighbourhood of the city, and especially where olive-trees are growing; for an olive grove is not thickly shaded. For the cicada is not found in cold places, and consequently is not found in any grove that keeps out the sunlight.

The large and the small cicada copulate alike, belly to belly. The male discharges sperm into the female, not the female into the male as is the case with

[26]Dittmeyer excises.

insects in general; and the female cicada has a cleft generative organ into which the male discharges the sperm.[27]

They lay their eggs in fallow lands, boring a hole with the pointed organ they carry in the rear, as do the locusts likewise; for the locust lays its eggs in untilled lands, and this fact accounts for their numbers in the territory adjacent to the city of Cyrene. The cicadae also lay their eggs in the canes which prop up vines, perforating the canes; and also in the stalks of the squill. This brood runs into the ground. And they are most numerous in rainy weather. The grub, on attaining full size in the ground, becomes a nymph, and the creature is sweetest to the taste at this stage before the husk is broken. When the summer solstice comes, the creature issues from the husk at night-time, and in a moment, as the husk breaks, the larva becomes the perfect cicada. The creature, also, at once turns black in colour and harder and larger, and takes to singing. In both species, the larger and the smaller, it is the male that sings, and the female that is unvocal. At first, the males are the sweeter eating; but, after copulation, the females, as they are full then of white eggs.

If you make a sudden noise as they are flying overhead they let drop something like water. Farmers, in regard to this, say that they are voiding urine, i.e. that they have an excrement, and that they feed upon dew.

If you present your finger to a cicada and bend back the tip of it and then extend it again, it will endure the presentation more quietly than if you were to keep your finger outstretched altogether; and it will set to climbing your finger; for the creature is so weak-sighted that it will take to climbing your finger as though that were a moving leaf.

31 · Of insects that are not carnivorous but that live on the juices of living flesh, such as lice and fleas and bugs, all generate what are called 'nits', and these nits generate nothing.

Of these insects the flea is generated out of the slightest amount of putrefying matter; for wherever there is any dry excrement, a flea is sure to be found. Bugs are generated from the moisture of living animals, as it dries up outside their bodies. Lice are generated out of the flesh of animals.

When lice are coming there is a kind of small eruption visible, unaccompanied by any discharge of purulent matter; and if you prick these the lice jump out. In some men the appearance of lice is a disease, in cases where the body is surcharged with moisture; and, indeed, men have been known to succumb to this louse-disease, as Alcman the poet and the Syrian Pherecydes are said to have done. Moreover, in certain diseases lice appear in great abundance.

There is also a species of louse called the 'wild louse', and this is harder than the ordinary louse, and there is exceptional difficulty in getting the skin rid of it. Boys' heads are apt to be lousy, but men's in less degree; and women are more subject to lice than men. But, whenever people are troubled with lousy heads, they

[27]Reading *ἐναφίησι δ' ὁ ἄρρην εἰς τὴν θήλειαν, οὐχ ἡ θήλεια εἰς τὸν ἄρρενα, ὥσπερ τἆλλα ἔντομα · ἔχει δ' ἡ θήλεια αἰδοῖον εἰς ὃ ἀφίησιν ὁ ἄρρην.*

are less than ordinarily troubled with headache. And lice are generated in other animals than man. For birds are infested with them; and pheasants, unless they clean themselves in the dust, are actually destroyed by them. All other winged animals that are furnished with feathers are similarly infested, and all hair-coated creatures also, with the single exception of the ass, which is infested neither with lice nor with ticks.

Cattle suffer both from lice and from ticks. Sheep and goats breed ticks, but do not breed lice. Pigs breed lice large and hard. In dogs are found the *Cynoroestes*. In all animals that are subject to lice, the latter originate from the animals themselves. Moreover, in those bathing animals that have lice, lice are more than usually abundant when they change the water in which they bathe.

In the sea, lice are found on fishes, but they are generated not out of the fish but out of slime; and they resemble multipedal wood-lice, only that their tail is flat. There is only one kind of sea-louse; they are found everywhere, and are particularly numerous on the fins. And all these insects[28] are multipedal and devoid of blood.

The parasite that feeds on the tunny is found in the region of the fins; it resembles a scorpion, and is about the size of a spider. In the seas between Cyrene and Egypt there is a fish that attends on the dolphin, which is called the louse. This fish gets exceedingly fat from enjoying an abundance of food while the dolphin is out in pursuit of its prey.

557b1 32 · Other animalcules besides these are generated, as we have already remarked, some in wool or in articles made of wool, as the clothes-moth. And these animalcules come in greater numbers if the woollen substances are dusty; and they come in especially large numbers if a spider be shut up with them; for the creature drinks up any moisture that may be there, and dries up the woollen substance. This grub is found also in men's clothes.

A creature is also found in cheese[29] long laid by, just as in wood, and it is the smallest of animalcules and is white in colour, and is designated the mite. In books also other animalcules are found, some resembling the grubs found in garments, and some resembling tailless scorpions, but very small. As a general rule we may state that such animalcules are found in practically anything, both in dry things that are becoming moist and in moist things that are drying, provided they contain the conditions of life.

There is a grub entitled the 'faggot-bearer', as strange a creature as is known. Its head projects outside its shell, mottled in colour, and its feet are near the end, as is the case with grubs in general; but the rest of its body is cased in a tunic as it were of spider's web, and there are little dry twigs about it, that look as though they had stuck by accident to the creature as it went walking about. But these twig-like formations are naturally connected with the tunic, for just as the shell is with the body of the snail so is the whole superstructure with our grub; and they do not drop off, but can only be torn off, as though they were all of a piece with him, and the

[28]Reading τὰ ἔντομα.
[29]Reading ἐν πικερίῳ.

removal of the tunic is as fatal to this grub as the removal of the shell would be to the snail. In course of time this grub becomes a chrysalis, as is the case with the caterpillar, and lives in a motionless condition. But as yet it is not known into what winged condition it is transformed.

The fruit of the wild fig contains the fig-wasp. This creature is a grub at first; but in due time the husk peels off and the wasp leaves the husk behind it and flies away, and enters into the fruit of the fig-tree through its orifice,[30] and causes the fruit not to drop off; and with a view to this phenomenon, farmers are in the habit of tying wild figs on to fig-trees, and of planting wild fig-trees near domesticated ones.

33 · In the case of animals that are quadrupeds and red-blooded and oviparous, generation takes place in the spring, but copulation does not take place in an uniform season. In some cases it takes place in the spring, in others in summer time, and in others in the autumn, according as the subsequent season may be favourable for the young.

The tortoise lays eggs with a hard shell and of two colours, like birds' eggs, and after laying them buries them in the ground and treads the ground hard over them; having done that, it comes back from time to time and broods over the eggs on the surface of the ground, and hatches the eggs the next year. The freshwater tortoise leaves the water and lays its eggs. It digs a hole of a cask-like shape, and deposits therein the eggs; after rather less than thirty days it digs the eggs up again and hatches them with great rapidity, and leads its young at once off to the water. The sea-turtle lays on the ground eggs just like the eggs of domesticated birds, buries the eggs in the ground, and broods over them in the night-time. It lays a very great number of eggs, amounting at times to one hundred.

Lizards and crocodiles, terrestrial and fluvial, lay eggs on land. The eggs of lizards hatch spontaneously on land, for the lizard does not live on into the next year; in fact, the life of the animal is said not to exceed six months. The river-crocodile lays a number of eggs, sixty at the most, white in colour, and broods over them for sixty days; for the creature is very long-lived. And the disproportion is more marked in this animal than in any other between the smallness of the original egg and the huge size of the full-grown animal. For the egg is not larger than that of the goose, and the young crocodile is small, answering to the egg in size, but the full-grown animal attains the length of twenty-six feet; and some say that the animal goes on growing to the end of its days.

34 · With regard to serpents, the viper is externally viviparous, having been previously oviparous internally. The egg, as with the egg of fishes, is uniform in colour and soft-skinned. The young serpent grows on the surface of the egg, and, like the young of fishes, has no shell-like envelopment. The young of the viper is born inside a membrane that bursts from off the young creature in three days; and

[30] Reading διὰ στομάτων, καί . . .

at times the young viper eats its way out from the inside of the egg. The mother viper brings forth all its young all at once in one day, more than twenty in number. 558b1 The other serpents are externally oviparous, and their eggs are strung on to one another like a woman's necklace; after the mother has laid her eggs in the ground she broods over them, and hatches the eggs in the following year.

BOOK VI

1 · So much for the generative processes in snakes and insects, and also in oviparous quadrupeds.

Birds without exception lay eggs, but the pairing season and the times of parturition are not alike for all. Some birds couple and lay at almost any time in the year, as for instance the fowl and the pigeon: the former of these coupling and laying during the entire year, with the exception of the month before and the month after the winter solstice. Some hens, even in the high breeds, lay a large quantity of eggs before brooding, amounting to as many as sixty; and the higher breeds are less prolific than the inferior ones. The Adrianic hens are small-sized, but they lay every day; they are cross-tempered, and often kill their chickens; they are of all colours. Some domesticated hens lay twice a day; indeed, instances have been known where hens, after exhibiting extreme fecundity, have died suddenly. Hens, then, lay eggs, as has been stated, continuously; the pigeon, the ring-dove, the turtle-dove, and the stock-dove lay twice a year, and the pigeon actually lays ten times a year. The great majority of birds lay during the spring-time. Some birds are prolific, and prolific in either of two ways—either by laying often, as the pigeon, or by laying many eggs at a sitting, as the hen. All birds with crooked talons are unprolific, except the kestrel: this bird is the most prolific of birds of prey; as many as four eggs have been observed in the nest, and occasionally it lays even more.

Birds in general lay their eggs in nests, but such as are disqualified for flight, as 559a1 the partridge and the quail, do not lay them in nests but on the ground, and cover them over with loose material. The same is the case with the lark and the tetrix. These birds nest in sheltered places; but the bird called eirops in Boeotia, alone of all birds, burrows into holes in the ground and hatches there.

Thrushes, like swallows, build nests of clay, on high trees, and build them in rows all close together, so that from their continuity the structure resembles a necklace of nests. Of all birds that hatch for themselves the hoopoe is the only one that builds no nest whatever; it gets into the hollow of the trunk of a tree, and lays its eggs there without making any sort of nest. The martin builds either under a dwelling-roof or on cliffs. The tetrix, called ourax in Athens, builds neither on the ground nor on trees, but on low-lying shrubs.

2 · The egg in the case of all birds alike is hard–shelled, if it be the produce of copulation and has not been damaged—for some hens lay soft eggs. The egg is of two colours, and the white part is outside and the yellow part within.

The eggs of birds that frequent rivers and marshes differ from those of birds that live on dry land; that is to say, the eggs of water-birds have comparatively more of the yellow and less of the white. Eggs vary in colour according to their kind. Some eggs are white, as those of the pigeon and of the partridge; others are yellowish, as the eggs of marsh birds; in some cases the eggs are mottled, as the eggs of the guinea-fowl and the pheasant; while the eggs of the kestrel are red, like vermilion.

Eggs are not symmetrically shaped at both ends: in other words, one end is sharp, and the other end is comparatively blunt; and it is the latter end that protrudes first at the time of laying. Long and pointed eggs are female; those that are round, or more rounded at the narrow end, are male. Eggs are hatched by the incubation of the mother-bird. In some cases, as in Egypt, they are hatched spontaneously in the ground, by being buried in dung heaps. A story is told of a toper in Syracuse, how he used to put eggs into the ground under his rush-mat and to keep on drinking until he hatched them. Instances have occurred of eggs being deposited in warm vessels and getting hatched spontaneously.

The sperm of all birds, as of animals in general, is white. After the female has submitted to the male, she draws up the sperm to underneath her midriff. At first it is little in size and white in colour; by and by it is red, the colour of blood; as it grows, it becomes pale and yellow all over. When at length it is getting ripe for hatching, it is subject to differentiation, and the yolk gathers together within and the white settles round it on the outside. When the full time is come, the egg detaches itself and protrudes, changing from soft to hard with such temporal exactitude that, whereas it is not hard during the process of protrusion, it hardens immediately after the process is completed—unless it comes out diseased. Cases have occurred where substances resembling the egg at a critical point of its growth—that is, when it is yellow all over, as the yolk is subsequently—have been found in the cock when cut open, underneath his midriff, just where the hen has her eggs; and these are entirely yellow in appearance and of the same size as ordinary eggs. Such phenomena are regarded as monstrosities.

Those who affirm that wind-eggs are the residua of eggs previously begotten from copulation are mistaken in this assertion; for we have cases well authenticated where chickens of the common hen and goose have laid wind-eggs without ever having been subjected to copulation. Wind-eggs are smaller, less palatable, and more liquid than true eggs, and are produced in greater numbers. When they are put under the mother bird, the liquid contents never coagulate, but both the yellow and the white remain as they were. Wind-eggs are laid by a number of birds: as for instance by the common hen, the partridge, the pigeon, the peahen, the goose, and the vulpanser. Eggs are hatched under brooding hens more rapidly in summer than in winter; that is to say, hens hatch in eighteen days in summer, but occasionally in winter take as many as twenty-five. And for brooding purposes some birds make better mothers than others. If it thunders while a hen-bird is brooding, the eggs get addled. Wind-eggs that are called by some *cynosura* and *uria* are produced chiefly in summer. Wind-eggs are called by some zephyr-eggs, because at spring-time hen-birds are observed to inhale the breezes; they do the same if they be stroked in a certain way by hand. Wind-eggs can turn into fertile eggs, and eggs due to previous copulation can change kind, if before the change of the yellow to the white the hen that contains wind-eggs or eggs begotten of copulation be trodden by another cock-bird. Under these circumstances the wind-eggs turn into fertile eggs, and the previously impregnated eggs follow the breed of the impregnator; but if the latter impregnation takes place during the change of the yellow to the white, then no change in the egg takes place: the wind-egg does not become a true egg, and the true egg does not take on the breed of the latter impregnator. If when the egg-substance is small copulation be intermitted, the previously existing egg-substance exhibits no increase; but if the hen be again submitted to the male the increase in size proceeds with rapidity.

The yolk and the white are opposite not only in colour but also in properties. Thus, the yolk congeals under the influence of cold, whereas the white instead of congealing is inclined rather to liquefy. Again, the white stiffens under the influence of fire, whereas the yolk does not stiffen; but, unless it be burnt through, it remains soft, and in point of fact is inclined to set or to harden more from the boiling than from the roasting of the egg. The yolk and the white are separated by a membrane from one another. The 'hail-stones' that are found at the extremity of the yellow in no way contribute towards generation, as some suppose: they are two in number, one below and the other above. If you take out of the shells a number of
560b1 yolks and a number of whites and pour them into a saucepan and boil them slowly over a low fire, the yolks will gather into the centre and the whites will set all round them.

Young hens lay first at the beginning of spring and lay more eggs than the older hens; but the eggs of the younger hens are comparatively small. As a general rule, if hens get no brooding they pine and sicken. After copulation hens shiver and shake themselves, and often kick rubbish about all round them—and this they do sometimes after laying—whereas pigeons trail their rumps on the ground, and geese dive under the water. Conception of the true egg and conformation of the wind-egg take place rapidly with most birds; as for instance with the hen-partridge when in heat. The fact is that, when she stands to windward and within scent of the male, she conceives, and becomes useless for decoy purposes; for the partridge appears to have a very acute sense of smell.

The generation of the egg after copulation and the generation of the chick from the subsequent concoction of the egg are not brought about within equal periods for all birds, but differ according to the size of the parent-birds. The egg of the common hen after copulation sets and matures in ten days as a general rule; the egg of the pigeon in a somewhat lesser period. Pigeons have the faculty of holding back the egg at the very moment of parturition; if a hen pigeon is put about by anyone, for instance if it be disturbed on its nest, or have a feather plucked out, or sustain any other annoyance or disturbance, then even though she was on the point of laying, she can keep the egg back in abeyance.

A singular phenomenon is observed in pigeons with regard to pairing: that is, they kiss one another just when the male is on the point of mounting the female, and without this preliminary the male would decline to perform his function.[1] With the

[1]Reading ἢ οὐκ ἂν ὀχεύσειεν.

older males the preliminary kiss is only given to begin with, and subsequently he mounts without previously kissing; with younger males the preliminary is never omitted. Another singularity in these birds is that the hens tread one another when a cock is not forthcoming, after kissing just as the males do. Though they do not impregnate one another they lay more eggs under these than under ordinary circumstances; no chicks, however, result therefrom, but all such eggs are wind-eggs. 561a1

3 · Generation from the egg proceeds in an identical manner with all birds, but the full periods from conception to birth differ, as has been said. With the common hen after three days and three nights there is the first indication of the embryo; with larger birds the interval being longer, with smaller birds shorter. Meanwhile the yolk comes into being, rising towards the sharp end, where the primal element of the egg is situated, and where the egg gets hatched; and the heart appears, like a speck of blood, in the white of the egg. This point beats and moves as though endowed with life, and from it, as it grows, two vein-ducts with blood in them trend in a convoluted course towards each of the two circumjacent integuments; and a membrane carrying bloody fibres now envelops the white, leading off from the vein-ducts. A little afterwards the body is differentiated, at first very small and white. The head is clearly distinguished, and in it the eyes, swollen out to a great extent. This condition lasts on for a good while, as it is only by degrees that they diminish in size and contract. At the outset the under portion of the body appears insignificant in comparison with the upper portion. Of the two ducts that lead from the heart, the one proceeds towards the circumjacent integument, and the other, like a navel-string, towards the yolk. The origin of the chick is in the white of the egg, and the nutriment comes through the navel-string out of the yolk.

When the egg is now ten days old the chick and all its parts are distinctly visible. The head is still larger than the rest of its body, and the eyes larger than the head, but still devoid of vision. At this time the eyes become projecting, larger than beans, and black; if the cuticle be peeled off them there is a white and cold liquid inside, quite glittering in the sunlight, but there is no hard substance whatsoever. Such is the condition of the head and eyes. At this time also the internal organs are 561b1 visible, as also the stomach and the arrangement of the viscera; and the veins that seem to proceed from the heart are now close to the navel. From the navel there stretch a pair of veins; one towards the membrane that envelops the yolk (and the yolk is now liquid, or more bulky than is normal), and the other towards that membrane which envelops collectively the membrane wherein the chick lies, the membrane of the yolk, and the intervening liquid. [For, as the chick grows, little by little one part of the yolk goes upward, and another part downward, and the white liquid is between them; and the white of the egg is underneath the lower part of the yolk, as it was at the outset. On the tenth day the white is at the extreme outer surface, reduced in amount, glutinous, firm in substance, and sallow in colour.][2]

The disposition of the several constituent parts is as follows. First and outermost, next to the shell, comes the membrane of the egg, not that of the shell,

[2]Dittmeyer excises.

but underneath it. Inside this membrane is a white liquid; then comes the chick, and a membrane round about it, separating it off so as to keep the chick free from the liquid; next after the chick comes the yolk [into which one of the two veins was described as leading, the other one leading into the enveloping white substance. A membrane with a liquid resembling serum envelops the entire structure. Then comes another membrane right round the embryo, as has been described, separating it from the liquid. Underneath this comes the yolk, enveloped in another membrane (into which yolk proceeds the navel-string that leads from the heart and the big vein), so as to keep the embryo free of both liquids.][3]

About the twentieth day, if you open the egg and touch the chick, it moves inside and chirps; and it is already coming to be covered with down, when, after the twentieth day is past, the chick begins to break the shell. The head is situated over the right leg close to the flank, and the wing is placed over the head; and about this time is plain to be seen the membrane resembling an after-birth that comes next after the outermost membrane of the shell, into which membrane the one of the navel-strings was described as leading (and the chick in its entirety is now within it), and so also is the other membrane resembling an after-birth, namely that surrounding the yolk, into which the second navel-string was described as leading; and both of them were described as being connected with the heart and the big vein. At this time the navel-string that leads to the outer after-birth collapses and becomes detached from the chick, and the membrane that leads into the yolk is fastened on to the thin gut of the creature, and by this time a considerable amount of the yolk is inside the chick and a yellow sediment is in its stomach. About this time it discharges residuum in the direction of the outer after-birth, and has residuum inside its stomach; and the outer residuum is white and there comes a white substance inside. By and by the yolk, diminishing gradually in size, at length becomes entirely used up and comprehended within the chick (so that, ten days after hatching, if you cut open the chick, a small remnant of the yolk is still left in connexion with the gut), but it is detached from the navel, and there is nothing in the interval between, but it has been used up entirely. During the period above referred to the chick sleeps, but if it is moved it wakes, looks up and chirps; and the heart and the navel together palpitate as though the creature were respiring. So much as to generation from the egg in the case of birds.

Birds lay some eggs that are unfruitful, even eggs that are the result of copulation, and no life comes from such eggs by incubation; and this phenomenon is observed especially with pigeons.

Twin eggs have two yolks. In some twin eggs a thin partition of white intervenes to prevent the yolks mixing with each other, but some twin eggs are unprovided with such partition, and the yolks run into one another. There are some hens that lay nothing but twin eggs, and in their case the phenomenon regarding the yolks has been observed. For instance, a hen has been known to lay eighteen eggs, and hatch twins out of them all, except those that were wind-eggs; the rest were fertile (though one of the twins is always bigger than the other), but the eighteenth was monstrous.

[3]Dittmeyer excises.

4 · Birds of the pigeon kind, such as the ring-dove and the turtle-dove, lay two eggs at a time as a general rule, and they never lay more than three. The pigeon, as has been said, lays at all seasons; the ring-dove and the turtle-dove lay in the spring-time, and they never lay more than twice in the same season. The hen-bird lays the second pair of eggs when the first pair happens to have been destroyed, for many of the hen-pigeons destroy the first brood. The hen-pigeon, as has been said, occasionally lays three eggs, but it never rears more than two chicks, and sometimes rears only one; and the odd one is always a wind-egg.

Very few birds propagate within their first year. All birds, after once they have begun laying, keep on having eggs, though in the case of some birds it is difficult to detect the fact from the minute size of the creature.

The pigeon, as a rule, lays a male and a female egg, and generally lays the male egg first; after laying she allows a day's interval to ensue and then lays the second egg. The male takes its turn of sitting during the daytime; the female sits during the night. The first-laid egg is hatched and brought to birth within twenty days; and the mother bird pecks a hole in the egg the day before she hatches it out. The two parent birds brood for some time over the chicks in the way in which they brooded previously over the eggs. In all connected with the rearing of the young the female parent is more cross-tempered than the male, as is the case with most animals after parturition. The hens lay as many as ten times in the year; occasional instances have been known of their laying eleven times, and in Egypt they actually lay twelve times. The pigeon, male and female, couples within the year; in fact, it couples when only six months old. Some assert that ring-doves and turtle-doves pair and procreate when only three months old, and instance their superabundant numbers by way of proof of the assertion. The hen-pigeon carries her eggs fourteen days; for as many more days the parent birds hatch the eggs; by the end of another fourteen days the chicks are so far capable of flight as to be overtaken with difficulty. [The ring-dove, 563a1
they say, lives up to forty years. The partridge lives over sixteen. After one brood the pigeon is ready for another within thirty days.][4]

5 · The vulture builds its nest on inaccessible cliffs; for which reason its nest and young are rarely seen. And therefore Herodorus, father of Bryson the Sophist, declares that vultures come from some foreign country unknown to us, stating as a proof of the assertion that no one has ever seen a vulture's nest, and also that vultures in great numbers make a sudden appearance in the rear of armies. However, difficult as it is to get a sight of it, a vulture's nest has been seen. The vulture lays two eggs.

Carnivorous birds in general have not been observed to lay more than once a year. The swallow is the only carnivorous bird that builds a nest twice. If you prick out the eyes of swallow chicks while they are yet young, the birds will get well again and will see by and by.

6 · The eagle lays three eggs and hatches two of them, as it is said in the verses ascribed to Musaeus:

[4] Dittmeyer excises.

That lays three, hatches two, and cares for one.

This is the case in most instances, though a brood of three has been observed. As the young ones grow, the mother becomes wearied with feeding them and extrudes one of the pair from the nest. [At the same time the bird is said to abstain from food, to avoid harrying the young of wild animals. Thus its wings blanch, and for some days its talons get turned awry. It is in consequence about this time cross-tempered to its own young.][5] The phene is said to rear the young one that has been expelled from the nest. The eagle broods for about thirty days.

The hatching period is about the same for the larger birds, such as the goose and the great bustard; for the middle-sized birds it extends over about twenty days, as in the case of the kite and the hawk. The kite in general lays two eggs, but occasionally rears three young ones. The so-called aegolius at times rears four. It is
563b1 not true that, as some aver, the raven lays only two eggs; it lays a larger number. It broods for about twenty days and then extrudes its young. Other birds perform the same operation; at all events mother birds that lay several eggs often extrude one of their young.

Birds of the eagle species are not alike in the treatment of their young. The white-tailed eagle is cross, the black eagle is affectionate in the feeding of the young; though, all birds of prey, as soon as their brood is able to fly, beat and extrude them from the nest. The majority of birds other than birds of prey, as has been said, also act in this manner, and after feeding their young take no further care of them; but the crow is an exception. This bird for a considerable time takes charge of her young; for, even when her young can fly, she flies alongside of them and supplies them with food.

7 · The cuckoo is said by some to be a hawk transformed, because the hawk disappears at that time. It is like . . .[6] And the other hawks too are hardly to be seen once the cuckoo has begun to call, except for a few days. The cuckoo appears only for a short time in summer, and in winter disappears. The hawk has crooked talons, which the cuckoo has not; neither with regard to the head does the cuckoo resemble the hawk. In point of fact, both as regards the head and the claws it more resembles the pigeon. However, in colour and in colour alone it does resemble the hawk, only that the markings of the hawk are striped, and of the cuckoo mottled. And in size and flight it resembles the smallest of the hawk tribe, which bird disappears as a rule about the time of the appearance of the cuckoo, though the two have been seen simultaneously. The cuckoo has been seen to be preyed on by the hawk; and this never happens between birds of the same species. They say no one has ever seen the young of the cuckoo. The bird lays eggs, but does not build a nest. Sometimes it lays its eggs in the nest of a smaller bird after first devouring the eggs of this bird; it lays by preference in the nest of the ring-dove, after first devouring the eggs of the
564a1 pigeon. (It occasionally lays two, but usually one.) It lays also in the nest of the

[5] Dittmeyer excises.
[6] There is a lacuna in the text here.

hypolais, and the hypolais hatches and rears the brood. It is about this time that the bird becomes fat and palatable. The young of hawks also get palatable and fat. One species builds a nest in the wilderness and on sheer cliffs.

8 · With most birds, as has been said of the pigeon, the hatching is carried on by the male and the female in turns: with some birds, however, the male only sits long enough to allow the female to provide herself with food. In the goose tribe the female alone incubates, and after once sitting on the eggs she continues brooding until they are hatched.

The nests of all marsh-birds are built in swampy districts well supplied with grass; consequently, the motherbird while sitting quiet on her eggs can provide herself with food without having to submit to absolute fasting.

With the crow also the female alone broods, and broods throughout the whole period; the male bird supports the female, bringing her food and feeding her. The female of the ring-dove begins to brood in the afternoon and broods through the entire night until breakfast-time of the following day; the male broods during the rest of the time. Partridges build a nest in two compartments; the male broods on the one and the female on the other. After hatching, each of the parent birds rears its brood. But the male, when he first takes his young out of the nest, treads them.

9 · Peafowl live for about twenty-five years, breed about the third year, and at the same time take on their spangled plumage. They hatch their eggs within thirty days or rather more. The peahen lays but once a year, and lays twelve eggs, or may be a slightly lesser number: she does not lay all the eggs one after the other, but at intervals of two or three days. Such as lay for the first time lay about eight eggs. The peahen lays wind-eggs. They pair in the spring; and laying begins immediately after pairing. The bird moults when the earliest trees are shedding their leaves, and recovers its plumage when the same trees are recovering their foliage. People that rear peafowl put the eggs under the domestic hen, owing to the fact that when the peahen is brooding over them the peacock attacks her and tries to trample on them; owing to this circumstance some birds of wild varieties run away from the males and lay their eggs and brood in solitude. Only two eggs are put under a hen, for she could not brood over and hatch a large number. They take every precaution, by supplying her with food, to prevent her going off the eggs and discontinuing the brooding.

With male birds about pairing time the testicles are larger than at other times, and this is conspicuously the case with the more salacious birds, such as the domestic cock and the cock partridge; the peculiarity is less conspicuous in such birds as are intermittent in regard to pairing.

10 · So much for the conception and generation of birds.

It has been previously stated that fishes are not all oviparous. The selachia are viviparous; the rest are oviparous. And the selachia are first oviparous internally and subsequently viviparous; they rear the embryos internally, the fishing-frog being an exception.

Fishes also, as was above stated, are provided with wombs of diverse kinds. The oviparous genera have wombs bifurcate in shape and low down in position; the selachia have wombs shaped like those of birds; but they differ in this respect from the womb of birds, that with some the eggs do not settle close to the diaphragm but middle-ways along the backbone, and as they grow they shift their position.

The egg with all fishes is not of two colours but is of even hue; and the colour is nearer to white than to yellow, and that both when the young is inside it and previously as well.

Development from the egg in fishes differs from that in birds in this respect, that it does not exhibit that one of the two navel-strings that[7] leads off to the membrane that lies close under the shell, while it does exhibit that one of the two that in the case of birds leads off to the yolk. In a general way the rest of the development from the egg onwards is identical in birds and fishes. That is to say, development takes place at the upper part of the egg, and the veins extend in like manner, at first from the heart; and at first the head, the eyes, and the upper parts are largest; and as the creature grows the egg decreases and eventually disappears and becomes absorbed within the embryo, just as takes place with the yolk in birds.

The navel-string is attached a little way below the mouth to the belly. When the creatures are young the navel-string is long, but as they grow it diminishes in size; at length it gets small and becomes incorporated, as was described in the case of birds. The embryo and the egg are enveloped by a common membrane, and just under this is another membrane that envelops the embryo by itself; and in between the two membranes is a liquid. The food inside the stomach of the little fishes resembles that inside the stomach of young chicks, and is partly white and partly yellow.

As regards the shape of the womb, the reader is referred to the *Anatomies*. The womb, however, is diverse in diverse fishes, as for instance in the dogfish as compared one with another or as compared with the flat fish. That is to say, in some dogfish the eggs adhere in the middle of the womb round about the backbone, as has been stated, and this is the case with the 'puppy'; as the eggs grow they shift their place; and since the womb is bifurcate and adheres to the midriff, as in the rest of similar creatures, the eggs pass into one or other of the two compartments. This womb and the womb of the other dogfish exhibit, as you go a little way off from the midriff, something resembling white breasts, which never make their appearance unless there be conception.

'Puppies' and rays have a kind of egg-shell, in which is found an egg-like liquid. The shape of the egg-shell resembles the tongue of a bagpipe, and hair-like ducts are attached to the shell. With the puppy which is called by some the dappled dogfish, the young are born when the shell-formation breaks in pieces and falls out; with the ray, after it has laid the egg the shell-formation breaks up and the young move out. The spiny dog-fish has its eggs close to the midriff above the breast-like

[7] Reading τὸν τείνοντα.

formations; when the egg descends, as soon as it gets detached the young is born. The mode of generation is the same in the case of the fox-shark. 565b1

The so-called smooth dogfish has its eggs in between the wombs like the 'puppy'; these eggs shift into each of the two horns of the womb and descend, and the young develop with the navel-string attached to the womb, so that, as the eggs get used up, the embryo is sustained to all appearance just as in the case of quadrupeds. The navel-string is long and adheres to the under part of the womb (each navel-string being attached as it were by a sucker), and also to the centre of the embryo in the place where the liver is situated. If the embryo be cut open, even though it has the egg no longer, the food inside is egg-like. Each embryo, as in the case of quadrupeds, is provided with a chorion and separate membranes. When young the embryo has its head upwards, but downwards when it gets strong and is completed in form. Males are generated on the left-hand side of the womb too, and females on the right-hand side, and males and females on the same side together. If the embryo be cut open, then, as with quadrupeds, such internal organs as it is furnished with, as for instance the liver, are found to be large and supplied with blood.

All selachia have at one and the same time eggs above close to the midriff (some larger, some smaller), in considerable numbers, and also embryos lower down. And this circumstance leads many to suppose that fishes of this species pair and bear young every month, inasmuch as they do not produce all their young at once, but now and again and over a lengthened period. But such eggs as have come down below within the womb are simultaneously ripened and completed in growth.

Dog-fish in general can extrude and take in again their young, as the angel-fish and the electric ray—and a large electric ray has been seen with about eighty embryos inside it—but the spiny dog-fish is an exception to the rule, being prevented by the spine of the young fish from so doing. Of the flat fish, the trygon and the ray cannot take in again in consequence of the roughness of their tails. The fishing-frog also is unable to take in its young owing to the size of the head and the prickles; and, as was previously remarked, it is the only one of these fishes that is not viviparous.

So much for the varieties of the selachia and for their modes of generation from the egg. 566a1

11 · At the breeding season the sperm-ducts of the male are filled with milt, so much so that if they be squeezed the sperm flows out as a white fluid; the ducts are bifurcate, and start from the midriff and the great vein. About this period the sperm-ducts of the male are quite distinct [from the womb of the female],[8] but at any other than the actual breeding time their distinctness is not obvious to a non-expert. The fact is that in certain fishes at certain times these organs are imperceptible, as was stated regarding the testicles of birds.

Among other distinctions observed between the milt ducts and the womb-ducts

[8]Excised by d'Arcy Thompson.

is the circumstance that the former are attached to the loins, while the womb-ducts move about freely and are attached by a thin membrane. The particulars regarding the milt ducts may be studied by a reference to the diagrams in the *Anatomies*.

Selachia are capable of superfoetation, and their period of gestation is six months at the longest. The so-called starry dog-fish bears young the most frequently; in other words it bears twice a month. The breeding-season begins in the month of Maemacterion. The dog-fish as a general rule bear twice in the year, with the exception of the 'puppy' which bears only once a year. Some of them bring forth in the springtime. The angel-fish bears its first brood in the springtime, and its second in the autumn, about the winter setting of the Pleiads; the second brood is the stronger of the two. The electric ray brings forth in the late autumn.

Selachia come out from the main seas and deep waters towards the shore and there bring forth their young, and they do so for the sake of warmth and by way of protection for their young.

No fish has been observed to mate outside its own kind, except the angel-fish and the ray; for there is a fish called the rhinobatus, with the head and front parts of the ray and the after parts of the angel-fish, just as though it were made up of both fishes together.[9]

Dog-fish then and their congeners, as the fox-shark and the hound, and the flat fishes, such as the electric ray, the ray, the smooth skate, and the trygon, are first
566b1 oviparous and then viviparous in the way above mentioned.

12 · The dolphin, the whale, and all the rest of the cetacea, all, that is to say, that are provided with a blow-hole instead of gills, are viviparous; so too are the saw-fish and the ox-fish. That is to say, no one of all these fishes is ever seen to be supplied with eggs, but directly with an embryo from whose differentiation comes the fish, just as in the case of mankind and the viviparous quadrupeds.

The dolphin bears one at a time generally, but occasionally two. The whale bears one or at the most two, generally two. The porpoise in this respect resembles the dolphin; for it is in form like a little dolphin, and is found in the Euxine; it differs, however, from the dolphin as being less in size and broader in the back; its colour is blue-black. Many people are of opinion that the porpoise is a variety of the dolphin.

All creatures that have a blow-hole respire and inspire, for they are provided with lungs. The dolphin has been seen asleep with his nose above water, and when asleep he snores.

The dolphin and the porpoise are provided with milk, and suckle their young. They also take their young, when small, inside them. The young of the dolphin grows rapidly, being full-grown at ten years of age. Its period of gestation is ten months. It brings forth its young in summer, and never at any other season; and under the Dog-star it actually disappears for about thirty days. Its young accompany it for a considerable period; and, in fact, the creature is remarkable for the strength of its parental affection. It lives for many years; some are known to have lived for more than twenty-five, and some for thirty years; the fact is fishermen nick

[9] Ῥινόβατος from ῥίνη (angel-fish) and βάτος (ray).

their tails sometimes and set them adrift again, and by this expedient their ages are ascertained.

The seal is an ambivalent animal: that is to say, it does not take in water, but breathes and sleeps and brings forth on dry land—only close to the shore—as being an animal furnished with feet; it spends, however, the greater part of its time in the sea and derives its food from it, so that it must be classed in the category of marine animals. It is viviparous by immediate conception and brings forth its young alive, and exhibits an after-birth and all else just like a ewe. It bears one or two at a time, 567a1
and three at the most. It has two teats, and suckles its young like a quadruped. Like the human species it brings forth at all seasons of the year, but especially at the time when the earliest kids are forthcoming. It conducts its young ones, when they are about twelve days old, over and over again during the day down to the sea, accustoming them by slow degrees to the water. It slips down steep places instead of walking, from the fact that it cannot steady itself by its feet. It can contract and draw itself in, for it is fleshy and soft and its bones are gristly. Owing to the flabbiness of its body it is difficult to kill a seal by a blow, unless you strike it on the temple. It lows like a cow. The female in regard to its genital organs resembles the cow; in all other respects it resembles the female of the human species.

So much for the phenomena of generation and of parturition in animals that live in water and are viviparous either internally or externally.

13 · Oviparous fishes have their womb bifurcate and placed low down, as was said previously—and all scaly fish are oviparous, as the basse, the mullet, the grey mullet, and the etelis, and all the so-called white-fish, and all the smooth fish except the eel—and their egg is of a crumbling substance. This seems to be one[10] because the whole womb of such fishes is full of eggs, so that in little fishes there seem to be only a couple of eggs there; for in small fishes the womb is indistinguishable, from its diminutive size and thin contexture. The pairing of fishes has been discussed previously.

Fishes for the most part are divided into males and females, but one is puzzled to account for the erythrinus and the channa, for specimens of these species are never caught except in a condition of pregnancy.

With such fish as pair, eggs are the result of copulation, but such fish have them also without copulation; and this is shown in the case of some river-fish, for the minnow has eggs when quite small,—almost, one may say, as soon as it is born. These fishes shed their eggs, and, as is stated, the males swallow the greater part of them, and some portion of them goes to waste in the water; but such of the eggs as 567b1
the female deposits in suitable places are saved. If all the eggs were preserved, each species would be vast in number. The greater number of these eggs are not productive, but only those over which the male sheds the milt; for when the female has laid her eggs, the male follows and sheds its milt over them, and from all the eggs so besprinkled young fishes proceed, while the rest are left to their fate.

The same phenomenon is observed in the case of cephalopods also; for in the case of the cuttlefish, after the female has deposited her eggs, the male besprinkles

[10]Reading τοῦτο δ' ἐνφαίνεται.

them. It is reasonable to suppose that a similar phenomenon takes place in regard to cephalopods in general, though up to the present time the phenomenon has been observed only in the case of the cuttlefish.

[Fishes deposit their eggs close in to shore, the goby close to stones; and the spawn of the goby is flat and crumbly. Fish in general so deposit their eggs; for the water close in to shore is warm and is better supplied with food, and serves as a protection to the spawn against the voracity of the larger fish. And it is for this reason that in the Euxine most fishes spawn near the mouth of the river Thermodon, because the locality is sheltered, genial, and supplied with fresh water.

Oviparous fish as a rule spawn only once a year. The black goby is an exception, as it spawns twice; the male of the black goby differs from the female as being blacker and having larger scales.][11]

Fishes then in general produce their young by copulation, and lay their eggs; but the pipe-fish, as some call it, when the time of parturition arrives, bursts in two, and the eggs escape out. For the fish has a cleft under the belly and abdomen (like the blind snakes), and after it has spawned the sides of the split grow together again.

Development from the egg takes place similarly with fishes that are oviparous internally and with fishes that are oviparous externally; that is to say, the embryo comes at the upper end of the egg and is enveloped in a membrane, and the eyes, large and spherical, are the first organs visible. From this circumstance it is plain that it is not true, as some say, that they develop in the same way as creatures that come from grubs; for the opposite phenomena are observed in the case of these latter, in that their lower extremities are the larger at the outset, and that the eyes
568a1 and the head appear later on.

After the egg has been used up, the young fishes are like tadpoles in shape, and at first, without taking any nutriment, they grow by sustenance derived from the juice oozing from the egg; by and by, they are nourished up to full growth by the river-waters.

[When the Euxine is 'purged' a substance called phycus is carried into the Hellespont, and this substance is of a pale yellow colour. Some writers aver that it is the flower of the phycus, from which rouge is made; it comes at the beginning of summer. Shellfish and the small fish of these localities feed on this substance, and some of the inhabitants of these maritime districts say that the purple murex derives its peculiar colour from it.][12]

14 · Marsh-fishes and river-fishes conceive at the age of five months as a general rule, and deposit their spawn towards the close of the year without exception. And with these fishes, as with the marine fishes, the female does not void all her eggs at one time, nor the male his milt; but they are at all times more or less provided, the female with eggs, and the male with milt. The carp spawns as the seasons come round, five or six times, and follows in spawning the rising of the stars.

[11]Excised by Dittmeyer.
[12]Excised by Dittmeyer.

The chalcis spawns three times, and the other fishes once only in the year. They all spawn in pools left by the overflowing of rivers, and near to reedy places in marshes; as for instance the minnow and the perch.

The sheat-fish and the perch deposit their spawn in one continuous string, like the frog; so continuous, in fact, is the convoluted spawn of the perch that, by reason of its smoothness, the fishermen in the marshes can unwind it off the reeds. The larger individuals of the sheat-fish spawn in deep waters, some in water of a fathom's depth, the smaller in shallower water, generally close to the roots of the willow or of some other tree, or close to reeds or to moss. At times these fishes intertwine with one another, a big with a little one; and, bringing into juxtaposition the ducts—which some writers designate as navels—at the point where they emit the generative products, the one discharges the egg and the other the milt. Such eggs as are besprinkled with the milt grow, in a day or thereabouts, whiter and larger, and in a little while afterwards the fish's eyes become visible, for these organs in all fishes, as for that matter in all other animals, are early conspicuous and seem disproportionately big. But such eggs as the milt fails to touch remain, as with marine fishes, useless and infertile. From the fertile eggs, as the little fish grow, a kind of sheath detaches itself; this is a membrane that envelops the egg and the young fish. When the milt has mingled with the eggs, the resulting product becomes very sticky and adheres to the roots of trees or wherever it may have been laid. The male keeps on guard at the principal spawning-place, and the female after spawning goes away.[13]

In the case of the sheat-fish the growth from the egg is exceptionally slow, and, in consequence, the male has to keep watch for forty or fifty days to prevent the spawn being devoured by such little fishes as chance to come by. Next in point of slowness is the generation of the carp. Nevertheless,[14] the spawn in this case too escapes if it is guarded.

In the case of some of the smaller fishes when they are only three days old young fishes are generated. Eggs touched by the milt take on increase both the same day and also later. The egg of the sheat-fish is as big as a vetch-seed; the egg of the carp and of the carp-species as big as a millet-seed.

These fishes then spawn and generate in the way here described. The chalcis, however, spawns in deep water in dense shoals of fish; and the so-called tilon spawns near to beaches in sheltered spots in shoals likewise. The carp, the baleros, and fishes in general push eagerly into the shallows for the purpose of spawning, and very often thirteen or fourteen males are seen following a single female. When the female deposits her spawn and departs, the males follow on and shed the milt. The greater portion of the spawn gets wasted; because, owing to the fact that the female moves about while spawning, the spawn scatters, or so much of it as is caught in the stream and does not get entangled with some rubbish. For, with the exception of the sheat-fish, no fish keeps on guard; unless it be the carp, which is said to remain on guard, if it so happen that its spawn lies in a solid mass.

[13]Dittmeyer excises this sentence.
[14]Reading ὅμως δὲ καὶ τούτων.

All male fishes are supplied with milt, excepting the eel: with the eel, the male is devoid of milt, and the female of eggs. The mullet goes up from the sea to marshes and rivers; the eels, on the contrary, make their way down from the marshes and rivers to the sea.

15 · The great majority of fish, then, as has been stated, proceed from eggs. [However, there are some fish that proceed from mud and sand, even of those kinds that proceed also from pairing and the egg. This occurs in ponds—especially in a pond in the neighbourhood of Cnidos. This pond, it is said, at one time ran dry about the rising of the dog-star, and the mud was all taken out; at the first fall of the rains there was a show of water in the pond, and on the first appearance of the water shoals of tiny fish were found in the pond. The fish in question was a kind of mullet, one which does not proceed from normal pairing, about the size of a small sprat, and not one of these fishes was provided with either egg or milt. There are found also in Asia Minor, in rivers not communicating with the sea, little fishes like whitebait, different but found under similar circumstances. Some writers actually aver that mullet all grow spontaneously. In this assertion they are mistaken, for the female of the fish is found provided with eggs, and the male with milt. However, there is a species of mullet that grows out of mud and sand.

From the facts above enumerated it is clear that certain fishes come spontaneously into existence, not being derived from eggs or from copulation. Such fish as are neither oviparous nor viviparous arise all either from mud or from sand and from decayed matter that rises thence as a scum; for instance, the so-called froth of the small fry comes out of sandy ground. This fry is incapable of growth and of propagating its kind; after living for a while it dies away and another creature takes its place, and so, with short intervals excepted, it may be said to last the whole year through. At all events, it lasts from the autumn rising of Arcturus up to the spring-time. As a proof that these fish occasionally come out of the ground we have the fact that in cold weather they are not caught, and that they are caught in warm weather, obviously coming up out of the ground to catch the heat; also, when the fishermen use dredges and the ground is scraped up, the fishes often appear in larger numbers and of superior quality. All other small fry are inferior in quality owing to rapidity of growth.

The fry are found in sheltered and marshy districts, when after a spell of fine weather the ground is getting warmer, as, for instance, in the neighbourhood of Athens, at Salamis and near the tomb of Themistocles and at Marathon; for in these districts the froth is found. It appears, then, in such districts and during such weather, and occasionally appears after a heavy fall of rain in the froth that is thrown up by the falling rain—which is why it is called froth. Foam is occasionally brought in on the surface of the sea in fair weather. And in this, where it has formed on the surface, the froth collects, as grubs swarm in manure; for which reason this fry is often brought in from the open sea. The fish is at its best in quality and quantity in moist warm weather.

The ordinary fry is the normal issue of fishes: the so-called gudgeon-fry of small insignificant gudgeon-like fish that burrow under the ground. From the Phaleric fry comes the membras, from the membras the trichis, from the trichis the trichias, and from one particular sort of fry, to wit from that found in the harbour of Athens, comes what is called the anchovy. There is another fry, derived from the sprat and the mullet.

The unfertile fry is watery and keeps only a short time, as has been stated; for at last only head and eyes are left. However, the fishermen of late have hit upon a 570a1
method of transporting it to a distance, as when salted it keeps for a considerable time.][15]

16 · Eels are not the issue of pairing, neither are they oviparous; nor was an eel ever found supplied with either milt or eggs, nor are they when cut open found to have within them passages for milt or for eggs. In point of fact, this entire species of blooded animals proceeds neither from pairing nor from the egg.

There can be no doubt that the case is so. For in some standing pools, after the water has been drained off and the mud has been dredged away, the eels appear again after a fall of rain. In time of drought they do not appear even in stagnant ponds, for the simple reason that their existence and sustenance is derived from rain-water.

There is no doubt, then, that they proceed neither from pairing nor from an egg. Some writers, however, are of opinion that they generate their kind, because in some eels little worms are found, from which they suppose that eels are derived. But this opinion is not founded on fact. Eels are derived from the so-called 'earth's guts' that grow spontaneously in mud and in humid ground; in fact, eels have at times been seen to emerge out of such earthworms, and on other occasions have been rendered visible when the earthworms were laid open by either scraping or cutting. Such earthworms are found both in the sea and in rivers where there is a lot of decayed matter: in the sea in places where sea-weed abounds, and in rivers and marshes near to the edge; for it is near to the water's edge that sun-heat has its chief power and produces putrefaction. So much for the generation of the eel.

17 · Fish do not all bring forth their young at the same season nor all in like manner, neither is the period of gestation for all of the same duration.

Before pairing the males and females gather together in shoals; at the time for copulation and parturition they pair off. With some fishes the time of gestation is not longer than thirty days, with others it is a lesser period; but with all it extends over a number of days divisible by seven. The longest period of gestation is that of the species which some call a *marinus*.

The sargue conceives during the month of Poseideon and carries its spawn for 570b1
thirty days; and the species of mullet named by some the chelon, and the myxon, go with spawn at the same period and over the same length of time.

All fish suffer greatly during the period of gestation, and are in consequence

[15]Excised by Dittmeyer.

very apt to be thrown up on shore at this time. In some cases they are driven frantic with pain and throw themselves on land. At all events they are throughout this time continually in motion until parturition is over (this being especially true of the mullet), and after parturition they are in repose. With many fish the time for parturition terminates on the appearance of grubs within the belly; for small living grubs get generated there and drive out the spawn.

With shoal fishes parturition takes place in the spring, and indeed, with most fishes, about the time of the spring equinox; with others it is at different times, in summer with some, and with others about the autumn equinox.

The first of shoal fishes to spawn is the atherine, and it spawns close to land; the last is the cephalus: and this is inferred from the fact that the brood of the atherine appears first of all and the brood of the cephalus last. The mullet also spawns early. The saupe spawns usually at the beginning of summer, but occasionally in the autumn. The aulopias, which some call the anthias, spawns in the summer. Next in order of spawning comes the gilthead, the basse, the mormyrus, and in general such fish as are nicknamed 'runners'. Latest in order of the shoal fish come the red mullet and the coracine; these spawn in autumn. The red mullet spawns on mud, and consequently, as the mud continues cold for a long while, spawns late in the year. The coracine carries its spawn for a long time; but, as it lives on rocky ground, it goes to a distance and spawns in places abounding in sea-weed, at a period later than the red mullet. The sprat spawns about the winter solstice. Of the others, such as are seagoing spawn for the most part in summer; which fact is proved by their not being caught during this period.

Of fishes the most prolific is the sprat; of selachia, the fishing-frog. Specimens, however, of the fishing-frog are rare from the facility with which the young are destroyed, as the female lays her spawn all in a lump close in to shore. As a rule,
571a1 selachia are less prolific than other fish owing to their being viviparous; and their young by reason of their size have a better chance of escaping destruction.

The so-called pipe-fish is late in spawning, and the greater portion of them are burst asunder by the eggs before spawning; and the eggs are not so many in number as large in size. The young fish cluster round the parent like so many young spiders, for the fish spawns on to herself; and, if any one touch the young, they swim away. The atherine spawns by rubbing its belly against the sand.

[Tunny fish also burst asunder by reason of their fat. They live for two years; and the fishermen infer this age from the circumstance that once when there was a failure of the young tunny fish for a year there was a failure of the full-grown tunny the next summer. They are of opinion that the tunny is a fish a year older than the pelamyd.][16] The tunny and the mackerel pair about the close of the month of Elaphebolion, and spawn about the commencement of the month of Hecatombaeon; they deposit their spawn in a sort of bag. The growth of the young tunny is rapid. After the females have spawned in the Euxine, there comes from the egg what some call scordylae, but what the Byzantines nickname 'growers', from their growing to a considerable size in a few days; these fish go out of the Pontus in autumn along with

[16]Excised by Dittmeyer.

the young tunnies, and enter Pontus in the spring as pelamyds. Fishes as a rule take on growth with rapidity, but this is peculiarly the case with all species of fish found in the Pontus; the growth, for instance, of the bonito is quite visible from day to day.

In general, we must bear in mind that the same fish, if they are not in the same localities, have not the same season for pairing, for conception, for parturition, or for flourishing. The coracine, for instance, in some places spawns about wheat-harvest. The statements here given aim only to give what happens for the most part.

The conger also spawns, but the fact is not equally obvious in all localities, nor is the spawn plainly visible owing to the fat of the fish; for the spawn is lanky in shape as it is with serpents. However, if it be put on the fire it shows its nature; for the fat evaporates and melts, while the eggs dance about and explode with a crack. Further, if you touch the substances and rub them with your fingers, the fat feels smooth and the egg rough. Some congers are provided with fat but not with any egg, 571b1
others are unprovided with fat but have eggs of the sort described.

18 · We have, then, treated pretty fully of the animals that fly in the air or swim in the water, and of such of those that walk on dry land as are oviparous, to wit of their pairing, conception, and the like phenomena; it now remains to treat of the same phenomena in connexion with viviparous land animals and with man.

The statements made in regard to the pairing of the sexes apply partly to the particular kinds of animal and partly to all in general. It is common to all animals to be most excited by the desire for and the pleasure derived from copulation. The female is most fierce just after parturition, the male during the time of pairing; for instance, stallions at this period bite one another, throw their riders, and chase them. Wild boars, though usually enfeebled at this time as the result of copulation, are now unusually fierce, and fight with one another in an extraordinary way, clothing themselves with defensive armour and deliberately thickening their hide by rubbing against trees or by coating themselves repeatedly with mud and then drying themselves. They drive one another away from the swine pastures, and fight with such fury that very often both combatants succumb. The case is similar with bulls, rams, and he-goats; for, though at ordinary times they herd together, at breeding time they hold aloof from and quarrel with one another. The male camel also is fierce at pairing time if either a man or a camel comes near him; as for a horse, a camel is ready to fight him at any time.[17] It is the same with wild animals. The bear, the wolf, and the lion are all at this time ferocious towards such as come in their way, but they are less given to fight with one another from the fact that they are at no time gregarious. The she-bear is fierce after cubbing, and the bitch after pupping.

Male elephants get savage about pairing time, and for this reason it is stated that men who have charge of elephants in India never allow the males to have

[17] Dittmeyer excises this sentence.

572a1 intercourse with the females; on the ground that the males go wild at this time and turn topsy-turvy the dwellings of their keepers, lightly constructed as they are, and commit all kinds of havoc. They also state that abundancy of food has a tendency to tame the males. They further introduce other elephants amongst the wild ones, and punish and break them in by setting on the new-comers to chastise the others.

Animals that pair frequently and not at a single specific season, as for instance animals domesticated by man, such as swine and dogs, are found to indulge in such behaviour to a lesser degree owing to the frequency of their sexual intercourse.

Of female animals the mare is the most sexually wanton, and next in order comes the cow. In fact, the mare is said to go a-horsing; and the term derived from the habits of this one animal serves as a term of abuse applicable to those who are unbridled in the way of sexual appetite. The mare is said also about this time to get wind-impregnated, and for this reason in Crete they never remove the stallion from the mares; and when the mare gets into this condition she runs away from all other horses. (This is the condition which in sows is known as going boaring.) The mares under these circumstances fly invariably either northwards or southwards, and never towards either east or west. When this complaint is on them they allow no one to approach, until either they are exhausted with fatigue or have reached the sea. Then they discharge a certain substance called 'hippomanes', the title given to a growth on a new-born foal; this resembles the sow-virus, and is in great demand amongst women who deal in drugs. About horsing time the mares huddle closer together, are continually switching their tails, their neigh is abnormal in sound, and from the sexual organ there flows a liquid resembling sperm, but much thinner than the sperm of the male. It is this substance that some call hippomanes, instead of the growth found on the foal; they say it is extremely difficult to get as it oozes out only in small drops at a time. Mares also, when in heat, discharge urine frequently, and frisk with one another. Such are the phenomena connected with the horse.

Cows go a-bulling; and so completely are they under the influence of the sexual excitement that the herdsmen have no control over them and cannot catch hold of
572b1 them. Mares and cows alike, when in heat, indicate the fact by the upraising of their genital organs, and by continually voiding urine. Further, cows mount the bulls, follow them about, and keep standing beside them. The younger females both with horses and cattle are the first to get in heat; and their sexual appetites are all the keener if the weather be warm and their bodily condition be healthy. Mares, when clipt of their coat, have the sexual feeling checked, and assume a downcast drooping appearance. The stallion recognizes by the scent the mares that form his company, even though they have been together only a few days before breeding time; and those which have mixed with others, the stallion bites and drives away. He feeds apart, accompanied by his own troop of mares. Each stallion has assigned to him about thirty mares or even somewhat more; when a strange stallion approaches, he huddles his mares into a close ring, runs round them, then advances to the encounter; if one of the mares make a movement, he bites her and drives her back. The bull in breeding time begins to graze with the cows, and fights with other bulls (having hitherto grazed with them), which is termed 'herd-spurning'. Often in

Epirus a bull disappears for three months together. In a general way one may state that of male animals either none or few herd with their respective females before breeding time; but they keep separate after reaching maturity, and the two sexes feed apart. Sows, when they are moved by sexual desire, or are, as it is called, a-boaring, will attack even human beings.

With bitches the same sexual condition is termed 'getting into heat'. The sexual organ rises at this time, and there is a moisture about the parts. Mares drip with a white liquid at this season.

Female animals are subject to menstrual discharges, but never in such abundance as is the female of the human species. With ewes and she-goats there are signs of menstruation in breeding time, just before the time for submitting to the male; after copulation also the signs are manifest, and then cease for an interval 573a1
until the period of parturition arrives; the process then comes on again, and it is by this that the shepherd knows that such and such an ewe is about to bring forth. After parturition comes copious menstruation, not at first much tinged with blood, but deeply dyed with it by and by. With the cow, the she-ass, and the mare, the discharge is more copious owing to their greater bulk, but proportionally to the greater bulk it is far less copious. The cow, for instance, when in heat, exhibits a small discharge to the extent of a quarter of a pint of liquid or a little less; and the time when this discharge takes place is the best time for her to be covered by the bull. Of all quadrupeds the mare is the most easily delivered of its young, exhibits the least amount of discharge after parturition, and emits the least amount of blood; that is to say, in proportion to size. With cows and mares menstruation usually manifests itself at intervals of two, four, and six months; but, unless one be constantly attending to and thoroughly acquainted with such animals, it is difficult to verify the circumstance, and the result is that some are under the belief that the process never takes place with these animals at all.

With mules menstruation never takes place, but the urine of the female is thicker than the urine of the male. As a general rule the discharge from the bladder in the case of quadrupeds is thicker than it is in the human species, and this discharge with ewes and she-goats is thicker than with rams and he-goats; but the urine of the jackass is thicker than the urine of the she-ass, and the urine of the bull is more pungent than the urine of the cow. After parturition the urine of all quadrupeds becomes thicker, especially with such animals as exhibit comparatively slight discharges. At breeding time the milk becomes purulent, but after parturition it becomes wholesome. During pregnancy ewes and she-goats get fatter and eat more; as is also the case with cows, and, indeed, with all quadrupeds.

In general the sexual appetites of animals are keenest in spring-time; the time of pairing, however, is not the same for all, but is adapted so as to ensure the rearing of the young at a convenient season.

Domesticated swine carry their young for four months, and bring forth a litter of twenty at the utmost; and if the litter be exceedingly numerous they cannot rear all the young. As the sow grows old she continues to bear, but grows indifferent to the boar; she conceives after a single copulation, but they have to put the boar to her 573b1 repeatedly owing to her dropping after intercourse what is called the sow-virus. This incident befalls all sows, but some of them discharge the sperm as well. During conception any one of the litter that gets injured or dwarfed is called a runt: such injury may occur at any part of the womb. After littering the mother offers the foremost teat to the first-born. [When the sow is in heat, she must not at once be put to the boar, but only after she lets her lugs drop, for otherwise she is apt to get into heat again; if she be put to the boar when in full condition of heat, one copulation, as has been said, is sufficient. It is as well to supply the boar at the period of copulation with barley, and the sow at the time of parturition with boiled barley. Some swine give fine litters only at the beginning, with others the litters improve as the mothers grow in age and size. It is said that a sow, if she have one of her eyes knocked out, is almost sure to die soon afterwards. Sows for the most part live for fifteen years, but some fall little short of the twenty.][18]

19 · Ewes conceive after three or four copulations with the ram. If rain falls after intercourse, she miscarries;[19] and it is the same with the she-goat. The ewe bears usually two lambs, sometimes three or four. Both ewe and she-goat carry their young for five months; consequently wherever a district is sunny and the animals are used to comfort and well fed, they bear twice in the year. The goat lives for eight years and the sheep for ten, but in most cases not so long; the bell-wether, however, lives to fifteen years. In every flock they train one of the rams for bell-wether. When he is called on by name by the shepherd, he takes the lead of the flock: and to this duty the creature is trained from its earliest years. Sheep in Ethiopia live for twelve or thirteen years, goats for ten or eleven. In the case of the sheep and the goat the two sexes have intercourse all their lives long.

Twins with sheep and goats may be due to richness of pasturage, or to the fact that either the ram or the he-goat is a twin-begetter or that the ewe or the she-goat is a twin-bearer. Of these animals some give birth to males and others to females;
574a1 and the difference in this respect depends on the waters they drink and also on the sires. And if they submit to the male when north winds are blowing, they are apt to bear males; if when south winds are blowing, females. Such as bear females may get to bear males, due regard being paid to their looking northwards when put to the male. Ewes accustomed to be put to the ram early will refuse him if he attempt to mount them late. Lambs are born white and black according as white or black veins are under the ram's tongue; the lambs are white if the veins are white, and black if the veins are black, and white and black if the veins are white and black; and red if the veins are red. The females that drink salted waters are the first to take the male; the water should be salted before and after parturition, and again in the springtime. With goats the shepherds appoint no bell-wether, as the animal is not of a stable nature but frisky and apt to ramble. If at the appointed season the elders of the flock are eager for intercourse, the shepherds say that it bodes well for the flock; if the younger ones, that the flock is going to be bad.

[18]Excised by Dittmeyer.
[19]Reading ἀμβλίσκει.

20 · Of dogs there are several breeds. Of these the Laconian hound of either sex is fit for breeding purposes when eight months old: at about the same age some dogs lift the leg when voiding urine. The bitch conceives with one lining; this is clearly seen in the case where a dog contrives to line a bitch by stealth, as they impregnate after mounting only once. The Laconian bitch carries her young the sixth part of a year or sixty days: or more by one, two, or three, or less by one; the pups are blind for twelve days after birth. After pupping, the bitch is mounted again in six months, but not before. Some bitches carry their young for the fifth part of the year or for seventy-two days; and their pups are blind for fourteen days. Other bitches carry their young for a quarter of a year or for three whole months; and the whelps of these are blind for seventeen days. The bitch appears to go in heat for the same length of time. Menstruation continues for seven days, and a swelling of the genital organ occurs simultaneously; it is not during this period that the bitch is disposed to submit to the dog, but in the seven days that follow. The bitch as a rule goes in heat for fourteen days, but occasionally for sixteen. The birth-discharge occurs simultaneously with the delivery of the whelps, and the substance of it is thick and mucous, and the quantity of it, when they have pupped, thins off less than in proportion to their body. The bitch is usually supplied with milk five days before parturition; some seven days previously, some four; and the milk is serviceable immediately after birth. The Laconian bitch is supplied with milk thirty days after lining. The milk at first is thickish, but gets thinner by degrees; with the bitch the milk is thicker than with the female of any other animal excepting the sow and the hare. When the bitch arrives at full growth an indication is given of her capacity for the male; that is to say, just as occurs in the female of the human species, a swelling takes place in the teats of the breasts, and the breasts take on gristle. This incident, however, it is difficult for any but an expert to detect, as the part that gives the indication is inconsiderable. The preceding statements relate to the female, and not one of them to the male. The male as a rule lifts his leg to void urine when six months old; some at a later period, when eight months old, some before they reach six months. In a general way one may put it that they do so when they begin to be strong. The bitch squats down when she voids urine; it is a rare exception that she lifts the leg to do so. The bitch bears twelve pups at the most, but usually five or six; occasionally a bitch will bear one only. The bitch of the Laconian breed generally bears eight. The two sexes have intercourse with each other at all periods of life. A peculiar phenomenon is observed in the case of the Laconian hound: he is found to be more vigorous in commerce with the female after being hard-worked than when allowed to live idle.

The dog of the Laconian breed lives ten years, and the bitch twelve. The bitch of other breeds usually lives for fourteen or fifteen years, but some live to twenty; and for this reason certain critics consider that Homer did well in representing the dog of Odysseus as having died in his twentieth year. With the Laconian hound, owing to the hardships to which the male is put, he is less long-lived than the female; with other breeds the distinction as to longevity is not very apparent, though as a general rule the male is the longer-lived.

The dog sheds no teeth except the so-called canines; these a dog of either sex sheds when four months old. As they shed these only, many people are in doubt as to the fact, and some people, owing to their shedding but two and its being hard to hit upon this, fancy that the animal sheds no teeth at all; others, after observing the shedding of two, come to the conclusion that the creature sheds the rest in due turn. Men discern the age of a dog by inspection of its teeth; with young dogs the teeth are white and sharp pointed, with old dogs black and blunted.

21 · The bull impregnates the cow at a single mount, and mounts with such vigour as to weigh down the cow; if his effort be unsuccessful, the cow must be allowed an interval of twenty days before being again submitted. Bulls of mature age decline to mount the same cow several times on one day, except at considerable intervals. Young bulls by reason of their vigour are enabled to mount the same cow several times in one day, and a good many cows besides. The bull is the least salacious of male animals. . . .[20] The victor among the bulls is the one that mounts the females; when he gets exhausted by his amorous efforts, his beaten antagonist sets on him and very often gets the better of the conflict. The bull and the cow are about a year old when it is possible for them to have commerce with chance of offspring; as a rule, however, they are about twenty months old, but it is universally allowed that they are capable in this respect at the age of two years. The cow goes with calf for nine months, and she calves in the tenth month; some maintain that they go in calf for ten months, to the very day. A calf delivered before the times here specified is an abortion and tends not to live, however little premature its birth may have been, as its hooves are weak and imperfect. The cow as a rule bears but one calf, very seldom two; she submits to the bull and bears as long as she lives.

Cows generally live for about fifteen years, and the bulls too, if they have been castrated; but some live for twenty years or even more, if their bodily constitutions
575b1 be sound. The herdsmen tame the castrated bulls, and give them an office in the herd analogous to the office of the bell-wether in a flock; and these bulls live to an exceptionally advanced age, owing to their exemption from hardship and to their browsing on pasture of good quality. The bull is in fullest vigour when five years old, which leads the critics to commend Homer for applying to the bull the epithets of 'five-year-old', or 'of nine seasons', which epithets are alike in meaning. The ox sheds his teeth at the age of two years, not all together but just as the horse sheds his. When the animal suffers from podagra it does not shed the hoof, but is subject to a considerable swelling in the feet. The milk of the cow is serviceable immediately after parturition, and before parturition there is no milk at all. The milk that first presents itself becomes as hard as stone when it clots; this result ensues unless it be previously diluted with water. Cows younger than a year old do not copulate unless under circumstances of a monstrous kind: instances have been recorded of copulation in both sexes at the age of ten months. Cows in general begin to submit to the male about the month of Thargelion or of Scirophorion; some, however, are capable of conception right on to the autumn. When cows in large numbers receive

[20]There is a lacuna in the text at this point.

the bull and conceive, it is looked upon as prognostic of rain and stormy weather. Cows herd together like mares, but in lesser degree.

22 · In the case of horses, the stallion and the mare are first fitted for breeding purposes when two years old. Instances, however, of such early maturity are rare, and their young are small and weak; the ordinary age for sexual maturity is three years, and from that age to twenty the two sexes go on improving in the quality of their offspring. The mare carries her foal for eleven months, and casts it in the twelfth. It is not a fixed number of days that the stallion takes to impregnate the mare; it may be one, two, three, or more. An ass in covering will impregnate more expeditiously than a stallion. The act of intercourse with horses is not laborious as it is with oxen. In both sexes the horse is the most salacious of animals next after the human species. The breeding faculties of the younger horses may be stimulated beyond their years if they be supplied with good feeding in abundance. The mare as a rule bears only one foal; occasionally she has two, but never more. A mare has been 576a1 known to cast two mules; but such a circumstance is regarded as monstrous.

The horse then is first fitted for breeding purposes at the age of two and a half years, but achieves full sexual maturity when it has ceased to shed teeth, except it be naturally infertile; however, some horses, it is said, have been known to impregnate the mare while the teeth were in process of shedding.

The horse has forty teeth. It sheds its first set of four, two from the upper jaw and two from the lower, when two and a half years old. After a year's interval, it sheds another set of four in like manner, two upper and two lower, and another set of four after yet another year's interval in like manner; after arriving at the age of four years and six months it sheds no more. An instance has occurred where a horse shed all his teeth at once, and another instance of a horse shedding all his teeth with his last set of four; but such instances are rare. It consequently happens that a horse when four and half years old is in excellent condition for breeding purposes.

The older horses, whether of the male or female, are the more generatively productive. Horses will cover mares from which they have been foaled and mares which they have begotten; and, indeed, a troop of horses is only considered perfect when they mount their own progeny. Scythians use pregnant mares for riding as soon as the embryo has turned in the womb, and they assert that thereby the mothers have all the easier delivery. Quadrupeds as a rule lie down for parturition, and in consequence the young of them all come out of the womb sideways. The mare, however, when the time for parturition arrives, stands erect and in that posture casts its foal.

The horse in general lives for eighteen or twenty years; some horses live for twenty-five or even thirty, and if a horse be treated with extreme care, it may last on to the age of fifty years [a horse, however, when it reaches thirty years is regarded as exceptionally old. The mare lives usually for twenty-five years, though instances have occurred of their attaining the age of forty.][21] The male is less long-lived than 576b1

[21]Excised by Dittmeyer.

the female by reason of the sexual service he is called on to render; and horses that are reared in a private stable live less long than such as are reared in troops. The mare attains her full length and height at five years old, the stallion at six; in another six years the animal reaches its full bulk, and goes on improving until it is twenty years old. The female, then, reaches maturity more rapidly than the male, but in the womb the case is reversed, just as is observed in the human species; and the same phenomenon is observed in the case of all animals that bear several young.[22]

The mare is said to suckle a mule-foal for six months, but not to allow its approach for any longer on account of the pain it is put to by the tugging; an ordinary foal it allows to suck for a longer period.

Horse and mule are at their best after the shedding of the teeth. After they have shed them all, it is not easy to distinguish their age; hence they are said to carry their mark before the shedding, but not after. However, even after the shedding their age is pretty well recognized by the aid of the canines; for in the case of horses much ridden these teeth are worn away by attrition caused by the insertion of the bit; in the case of horses not ridden the teeth are large and detached, and in young horses they are sharp and small.

The male of the horse will breed at all seasons and during its whole life; the mare can take the horse all its life long, but is not ready to pair at all seasons unless it be held in check by a halter or some other compulsion be brought to bear. There is no fixed time at which intercourse of the two sexes takes place;[23] however, if intercourse has taken place at some chance time, they may not be able to rear the offspring. In a stable in Opus there was a stallion that used to serve mares when forty years old: his fore legs had to be lifted up for the operation.

Mares first take the horse in the spring-time. After a mare has foaled she does not get impregnated at once again, but only after an interval; in fact, the foals will be all the better if the interval extend over four or five years. It is, at all events,
577ª1 absolutely necessary to allow an interval of one year, and for that period to let her lie fallow. A mare, then, breeds at intervals; a she-ass breeds without intermission. Of mares some are absolutely sterile, others are capable of conception but incapable of bringing the foal to full term; it is said to be an indication of this condition in a mare, that her foal if dissected is found to have other kidney-shaped substances round about its kidneys, presenting the appearance of having four kidneys.

After parturition the mare at once swallows the after-birth, and bites off the growth, called the 'hippomanes', that is found on the forehead of the foal. This growth is somewhat smaller than a dried fig; and in shape is broad and round, and in colour black. If anyone gets possession of it before the mare, and the mare gets a smell of it, she goes wild and frantic at the smell. And it is for this reason that venders of drugs seek it out and collect it.

If an ass cover a mare after the mare has been covered by a horse, the ass will destroy the previously formed embryo.

[22]Omitting μή.
[23]Reading ἀφώρισται.

[Horse-trainers do not appoint a horse as leader to a troop, as herdsmen appoint a bull as leader to a herd, because the horse is not steady but quick-tempered and skittish.][24]

23 · The ass of both sexes is capable of breeding, and sheds its first teeth, at the age of two and a half years; it sheds its second teeth within six months, its third within another six months, and the fourth after the like interval. These fourth teeth are termed the marks.

A she-ass has been known to conceive when a year old, and the foal to be reared. After intercourse with the male it will discharge the sperm with its urine unless it be hindered, and for this reason it is usually beaten after such intercourse and chased about. It casts its young in the twelfth month. It usually bears but one foal, and that is its natural number; occasionally however it bears twins. The ass if it cover a mare destroys, as has been said, the embryo previously begotten by the horse; but, after the mare has been covered by the ass, the horse will not spoil the embryo. The she-ass has milk in the tenth month of pregnancy. Seven days after casting a foal the she-ass submits to the male, and is almost sure to conceive if put to the male on this particular day; the same result, however, is quite possible later on. If she has not given birth before losing her marks, she will not conceive or become pregnant in the whole of her remaining life. The she-ass will refuse to cast her foal with any one looking on or in the daylight, and just before foaling she has to be led away into a dark place. If the she-ass has had young before the shedding of the marks, she will bear all her life through. The ass lives for more than thirty years, and the she-ass lives longer than the male.

When there is a cross between a horse and a she-ass or a jackass and a mare, there is much greater chance of a miscarriage than where the commerce is normal. The period for gestation in the case of a cross depends on the male, and is just what it would have been if the male had had commerce with a female of his own kind. In regard to size, looks, and vigour, the foal is more apt to resemble the mother. If such hybrid connexions be continued without intermittence, the female will soon go sterile; and for this reason trainers always allow of intervals between breeding times. A mare will not take the ass, nor a she-ass the horse, unless the ass shall have been suckled by a mare; and for this reason they put what they call 'mare-sucklings' under mares. These mount the mares in the open pastures, mastering them by force as the stallions do.

24 · A mule is fitted for commerce with the female after the first shedding of its teeth, and at the age of seven will impregnate effectually; and where connexion has taken place with a mare, a jennet has been known to be produced. After the seven year it has no further intercourse with the female. A female mule has been known to be impregnated, but without the impregnation being followed up by parturition. In Syrophoenicia she-mules submit to the mule and bear young; but the

[24]Excised by Dittmeyer.

breed, though it resembles the ordinary one, is different. The jennet is foaled by a mare when she has gone sick during gestation, and corresponds to the dwarf in the human species and to the runt in swine; and, as is the case with dwarfs, the sexual organ of the jennet is abnormally large.

The mule lives for a number of years. There are on record cases of mules living to the age of eighty, as did one in Athens at the time of the building of the temple; this mule on account of its age was let go free, but continued to assist in dragging burdens, and would go side by side with the other draught-beasts and stimulate them to their work; and in consequence a public decree was passed forbidding any corn-merchant from driving the creature away from his trays. The she-mule grows old more slowly than the mule. Some assert that the she-mule menstruates by the act of voiding her urine, and that the mule owes the prematurity of his decay to his habit of smelling at the urine. So much for the modes of generation in connexion with these animals.

25 · Breeders can distinguish between young and old quadrupeds. If, when drawn back from the jaw, the skin at once goes back to its place, the animal is young; if it remains long wrinkled up, the animal is old.

26 · The camel carries its young for ten months, and bears but one at a time and never more; the young camel is removed from the mother when a year old. The animal lives for a long period, more than fifty years. It bears in spring-time, and gives milk until the time of the next conception. Its flesh and milk are exceptionally palatable. The milk is drunk mixed with water in the proportion of either two to one or three to one.

27 · The elephant of either sex is fitted for breeding before reaching the age of twenty. The female carries her young, according to some accounts, for eighteen months; according to others, for three years; and the discrepancy is due to the fact that their copulation is not easily observed. The female settles down on its rear to cast its young, and obviously suffers greatly during the process. The young one, immediately after birth, sucks the mother, not with its trunk but with the mouth; and can walk about and see distinctly the moment it is born.

28 · The wild sow submits to the boar at the beginning of winter, and in the spring-time retreats for parturition to a lair in some district inaccessible to intrusion, hemmed in with sheer cliffs and chasms and overshadowed by trees. The boar usually remains by the sow for thirty days. The number of the litter and the period of gestation is the same as in the case of the domesticated pig. The sound of the grunt also is similar; only that the sow grunts more, and the boar seldom. Of the wild boars such as are castrated grow to the largest size and become fiercest: to which circumstance Homer alludes when he says:—

'He reared against him a wild castrated boar: it was not like a corn-eating beast, but like a forest-clad promontory.'[25]

Wild boars become castrated owing to an itch befalling them in early life in the region of the testicles, and they squeeze out their testicles by their rubbing themselves against the trunks of trees.

29 · The hind, as has been stated, submits to the stag as a rule only under compulsion, as she is unable to endure the male often owing to the rigidity of the penis. However, they do occasionally submit to the stag as the ewe submits to the ram; and when they are in heat the hinds avoid one another. The stag is not constant to one particular hind, but after a while quits one and mates with others. The breeding time is after the rising of Arcturus, during the months of Boedromion and Maimacterion. The period of gestation lasts for eight months. Conception comes on a few days after intercourse; and a number of hinds can be impregnated by a single male. The hind, as a rule, bears but one fawn, although instances have been known of her casting two. Out of dread of wild beasts she casts her young by the side of the high-road. The young fawn grows with rapidity. Menstruation occurs at no other time with the hind; it takes place only after parturition, and the substance is phlegm-like.

The hind leads the fawn to her lair; this is her place of refuge, a cave with a single inlet, inside which she shelters herself against attack.

Fabulous stories are told concerning the longevity of the animal, but the stories have never been verified, and the period of gestation and the growth in the fawn would not lead one to attribute extreme longevity to this creature.

In the mountain called Deer Mountain, which is in Arginussa in Asia Minor—the place where Alcibiades died—all the hinds have one ear split, so that, if they stray to a distance, they can be recognized by this mark; and the embryo actually has the mark while yet in the womb of the mother.

The hind has four teats like the cow. After the hinds have become pregnant, the males all segregate one by one, and in consequence of the violence of their sexual passions they keep each one to himself and dig a hole in the ground; they smell rank, 579a1
like goats, and their foreheads from getting wetted become black. In this way they pass the time until the rain falls, after which time they turn to pasture. The animal acts in this way owing to its sexual wantonness and also to its obesity; for in summertime it becomes so exceptionally fat as to be unable to run: in fact at this period they can be overtaken by the hunters that pursue them on foot in the second or third run; and in consequence of the heat of the weather and their getting out of breath they always make for water. In the rutting season, the flesh of the deer is unsavoury and rank, like the flesh of the he-goat. In wintertime the deer becomes thin and weak, but towards the approach of the spring he is at his best for running. When on the run the deer keeps pausing from time to time, and waits until his pursuer draws upon him, whereupon he starts off again. This habit appears due to

[25]See *Iliad* IX 539 and *Odyssey* IX 190.

some internal pain: at all events, the gut is so slender and weak that, if you strike the animal ever so softly, it is apt to break asunder, though the hide of the animal remains sound and uninjured.

30 · Bears, as has been previously stated, do not copulate with the male mounting the back of the female, but with the female lying down under the male. The she-bear goes with young for thirty days. She brings forth sometimes one cub, sometimes two cubs, and at most five. Of all animals the newly born cub of the she-bear is the smallest in proportion to the size of the mother; that is to say, it is larger than a mouse but smaller than a weasel. It is also smooth and blind, and its legs and most of its organs are as yet inarticulate. Pairing takes place in the month of Posideon, and they hibernate until Elaphebolion; parturition takes place about the time for retiring into winter quarters; about this time the bear and the she-bear are at the fattest. After the she-bear has reared her young, she comes out of her winter lair in the third month, when it is already spring. The female porcupine hibernates and goes with young the same number of days as the she-bear, and in other respects resembles this animal. When a she-bear is with young, it is a very hard task to catch her.

31 · It has already been stated that the lion and lioness copulate rearwards, and that these animals are retromingent. They do not copulate nor bring forth at all seasons indiscriminately, but once in the year only. The lioness brings forth in the
579b1 spring, generally two cubs at a time, and six at the very most; but sometimes only one. The story about the lioness discharging her womb in the act of parturition is a pure fable, and was merely invented to account for the scarcity of the animal by someone who was at a loss to explain it otherwise; for the animal is a rare animal, and is not found in many countries. In fact, in the whole of Europe it is only found in the strip between the rivers Achelous and Nessus. The cubs of the lioness when newly born are exceedingly small, and can scarcely walk when two months old. The Syrian lion bears cubs five times: five cubs at the first litter, then four, then three, then two, and lastly one; after this the lioness ceases to bear for the rest of her days. The lioness has no mane, but this appendage is peculiar to the lion. The lion sheds only the four so-called canines, two in the upper jaw and two in the lower; and it sheds them when it is six months old.

32 · The hyena in colour resembles the wolf, but is more shaggy, and is furnished with a mane running all along the spine. What is recounted concerning its genital organs, to the effect that every hyena is furnished with the organ both of the male and the female, is untrue. The fact is that the sexual organ of the male hyena resembles the same organ in the wolf and in the dog; the part resembling the female genital organ lies underneath the tail, and does to some extent resemble the female organ, but it has no duct, and the passage for the residuum comes underneath it. The female hyena has the part that resembles the organ of the female, and, as in the case of the male, has it underneath her tail, unprovided with duct; and after it the

passage for the residuum, and underneath this the true female genital organ. The female hyena has a womb, like all other female animals of the same kind. It is an exceedingly rare circumstance to meet with a female hyena. At least a hunter said that out of eleven hyenas he had caught, only one was a female.

33 · Hares copulate in a rearward posture, as has been stated, for the animal is retromingent. They breed and bear at all seasons, superfoetate during pregnancy, and bear young every month. They do not give birth to their young ones all together at one time, but bring them forth at intervals over as many days as it may happen to be. The female is supplied with milk before parturition; and after bearing submits 580a1
immediately to the male, and is capable of conception while still suckling her young. The milk in consistency resembles sow's milk. The young are born blind, as is the case with the greater part of the fissipeds.

34 · The fox mounts the vixen in copulation, and the vixen bears young like the she-bear; in fact, her young ones are even more inarticulately formed. Before parturition she retires to sequestered places, so that it is a great rarity for a vixen to be caught while pregnant. After parturition she warms her young and gets them into shape by licking them. She bears four at most at a birth.

35 · The wolf resembles the dog in regard to the time of conception and parturition, the number of the litter, and the blindness of the new-born young. The sexes couple at one special period, and the female brings forth at the beginning of the summer. There is an account given of the parturition of the she-wolf that borders on the fabulous, to the effect that she confines her lying-in to within twelve particular days of the year. And they give the reason for this in the form of a myth, viz. that when they transported Leto in so many days from the land of the Hyperboreans to the island of Delos, she assumed the form of a she-wolf to escape the anger of Hera. Whether the account be correct or not[26] has not yet been verified; I give it merely as it is currently told. There is no truth in the current statement that the she-wolf bears only once in her lifetime.

The cat and the ichneumon bear as many young as the dog, and live on the same food; they live about six years. The cubs of the panther are born blind like those of the wolf, and the female bears four at the most at one birth. The particulars of conception are the same for the jackal as for the dog; the cubs of the animal are born blind, and the female bears two, or three, or four at a birth. It is long in the body and low in stature; but[27] notwithstanding the shortness of its legs it is exceptionally fleet of foot, owing to the suppleness of its frame and its capacity for leaping. 580b1

36 · There is found in Syria a so-called mule. It is not the same as the cross between the horse and ass, but resembles it just as a wild ass resembles the

[26]Reading ἢ μὴ ἐστιν.
[27]Reading ὅμως.

domesticated congener, and derives its name from the resemblance. Like the wild ass, this wild mule is remarkable for its speed. The animals of this species interbreed with one another; and a proof of this statement may be gathered from the fact that a certain number of them were brought into Phrygia in the time of Pharnaces, the father of Pharnabazus, and the animal is there still. There are three now, but there were originally nine, so they say.

37 · The phenomena of generation in regard to the mouse are the most astonishing both for the number of the young and for the rapidity. On one occasion a she-mouse in a state of pregnancy was shut up by accident in a jar containing millet-seed, and after a little while the lid of the jar was removed and one hundred and twenty mice were found inside it.

The way in which mice in country places appear in enormous numbers and disappear is puzzling. In many places their number is so incalculable that but very little of the corn-crop is left; and so rapid is their mode of proceeding that sometimes a small farmer will one day observe that it is time for reaping, and on the following morning, when he takes his reapers afield, he finds his entire crop devoured. Their disappearance is unaccountable: in a few days not a mouse will there be to be seen. And yet in the time before these few days men fail to keep down their numbers by fumigating and unearthing them, or by hunting them and turning in swine upon them; for pigs root up the mouse-holes. Foxes also hunt them, and the wild ferrets in particular destroy them, but they make no way against the prolific qualities of the animal and the rapidity of its breeding. When they attack, nothing succeeds in thinning them down except the rain; and then they disappear rapidly.

In a certain district of Persia when a female mouse is dissected the female embryos appear to be pregnant. Some people assert, and positively assert, that a 581a1 female mouse by licking salt can become pregnant without the intervention of the male.

Mice in Egypt are covered with bristles like the hedgehog. There is also a different breed of mice that walk on their two hind-legs; their front legs are small and their hind-legs long; the breed is exceedingly numerous. There are many other breeds of mice.

BOOK VII

1 · As to man's growth, first within his mother's womb and afterward to old age, the course of nature, in so far as man is specially concerned, is after the following manner. The difference of male and female and of their respective organs has been dealt with earlier. When twice seven years old, in the most of cases, the male begins to engender seed; and at the same time hair appears upon the pubes, in like manner, so Alcmaeon of Croton remarks, as plants first blossom and then seed. About the same time, the voice begins to alter, getting harsher and more uneven,

neither shrill as formerly nor deep as afterward, nor yet of any even tone, but like an instrument whose strings are frayed and out of tune—they say his voice is 'breaking'. Now this breaking of the voice is the more apparent in those who are making trial of their sexual powers; for in those who are prone to lustfulness the voice turns into the voice of a man, but not so in the continent. For if a lad strives diligently to hinder his voice from breaking, as some do of those who devote themselves to music, the voice lasts a long while unbroken and may even persist with little change. And the breasts swell and likewise the private parts, altering in size and shape. (And at this time of life those who try by friction to provoke emission of seed are apt to experience pain as well as pleasure.) At the same age in the female, the breasts swell and the so-called menstrual fluids commence to flow; and this fluid resembles fresh blood. The 'whites' occur even in very young children, more especially if their diet be largely of a fluid nature; and this malady causes arrest of growth and loss of flesh. In the majority of cases menstruation begins by the time the breasts have grown to the height of two fingers' breadth. In girls, too, about this time the voice changes to a deeper note; for while in general the woman's voice is higher than the man's, so also the voices of girls are pitched in a higher key than the elder women's, just as the boy's are higher than the men's; and the girls' voices are shriller than the boys', and a maid's flute is tuned sharper than a lad's.

Girls of this age have much need of surveillance. For then in particular they feel a natural impulse to make usage of the sexual faculties that are developing in them; so that unless they guard against any further impulse beyond that[1] which their bodily development of itself supplies, even in the case of those who abstain altogether from passionate indulgence, they contract habits which are apt to continue into later life. For girls who give way to wantonness grow more and more wanton; and the same is true of boys, if they do not guard against the one temptation or both; for the passages become dilated and set up a flux and besides this the recollection of pleasure associated with former indulgence creates a longing for its repetition.

Some men are congenitally impotent and sterile owing to structural defect; and in like manner women also may suffer from congenital incapacity. Both men and women are liable to constitutional change, growing healthier or more sickly, or altering in the way of leanness, stoutness, and vigour; thus, after puberty some lads who were thin before grow stout and healthy, and the converse also happens; and the same is equally true of girls. For when in boy or girl the body is loaded with superfluous matter, then, when such superfluities are got rid of in the spermatic or menstrual discharge, their bodies improve in health and condition owing to the removal of what had acted as an impediment to health and nutrition; but in such as are of opposite habit their bodies become emaciated and out of health, for then the spermatic discharge in the one case and the menstrual flow in the other take place at the cost of natural healthy conditions.

Furthermore, in the case of maidens the condition of the breasts is diverse in different individuals, for they are sometimes quite big and sometimes little; and as a

[1]Reading ἢ ὅσον for οὗ.

general rule their size depends on whether the body was burdened in childhood with superfluous material. For when the signs of womanhood are nigh but not come, the more there be of moisture the more will it cause the breasts to swell, even to the bursting point; and the result is that the breasts remain during after-life of the bulk that they then acquired. And among men, the breasts grow more conspicuous and more like to those of women, both in young men and old, when the individual is moist and sleek and not veined, and all the more among the dark than the fair.

At the outset and till the age of twenty-one the semen is sterile; afterwards it becomes fertile, but young men and women produce undersized and imperfect progeny, as is the case also with the common run of animals. Young women conceive readily, but, having conceived, their labour in childbed is apt to be difficult.

The body generally fails to reach its full development and ages quickly in men of intemperate lusts and in women who become mothers of many children; for it appears to be the case that growth ceases when the woman has given birth to three children. Women of a lascivious disposition grow more sedate and virtuous after they have borne several children.

After the age of twenty-one women are fully ripe for child-bearing, but men go on increasing in vigour. When the spermatic fluid is of a thin consistency it is infertile; when granular it is fertile and likely to produce male children, but when thin and unclotted it is apt to produce female offspring. And it is about this time of life that in men the beard makes its appearance.

2 · The onset of menstruation takes place towards the end of the month; and
582b1 on this account the wiseacres assert that the moon is feminine, because the discharge in women and the waning of the moon happen at one and the same time, and after the wane and the discharge both one and the other grow whole again. In some women menstruation occurs regularly but sparsely every month, but for most women every third month. With those in whom it lasts but a little while, two days or three, recovery is easy; but where the duration is longer, it is more troublesome. For women are ailing during these days; and sometimes the discharge is sudden and sometimes gradual, but in all cases alike there is bodily distress until the attack be over. In many cases at the commencement of the attack, when the discharge is about to appear, there occur spasms and rumbling noises within the womb until such time as the discharge manifests itself.

Under natural conditions it is after recovery from these symptoms that conception takes place in women, and women in whom the signs do not manifest themselves for the most part remain childless. But some conceive in spite of the absence of these symptoms; and these are cases in which a secretion accumulates, not in such a way as actually to issue forth, but in amount equal to the residuum left in the case of child-bearing women after the normal discharge has taken place. And some conceive while the signs are on but not afterwards, those namely in whom the womb closes up immediately after the discharge. In some cases the menses persist during pregnancy up to the very last; but the result in these cases is that the offspring are poor, and either fail to survive or grow up weakly.

In many cases, owing to excessive desire, arising either from youthful impetuosity or from lengthened abstinence, prolapsion of the womb takes place and the menses appear repeatedly, thrice in the month, until conception occurs; and then the womb withdraws upwards again to its proper place. Sometimes even if she possesses it but happens to be moist, she blows out the moister part of the semen.[2]

As we have remarked above, the discharge is wont to be more abundant in women than in the females of any other animals. In creatures that do not bring forth their young alive nothing of the sort manifests itself, this particular residue being converted into bodily substance; and in such animals the females are sometimes larger than the males; and moreover, the material is used up sometimes for scutes and sometimes for scales, and sometimes for the abundant covering of feathers, whereas in the vivipara possessed of limbs it is turned into hair and into bodily substance (for man alone among them is smooth-skinned), and into urine, for this excretion is in the majority of such animals thick and copious. Only in the case of women is the residue turned into a discharge instead of being utilized in these other ways.

There is something similar to be remarked of men; for in proportion to his size man emits more seminal fluid than any other animals (for which reason man is the smoothest of animals), especially such men as are of a moist habit and not over corpulent, and fair men in greater degree than dark. It is likewise with women; for in the stout, a great part of the excretion goes to nourish the body. In the act of intercourse, women of a fair complexion discharge a more plentiful secretion than the dark; and furthermore, a watery and pungent diet conduces to this phenomenon.

3 · It is a sign of conception in women when the place is dry immediately after intercourse. If the lips of the orifice be smooth conception is difficult, for the matter slips off; and if they be thick it is also difficult. But if on digital examination the lips feel somewhat rough and adherent, and if they be likewise thin, then the chances are in favour of conception. Accordingly, if conception be desired, we must bring the parts into such a condition as we have just described; but if on the contrary we want to avoid conception then we must bring about a contrary disposition. For if the lips are smooth, conception does not take place—that is why some anoint that part of the womb on which the seed falls with oil of cedar, or with ointment of lead or with frankincense, commingled with olive oil. If the seed remain within for seven days then it is certain that conception has taken place; for it is during that period that what is known as effluxion takes place.

In most cases the menstrual discharge recurs for some time after conception has taken place, its duration being mostly thirty days in the case of a female and about forty days in the case of a male child. After parturition also it is common for the discharge to be withheld for an equal number of days, but not in all cases with equal exactitude. After conception, and when the above-mentioned days are past,

[2]The text of this sentence is corrupt.

the discharge no longer takes its natural course but finds its way to the breasts and turns to milk. The first appearance of milk in the breasts is scant in quantity and so to speak cobwebby. And when conception has taken place, there is apt to be a sort of
583b1 feeling in the region of the flanks, which in some cases quickly swell up a little, especially in thin persons, and also in the groin.

In the case of male children the first movement usually occurs on the right-hand side of the womb and about the fortieth day, but if the child be a female then on the left-hand side and about the ninetieth day. However, we must by no means assume this to be an accurate statement of fact, for there are many cases in which the movement is manifested on the right-hand side though a female child be coming, and on the left-hand side though the infant be a male. And in short, these and all suchlike phenomena are usually subject to differences that may be summed up as differences of degree.

About this period the embryo begins to resolve into distinct parts, it having hitherto consisted of a fleshlike substance without distinction of parts.

What is called effluxion is a destruction of the embryo within the first week, while abortion occurs up to the fortieth day; and the greater number of such embryos as perish do so within the space of these forty days.

In the case of a male embryo aborted at the fortieth day, if it be placed in cold water it holds together in a sort of membrane, but if it be placed in any other fluid it dissolves and disappears. If the membrane be pulled to bits the embryo is revealed, as big as one of the large kind of ants; and all the limbs are plain to see, including the penis, and the eyes also, which as in other animals are of great size. But the female embryo, if it suffer abortion during the first three months, is as a rule found to be undifferentiated; if however it reach the fourth month it comes to be subdivided and quickly attains further differentiation. In short, while within the womb, the female infant accomplishes the whole development of its parts more slowly than the male, and more frequently than the man-child takes ten months to come to perfection. But after birth, the females pass more quickly than the males through youth and maturity and age; and this is especially true of those that bear many children, as I have already said.

4 · When the womb has conceived the seed, straightway in the majority of cases it closes up until seven months are fulfilled; but in the eight month it opens, and the embryo, if it be fertile, descends in the eighth month. But such embryos as are not fertile but are devoid of breath at eight months old, their mothers do not bring into the world by parturition, neither does the embryo descend within the womb at that period nor does the womb open. And it is a sign that the embryo is not
584a1 capable of life if it be formed without the above-named circumstances taking place.

After conception women are prone to a feeling of heaviness in all parts of their bodies, and they experience a sensation of darkness in front of the eyes and suffer also from headache. These symptoms appear sooner or later, sometimes as early as the tenth day, according as the patient be more or less productive of residues. Nausea also and sickness affect most women, and especially such as those that we have just now mentioned, after the menstrual discharge has ceased and before it is yet turned in the direction of the breasts.

Moreover, some women suffer most at the beginning of their pregnancy and some at a later period when the embryo has had time to grow; and in some women it is a common occurrence to suffer from strangury towards the end of their time. As a general rule women who are pregnant of a male child escape comparatively easily and retain a comparatively healthy look, but it is otherwise with those whose infant is a female; for these latter look as a rule paler and suffer more pain, and in many cases they are subject to swellings of the legs and eruptions on the body. Nevertheless in some the opposite occurs.

Women in pregnancy are a prey to all sorts of longings and to rapid changes of mood, and some call this the 'ivy-sickness'; and with the mothers of female infants the longings are more acute, and they are less contented when they have got what they desired.

In a certain few cases the patient feels unusually well during pregnancy. The worst time of all is just when the child's hair is beginning to grow.

In pregnant women their own natural hair is inclined to grow thin and fall out, but on the other hand hair tends to grow on parts of the body where it was not wont to be. As a general rule, a man-child is more prone to movement within its mother's womb than a female child, and it is usually born sooner. And labour in the case of female children is apt to be protracted and sluggish, while in the case of male children it is acute and by a long way more difficult. Women who have connexion with their husbands shortly before childbirth are delivered all the more quickly. Occasionally women seem to be in the pains of labour though labour has not in fact commenced, what seemed like the commencement of labour being really the result of the foetus turning its head.

Now all other animals bring the time of pregnancy to an end in a uniform way; in other words, one single term of pregnancy is defined for each of them. But in the case of mankind alone of all animals the times are diverse; for pregnancy may be of seven months' duration, or of eight months or of nine, and still more commonly of ten months, while some few women go even into the eleventh month. 584b1

Children that come into the world before seven months can under no circumstances survive. The seven-months' children are the earliest that are capable of life, and most of them are weakly—for which reason, by the way, it is customary to swaddle them in wool,—and many of them are born with some of the orifices of the body imperforate, for instance the ears or the nostrils. But as they get bigger they become more perfectly developed, and many of them grow up.

In Egypt, and in some other places where the women are fruitful and are wont to bear and bring forth many children without difficulty, and where the children when born are capable of living even if they be born subject to deformity, in these places the eight-months' children live and are brought up, but in Greece it is only a few of them that survive while most perish. And this being the general experience, when such a child does happen to survive the mother is apt to think that it was not an eight-months' child after all, but that she had conceived at an earlier period without being aware of it.

Women suffer most pain about the fourth and the eighth months, and if the foetus perishes in the fourth or in the eighth month the mother also succumbs as a general rule; so that not only do the eight-months' children not live, but when they die their mothers are in great danger of their own lives. In like manner children that are apparently born at a later term than eleven months are held to be in doubtful case; inasmuch as with them also the beginning of conception may have escaped the notice of the mother. For often the womb gets filled with wind, and then when at a later period intercourse and conception take place, they think that the former circumstance was the beginning of conception from the similarity of the symptoms that they experienced.

Such then are the differences between mankind and other animals in regard to the many various modes[3] of completion of the term of pregnancy. Furthermore, some animals produce one and some produce many at a birth, but the human species does sometimes the one and sometimes the other. As a general rule and among most nations the women bear one child at a birth; but frequently and in many lands they bear twins, as for instance in Egypt. Sometimes women bring forth three and even four children, and especially in certain parts of the world, as has already been stated. The largest number ever brought forth is five, and such an occurrence has been witnessed on several occasions. There was once a certain woman who had twenty children at four births; each time she had five, and most of them grew up.

Now among other animals, if a pair of twins happen to be male and female
585a1 they have as good a chance of surviving as though both had been males or both females; but among mankind very few twins survive if one happen to be a boy and the other a girl.

Of all animals the woman and the mare are most inclined to receive the commerce of the male during pregnancy; while all other animals when they are pregnant avoid the male, save those in which the phenomenon of superfoetation occurs, such as the hare. Unlike that animal, the mare after once conceiving cannot be rendered pregnant again, but brings forth one foal only, at least as a general rule; in the human species cases of superfoetation are rare, but they do happen now and then.

An embryo conceived some considerable time after a previous conception does not come to perfection, but gives rise to pain and causes the destruction of the earlier embryo; and a case has been known to occur where owing to this destructive influence no less than twelve embryos conceived by superfoetation have been discharged. But if the second conception take place at a short interval, then the mother bears that which was later conceived, and brings forth the two children like actual twins, as happened, according to the legend, in the case of Iphicles and Hercules. The following also is a striking example: a certain woman, having committed adultery, brought forth the one child resembling her husband and the other resembling the adulterous lover.

The case has also occurred where a woman, being pregnant of twins, has

[3] Reading τρόπων.

subsequently conceived a third child; and in course of time she brought forth the twins perfect and at full term, but the third a five-months' child; and this last died there and then. And in another case it happened that the woman was first delivered of a seventh-months' child, and then of two which were of full term; and of these the first died and the other two survived.

Some also have been known to conceive while about to miscarry, and they have lost the one child and been delivered of the other.

If women while going with child cohabit after the eighth month the child is in most cases born covered over with a slimy fluid. Often also the child is found to be replete with food of which the mother had partaken.

When women have partaken of salt in over-abundance their children are apt to be born destitute of nails.

5 · Milk that is produced earlier than the seventh month is unfit for use; but as soon as the child is fit to live the milk is fit to use. The first of the milk is saltish, as it is with sheep. Most women are sensibly affected by wine during pregnancy; for if they partake of it they grow relaxed and debilitated.

The beginning of child-bearing in women and of the capacity to procreate in men, and the cessation of these functions in both cases, coincide in the one case with the emission of seed and in the other with the discharge of the menstrual fluids: with this qualification, that there is a lack of fertility at the commencement of these symptoms, and again towards their close when the emissions become scanty and weak. The age at which the sexual powers begin has been related already. As for their end, the menstrual discharge ceases in most women about their fortieth year; but with those in whom it goes on longer it lasts even to the fiftieth year, and women of that age have been known to bear children. But beyond that age there is no case on record.

6 · Men in most cases continue to be fertile until they are sixty years old, and if that limit be overpassed then until seventy years; and men have been actually known to procreate children at seventy years of age. With many men and many women it so happens that they are unable to produce children to one another, while they are able to do so in union with other individuals. The same thing happens with regard to the production of male and female offspring; for sometimes men and women in union with one another produce male children or female, as the case may be, but children of the opposite sex when otherwise mated. And they are apt to change in this respect with advancing age; for sometimes a husband and wife while they are young produce female children and in later life male children; and in other cases the very contrary occurs. And just the same thing is true in regard to the generative faculty; for some while young are childless, but have children when they grow older; and some have children to begin with, and later on no more.

There are certain women who conceive with difficulty, but if they do conceive, bring the child to maturity; while others again conceive readily, but are unable to bring the child to birth. Furthermore, some men and some women produce female offspring and some male, as for instance in the story of Hercules, who among all his two and seventy children is said to have begotten but one girl. Those women who are unable to conceive, save with the help of medical treatment or some other adventitious circumstance, are as a general rule apt to bear female children rather than male.

It is a common thing with men to be at first sexually competent and afterwards impotent, and then again to revert to their former powers.

From deformed parents come deformed children, lame from lame and blind from blind, and speaking generally, children often resemble their parents in respect of their unnatural features and are born with similar marks, such as pimples or scars. Such things have been known to be handed down through three generations; for instance, a certain man had a mark on his arm which his son did not possess, but his grandson had it in the same spot though not very distinct.

Such cases, however, are few; for the children of cripples are mostly sound,[4] and there is no hard and fast rule regarding them. While children mostly resemble their parents or their ancestors, it sometimes happens that no such resemblance is to be traced. But parents may pass on resemblance after several generations, as in the case of the woman in Elis, who committed adultery with a negro; in this case it was not the woman's own daughter but the daughter's child that was a negro.

As a rule the girls have a tendency to take after the mother, and the boys after the father; but sometimes it is the other way, the boys taking after the mother and the girls after the father. And they may resemble both parents in particular features.

There have been known cases of twins that had no resemblance to one another, but they are alike as a general rule. There was once a woman who had intercourse with her husband a week after giving birth to a child, and she conceived and bore a second child as like the first as any twin. Some women have a tendency to produce children that take after themselves, and others children that take after the husband; and this latter case is like that of the mare in Pharsalus, that got the name of the Honest Wife.

7 · In the emission of semen there is a preliminary discharge of air, and the outflow is manifestly caused by a blast of air; for nothing is cast to a distance save by force of air. After the seed reaches the womb and remains there for a while, a membrane forms around it; for when it happens to escape before it is distinctly formed, it looks like an egg enveloped in its membrane after removal of the eggshell; and the membrane is full of veins.

All animals, whether they fly or swim or walk upon dry land, whether they bring forth their young alive or in the egg, develop in the same way: save only that some have the navel attached to the womb, namely the viviparous animals, and some have it attached to the egg, and some to both parts alike, as in a certain sort of fishes. And in some cases membranous envelopes surround the egg, and in other

[4]Reading *τὰ δὲ πλεῖστα γίγνεται ὁλόκληρα.*

cases the chorion surrounds it. And first of all the animal develops within the innermost envelope, and then another membrane appears around the former one, which latter is for the most part attached to the womb, but is in part separated from it and contains fluid. In between is a watery or sanguineous fluid, which women call the forewaters.

8 · All animals which have a navel, grow by the navel. And the navel is attached to the cotyledon in all such as possess cotyledons, and to the womb itself by a vein in all such as have the womb smooth. And as regards their shape within the womb, the four-footed animals all lie stretched out, and the footless animals lie on their sides, as for instance fishes; but two-legged animals lie in a bent position, as for instance birds; and human embryos lie bent, with nose between the knees and eyes upon the knees, and the ears free at the sides.

All animals alike have the head upwards to begin with; but as they grow and approach the term of egress from the womb they turn downwards, and birth in the natural course of things takes place in all animals head foremost; but in abnormal cases it may take place in a bent position, or feet foremost.

The young of quadrupeds when they are near their full time contain excrements, both liquid and in the form of solid lumps, the latter in the lower part of the bowel and the urine in the bladder.

In those animals that have cotyledons in the womb the cotyledons grow less as the embryo grows bigger, and at length they disappear altogether. The navel-string is a sheath wrapped about blood-vessels which have their origin in the womb, from the cotyledons in those animals which possess them and from a blood-vessel in those which do not. In the larger animals, such as the embryos of oxen, the vessels are four in number, and in smaller animals two; in the very little ones, such as birds, one vessel only.

Of the vessels that run into the embryo, two pass through the liver where the so-called gates are, running in the direction of the great vein, and the other two run in the direction of the aorta towards the point where it divides and becomes two vessels instead of one. Around each pair of blood-vessels are membranes, and surrounding these membranes is the navel-string itself, after the manner of a sheath. And as the embryo grows, the veins themselves tend more and more to dwindle in size. And also as the embryo matures it comes down into the hollow of the womb and is observed to move here, and sometimes rolls over in the vicinity of the pudenda.

9 · When women are in labour, their pains occur in many different parts of the body, and in most cases to one or other of the thighs. Those are the quickest to be delivered who experience severe pains in the region of the belly; and parturition is difficult in those who begin by suffering pain in the loins, and speedy when the pain is abdominal. If the child about to be born be a male, the preliminary flood is watery and pale in colour, but if a girl it is tinged with blood, though still watery. In some cases of labour these latter phenomena do not occur, either one way or the other.

587a1 In other animals parturition is unaccompanied by pain, and the dam is plainly seen to suffer but moderate inconvenience. In women, however, the pains are more severe, and this is especially the case in persons of sedentary habits, and in those who are weak-chested and short of breath. Labour is apt to be especially difficult if during the process the woman while exerting force with her breath fails to hold it in.

First of all, when the embryo starts to move and the membranes burst, there issues forth the watery flood; then afterwards comes the embryo, while the womb everts and the afterbirth comes out from within.

10 · The cutting of the navel-string, which is the nurse's duty, is a matter calling for no little care and skill. For not only in cases of difficult labour must she be able to render assistance with skilful hand, but she must also have her wits about her in all contingencies, and especially in the operation of tying the cord. For if the afterbirth has come away, the navel is tied off from the afterbirth with a woollen thread and is then cut above it; and at the place where it has been tied it heals up, and the remaining portion drops off. (If the tie comes loose the child dies from loss of blood.) But if the afterbirth has not yet come away, but remains after the child itself is extruded, it is cut away within after the tying of the cord.

It often happens that the child appears to have been born dead when it is merely weak, and when, before the umbilical cord has been tied the blood has run out into the cord and its surroundings. But experienced midwives have been known to squeeze back the blood into the child's body from the cord, and immediately the child that a moment before was bloodless came back to life again.

It is the natural rule, as we have mentioned above, for all animals to come into the world head foremost, and children, moreover, have their hands stretched out by their sides. And the child gives a cry and puts its hands up to its mouth as soon as it issues forth.

Moreover the child voids excrement sometimes at once, sometimes a little later, but in all cases during the first day; and this excrement is unduly copious in comparison with the size of the child; it is what the midwives call the 'poppy-juice'. In colour it resembles blood, extremely dark and pitch-like, but later on it becomes milky, for the child takes at once to the breast. Before birth the child makes no sound—not even when in difficult labor it puts forth its head while the rest of the body remains within.

587b1 In cases where flooding takes place rather before its time, it is apt to be followed by difficult parturition. But if discharge take place after birth in small quantity, and in cases where it only takes place at the beginning and does not continue till the fortieth day, then in such cases women make a better recovery and are the sooner ready to conceive again.

Until the child is forty days old it neither laughs nor weeps during waking hours, but of nights it sometimes does both; and for the most part it does not even notice being tickled, but passes most of its time in sleep. As it keeps on growing it gets more and more wakeful; and moreover it shows signs of dreaming, though it is long afterwards before it remembers what it dreams.

In other animals there is no contrasting difference between one bone and another, but all are properly formed; but in children the fontanelle is soft and late ossifying. And some animals are born with teeth, but children begin to cut their teeth in the seventh month; and the front teeth are the first to come through, sometimes the upper and sometimes the lower ones. And the warmer the nurses' milk so much the quicker are the children's teeth to come.

11 · After parturition and the cleansing flood the milk comes in plenty, and in some women it flows not only from the nipples but at divers parts of the breasts, and in some cases even from the armpits. And for some time afterwards there continue to be 'knots', which occur when it so happens that the moisture is not concocted and finds no outlet but solidifies. For the whole breast is so spongy that if a woman in drinking happen to swallow a hair, she gets a pain in her breast, which ailment is called 'trichia'; and the pain lasts till the hair either find its own way out or be sucked out with the milk. Women continue to have milk until their next conception; and then the milk stops coming and goes dry, alike in the human species and in the quadrupedal vivipara. So long as there is a flow of milk the menstrual discharges do not take place as a general rule, though the discharge has been known to occur during the period of suckling. For, speaking generally, a flow of moisture does not take place at one and the same time in several directions; as for instance the menstrual discharges tend to be scanty in persons suffering from haemorrhoids. And in some women the like happens owing to their suffering from varicose veins, when the fluids issue from the pelvic region before entering into the womb. And patients who during suppression of the menses happen to vomit blood are no whit the worse.

12 · Children are very commonly subject to convulsions, more especially such of them as are more than ordinarily well-nourished on rich or unusually plentiful milk from a stout nurse. Wine tends to excite this malady, and red wine is worse than white, especially when taken undiluted; and most things that tend to induce flatulency are also bad, and constipation too is prejudicial. The majority of deaths in infancy occur before the child is a week old, hence it is customary to name the child at that age, from a belief that it has now a better chance of survival. This malady is worst at the full moon; and it is a dangerous symptom when the spasms begin in the child's back.

BOOK VIII

1 · We have now discussed the physical characteristics of animals and their methods of generation. Their habits and their modes of living vary according to their character and their food.

In the great majority of animals there are traces of psychical qualities which are more markedly differentiated in the case of human beings. For just as we pointed out resemblances in the physical organs, so in a number of animals we observe gentleness or fierceness, mildness or cross temper, courage or timidity, fear or confidence, high spirit or low cunning, and, with regard to intelligence, something equivalent to sagacity. Some of these qualities in man, as compared with the corresponding qualities in animals, differ only quantitatively: that is to say, a man has more of this quality, and an animal has more of some other; other qualities in man are represented by analogous qualities: for instance, just as in man we find knowledge, wisdom, and sagacity, so in certain animals there exists some other natural capacity akin to these. The truth of this statement will be the more clearly apprehended if we have regard to the phenomena of childhood; for in children may be observed the traces and seeds of what will one day be settled habits, though psychologically a child hardly differs for the time being from an animal; so that one is quite justified in saying that, as regards man and animals, certain psychical qualities are identical with one another, whilst others resemble, and others are analogous to, each other.

Nature proceeds little by little from things lifeless to animal life in such a way that it is impossible to determine the exact line of demarcation, nor on which side thereof an intermediate form should lie. Thus, next after lifeless things comes the plant, and of plants one will differ from another as to its amount of apparent vitality; and, in a word, the whole genus of plants, whilst it is devoid of life as compared with an animal, is endowed with life as compared with other corporeal entities. Indeed, as we just remarked, there is observed in plants a continuous scale of ascent towards the animal. So, in the sea, there are certain objects concerning which one would be at a loss to determine whether they be animal or vegetable. For instance, certain of these objects are fairly rooted,[1] and in several cases perish if detached; thus the pinna is rooted to a particular spot, and the razor-shell cannot survive withdrawal from its burrow. Indeed, broadly speaking, the entire genus of testaceans have a resemblance to vegetables, if they be contrasted with such animals as are capable of progression.

In regard to sensibility, some animals give no indication whatsoever of it, whilst others indicate it but indistinctly. Further, the substance of some of these intermediate creatures is fleshlike, as is the case with the so-called ascidians and the sea-anemones; but the sponge is in every respect like a vegetable. And so throughout the entire animal scale there is a graduated differentiation in amount of vitality and in capacity for motion.

A similar statement holds good with regard to habits of life. Thus of plants that spring from seed the one function seems to be the reproduction of their own particular species, and the sphere of action with certain animals is similarly limited. Such activities, then, are common to all alike. If sensibility be superadded,[1] then their lives will differ from one another in respect to sexual intercourse through the varying amount of pleasure derived therefrom, and also in regard to modes of parturition and ways of rearing their young. Some animals, like plants, simply procreate their own species at definite seasons; other animals busy themselves also

[1]Reading προσούσης.

in procuring food for their young, and after they are reared quit them and have no further dealings with them; other animals are more intelligent and endowed with memory, and they live with their offspring for a longer period and on a more social footing.

The life of animals, then, may be divided into two parts, procreation and feeding; for on these two acts all their interests and life concentrate. Their food varies chiefly according to the matter of which they are severally constituted; for the source of their growth in all cases will be this substance. And whatsoever is in conformity with nature is pleasant, and all animals pursue pleasure in keeping with their nature.

2 · Animals are also differentiated locally: that is to say, some live upon dry land, while others live in the water. And this differentiation may be interpreted in two[2] different ways. Thus, some animals are termed terrestrial as inhaling air, and others aquatic as taking in water; and there are others which do not actually take in these elements, but nevertheless are naturally adapted to the cooling influence, so far as is needful to them, of one element or the other, and hence are called terrestrial or aquatic [though they neither breathe air nor take in water.][3] Again, other animals are so called from their finding their food and fixing their habitat on land or in water: for many animals, although they inhale air and breed on land, yet derive their food from the water, and live in water for the greater part of their lives; and these are the only animals which seem to be ambivalent—for you might class them both as terrestrial and as aquatic. There is no animal taking in water that is terrestrial or that derives its food from the land, whereas of the great number of land animals inhaling air many get their food from the water; moreover some are such that if they be shut off altogether from the water they cannot possibly live, as for instance, the so called seaturtle, the crocodile, the hippopotamus, the seal, and some of the smaller creatures, such as the fresh-water tortoise and the frog: now all these animals choke if they do not from time to time breathe; they breed and rear their young on dry land, or near the land, but they pass their lives in water.

But the dolphin is equipped in the most remarkable way of all animals: the dolphin and other similar aquatic animals, including the other cetaceans which resemble it;[4] that is to say, the whale, and all the other creatures that are furnished with a blow-hole. One can hardly allow that such an animal is terrestrial and terrestrial only, or aquatic and aquatic only, if by terrestrial we mean an animal that inhales air, and if by aquatic we mean an animal that takes in water. For the fact is the dolphin performs both these processes: he takes in water and discharges it by his blow-hole, and he also inhales air into his lungs; for the creature is furnished with this organ and respires thereby, and accordingly, when caught in the nets, he is quickly suffocated for lack of air. He can also live for a considerable while out of the water, moaning and groaning, like other animals that breathe; furthermore, when

[2]Reading διχῶς
[3]Excised by Dittmeyer.
[4]Dittmeyer excises 'including . . . resemble it'.

sleeping, the animal keeps his nose above water, so that he may breathe the air. Now it would be unreasonable to assign one and the same class of animals to both categories seeing that these are contrary to one another; we must accordingly supplement our definition of the term 'aquatic'. For the fact is, some aquatic animals take in water and discharge it again, for the same reason that leads air-breathing animals to inhale air: in other words, with the object of cooling the blood. Others take in water as incidental to their mode of feeding; for as they get their food in the water they cannot but take in water along with their food, and if they take in water they must be provided with some organ for discharging it. Those sanguineous animals, then, that use water for a purpose analogous to respiration are provided with gills; and such as take in water when feeding, with the blow-hole. Similar remarks are applicable to cephalopods and crustaceans; for again it is by way of procuring food that these creatures take in water.

Aquatic in different ways, the differences depending on bodily constitution and on habit of life, are such animals on the one hand as take in air but live in water, and such on the other hand as take in water and are furnished with gills but go upon dry land and get their living there. At present only one animal of the latter kind is known, the so-called water-newt; this creature is furnished not with lungs but with gills, but for all that it is a quadruped and fitted for walking on dry land.

In the case of all these animals their nature appears in some kind of a way to have got warped, just as some male animals get to resemble the female, and some female animals the male. The fact is that animals, if they be subjected to a modification in minute organs, are liable to immense modifications in their general configuration. This phenomenon may be observed in the case of gelded animals:
590a1 only a minute organ of the animal is mutilated, and the creature passes from the male to the female form. We may infer, then, that if in the primary conformation of the embryo an infinitesimally minute but essential organ sustain a change of magnitude, the animal will in one case turn to male and in the other to female; and also that, if the said organ be obliterated altogether, the animal will be of neither one sex nor the other. And so by the occurrence of modification in minute organs it comes to pass that one animal is terrestrial and another aquatic, in both senses of these terms. And again, some animals are ambivalent, whilst other animals are not ambivalent, owing to the circumstance that in their conformation while in the embryonic condition there got intermixed into them some portion of the matter of which their subsequent food is constituted; for, as was said above, what is in conformity with nature is to every animal agreeable.

Animals then have been categorized into terrestrial and aquatic in three ways, according to their taking in of air or of water, the constitution of their bodies, or the character of their food; and the mode of life of an animal corresponds to the category in which it is found. That is to say, in some cases it depends on constitution and diet combined, as well as upon its method of respiration; and sometimes on constitution and habits alone.

Of testaceans, some, that are incapable of motion, subsist on fresh water (for, being thinner than the seawater which concocts with it, it percolates through the grosser parts)—just as they were originally engendered from the same. Now that fresh water is contained in the sea and can be strained off from it is plain; for a test has already been made to prove it: take a thin vessel of moulded wax, attach a cord to it, and let it down quite empty into the sea: in twenty-four hours it will be found to contain a quantity of water, and the water will be fresh.

Sea-anemones feed on such small fishes as come in their way. The mouth of this creature is in the middle of its body; and this fact may be clearly observed in the case of the larger varieties. Like the oyster it has a duct for the outlet of the residuum; and this duct is at the top of the animal. In other words, the sea-anemone corresponds to the inner fleshy part of the oyster, and the stone to which the one creature clings corresponds to the shell.

The limpet detaches itself from the rock and goes about in quest of food. Of shell-fish that are mobile, some are carnivorous and live on little fishes, as for instance, the purple murex—and there can be no doubt that the purple murex is carnivorous, as it is caught by a bait of fish; others feed also on marine vegetation.

The sea-turtles feed on shell-fish—for their mouths are extraordinarily hard; (whatever object it seizes, stone or other, it crunches into bits, but when it leaves the water it browses on grass). These creatures suffer greatly, and oftentimes die when they lie on the surface of the water exposed to a scorching sun; for they find a difficulty in sinking again.

Crustaceans feed in like manner. They are omnivorous; that is to say, they live on stones, slime, sea-weed, and excrement—as for instance the rock-crab—and are also carnivorous. The crayfish can get the better of fishes even of the larger species, though in some of them it occasionally finds more than its match. Thus, this animal is so overmastered by the octopus that it dies of terror if it become aware of an octopus in the same net with itself. The crayfish can master the conger-eel, for owing to the rough spines the eel cannot slip away. The conger-eel, however, devours the octopus, for owing to the slipperiness of its antagonist the octopus can make nothing of it. The crayfish feeds on little fish, capturing them beside its hole; for it is found out at sea on rough and stony bottoms, and in such places it makes its den. Whatever it catches, it puts into its mouth with its pincer-like claws, like the crab. Its nature is to walk straight forward when it has nothing to fear, with its feelers hanging sideways; if it be frightened, it makes its escape backwards, darting off to a great distance. These animals fight one another with their claws, just as rams fight with their horns, raising them and striking their opponents; they are often also seen crowded together as it were in herds. So much for the mode of life of the crustacean.

Cephalopods are all carnivorous;[5] and of cephalopods the calamary and the cuttlefish are more than a match for fishes even of the large species. The octopus for the most part gathers shell-fish, extracts the flesh, and feeds on that; in fact, fishermen recognize their holes by the number of shells lying about. Some say that the octopus devours itself, but this statement is incorrect—in fact, some have had their tentacles eaten off by the conger.

Fishes all feed on spawn in the spawning season; but in other respects the food

[5]This sentence is transposed from line 21.

varies with the varying species. Some fishes are exclusively carnivorous, as the Selachia, the conger, the channa, dentex, the tunny, the bass, the bonito, the sea-perch, and the muraena. The red mullet is carnivorous, but feeds also on sea-weed, on shell-fish, and on mud. The grey mullet feeds on mud,[6] the dascyllus on mud and excrement, the scarus and the melanurus on sea-weed, the saupe on excrement and sea-weed; the saupe feeds also on zostera,[7] and is the only fish that is captured with a gourd. All fishes devour their own species, with the exception of the mullet; and the conger is especially ravenous in this respect. The cephalus and the mullet in general are the only fish that eat no flesh; this may be inferred from the facts that when caught they are never found with flesh in their intestines, and that the bait used to catch them is not flesh but barley-cake. Every fish of the mullet-kind lives on sea-weed and sand. The cephalus, called by some the chelon, keeps near in to the shore, the peraeas keeps out at a distance from it, and feeds on a mucous substance exuding from itself, and consequently is always in a starved condition. The cephalus lives in mud, and is in consequence heavy and slimy; it never feeds on any other fish. As it lives in mud, it often makes a leap upwards so as to wash the slime from off its body. There is no creature known to prey upon the spawn of the cephalus, so that the species is exceedingly numerous; when, however, the fish is fullgrown it is preyed upon by a number of fishes, and especially by the bass. Of all fishes the mullet is the most voracious and insatiable, and in consequence its belly is kept at full stretch; whenever it is not starving, it may be considered as out of condition. When it is frightened, it hides its head in mud, under the notion that it is hiding its whole body. The synodon is carnivorous and feeds on cephalopods. Very often the synodon and the channa cast up their stomachs while chasing smaller fishes; for fishes have their stomachs close to the mouth, and are not furnished with a gullet.

Some fishes then, as has been stated, are carnivorous, and carnivorous only, as the dolphin, the synodon, the gilthead, the selachians, and the cephalopods.[8] Other fishes feed habitually on mud or sea-weed or sea-moss or the so-called stalk-weed or growing plants; as for instance, the phycis, the goby, and the rock-fish; and the only meat that the phycis will touch is that of prawns. Very often, however, as has been stated, they devour one another, and especially do the larger ones devour the smaller. The proof of their being carnivorous is the fact that they can be caught with flesh for a bait. The bonito, the tunny, and the bass are for the most part carnivorous, but they do occasionally feed on sea-weed. The sargue feeds on the leavings of the red mullet. The red mullet burrows in the mud, and when it sets the mud in motion and quits its haunt, the sargue settles down into the place and feeds on what is left behind, and prevents any smaller fish from settling in the immediate vicinity.

Of all fishes the so-called scarus is the only one known to chew the cud like a quadruped.

[6]Dittmeyer excises this sentence.
[7]Reading *πράσου*.
[8]Retaining *μαλακία*.

As a general rule the larger fishes catch the smaller ones in their mouths whilst swimming straight after them in the ordinary position; but the selachians, the dolphin, and all the cetacea must first turn over on their backs, as their mouths are placed down below; this allows a fair chance of escape to the smaller fishes, and, indeed, if it were not so, there would be very few of the little fishes left, for the speed and voracity of the dolphin is something marvellous.

Of eels a few here and there feed on mud and on chance morsels of food thrown 592a1
to them; the greater part of them subsist on fresh water. Eel-breeders are particularly careful to have the water kept perfectly clear, by its perpetually flowing on to flat slabs of stone and then flowing off again; sometimes they coat the eel-tanks with plaster. The fact is that the eel will soon choke if the water is not clear, as his gills are peculiarly small. On this account, when fishing for eels, they disturb the water. In the river Strymon eel-fishing takes place at the rising of the Pleiads, because at this period the water is troubled and the mud raised up by contrary winds; unless the water be in this condition, it is as well to leave the eels alone. When dead the eel, unlike the majority of fishes, neither floats on nor rises to the surface; and this is owing to the smallness of the stomach. A few eels are supplied with fat, but the greater part are not. When removed from the water they can live for five or six days; for a longer period if north winds prevail, for a shorter if south winds. If they are removed in summer from the pools to the tanks they will die; but not so if removed in the winter. They are not capable of holding out against any abrupt change; for example, they often die in large numbers when men engaged in transporting[9] them from one place to another dip them into water particularly cold. They will also die of suffocation if they be kept in a scanty supply of water. This same remark will hold good for fishes in general; for they are suffocated if they be long confined in a short supply of water, with the water kept unchanged—just as animals that respire are suffocated if they be shut up with a scanty supply of air. The eel in some cases lives for seven or eight years. The river-eel feeds on his own species, on grass, or on roots, or on any chance food found in the mud. Their usual feeding-time is at night, and during the day-time they retreat into deep water. And so much for the food of fishes.

3 · Of birds, such as have crooked talons are carnivorous without exception,
and cannot swallow corn even if it be put into their bills; as for instance, the eagle of 592b1
every variety, the kite, the two species of hawks, to wit, the dove-hawk and the sparrow-hawk—and these two hawks differ greatly in size from one another—and the buzzard. The buzzard is of the same size as the kite, and is visible at all seasons of the year. There is also the phene and the vulture. The phene is larger than the common eagle and is ashen in colour. Of the vulture there are two varieties: one small and whitish, the other comparatively large and rather more ashen-coloured. Further, of birds that fly by night, some have crooked talons, such as the night-raven, the owl, and the eagle-owl. The eagle-owl resembles the common owl

[9]Retaining τοῖς φέρουσιν.

in shape, but it is quite as large as the eagle. Again, there is the eleus, the Aegolian owl, and the little horned owl. Of these birds, the eleus is somewhat larger than the domestic cock, and the Aegolian owl is of about the same size as the eleus, and both these birds hunt the jay; the little horned owl is smaller than the common owl. All these three birds are alike in appearance, and all three are carnivorous.

Again, of birds that have not crooked talons some are carnivorous, such as the swallow. Others feed on grubs, such as the chaffinch, the sparrow, the batis, the green linnet, and the titmouse. Of the titmouse there are three varieties. The largest is the finch-titmouse—for it is about the size of a finch; the second has a long tail, and from its habitat is called the hill-titmouse; the third resembles the other two in appearance, but is less in size than either of them. Then come the becca-fico, the black-cap, the bullfinch, the robin, the epilais, the midget-bird, and the golden-crested wren. This wren is little larger than a locust, has a crest of bright red, and is in every way a beautiful and graceful little bird. Then the anthus, a bird about the size of a finch; and the mountain-finch, which resembles a finch and is of much the same size, but its neck is blue, and it lives in the mountains; and lastly the wren and the rook. The above-enumerated birds and the like of them feed either wholly or for the most part on grubs, but the following and the like feed on thistles; to wit, the linnet, the thraupis, and the goldfinch. All these birds feed on thistles, but never on grubs or any living thing whatever; they sleep also on the plants from which they derive their food.

There are other insectivorous birds, which live by hunting insects—as for instance, the great and the small pie, which are nicknamed the woodpeckers. These two birds resemble one another in plumage and in note, only that the note of the larger bird is the louder of the two; they both frequent the trunks of trees in quest of food. There is also the greenpie, a bird about the size of a turtle-dove, green-coloured all over, that pecks at the bark of trees with extraordinary vigour, lives generally on the branch of a tree, has a loud note, and is mostly found in the Peloponnese. There is another bird called the 'grubpicker', about as small as the penduline titmouse, with speckled plumage of an ashen colour, and with a poor note; it is a variety of the woodpecker.

There are other birds that live on fruit and herbage, such as the wild pigeon or ring-dove, the common pigeon, the rock-dove, and the turtle-dove. The ring-dove and the common pigeon are visible at all seasons; the turtle-dove only in the summer, for in winter it lurks in some hole or other and is never seen. The rock-dove is chiefly visible in the autumn, and is caught at that season; it is larger than the common pigeon but smaller than the wild one; it is generally caught while drinking. These pigeons bring their young ones with them when they visit this country. All our other birds come to us in the early summer and build their nests here, and the greater part of them rear their young on animal food, with the sole exception of the pigeon and its varieties.

The whole genus of birds may be pretty well divided into such as procure their food on dry land, such as frequent rivers and lakes, and such as live on or by the sea.

Of water-birds such as are web-footed live actually on the water, while such as are split-footed live by the edge of it—and water-birds that are not carnivorous live 593b1 on water-plants, but most of them live on fish, like the heron and the spoonbill that frequent the banks of lakes and rivers; and the spoonbill is smaller than the common heron, and has a long flat bill. There are furthermore the stork and the seamew; and the seamew is ashen-coloured. There is also the schoenilus, the cinclus, and the white-rump. Of these smaller birds the last mentioned is the largest, being about the size of the common thrush; all three may be described as 'wagtails'. Then there is the scalidris, with plumage ashen-grey, but speckled. Moreover, the family of the kingfishers live by the waterside. Of kingfishers there are two varieties; one that sits on reeds and sings; the other, the larger of the two, is without a note. Both these varieties are blue on the back. There is also the trochilus. The kingfisher and the cerylus are found near the seaside. The crow also feeds on such animal life as is cast up on the beach, for the bird is omnivorous. There are also the white gull, the cepphus, the aethyia, and the charadrius.

Of web-footed birds, the larger species live on the banks of rivers and lakes; as the swan, the duck, the coot, the grebe, and the teal—a bird resembling the duck but less in size—and the cormorant. This bird is the size of a stork, only that its legs are shorter; it is web-footed and is a good swimmer; its plumage is black. It roosts on trees, and is the only one of all such birds as these that is found to build its nest in a tree. Further there is the goose, the little gregarious goose, the vulpanser, the aix and the penelops. The sea-eagle lives in the neighbourhood of the sea and seeks its quarry in lagoons.

A great number of birds are omnivorous. Birds of prey feed on any animal or bird that they may catch, except that they never touch one of their own genus, whereas fishes often devour members actually of their own species. 594a1

Birds, as a rule, are very spare drinkers. In fact birds of prey never drink at all, excepting a very few, and these drink very rarely; and this last observation is peculiarly applicable to the kestrel. The kite has been seen to drink, but he certainly drinks very seldom.

4 · Animals that are coated with tessellates—such as the lizard and the other quadrupeds, and the serpents—are omnivorous: at all events they are carnivorous and graminivorous; and serpents are of all animals the greatest gluttons.

Tessellated animals are spare drinkers, as are also all such animals as have a spongy lung, and such a lung, scantily supplied with blood, is found in all oviparous animals. Serpents have an insatiate appetite for wine; consequently, at times men hunt for vipers by pouring wine into saucers and putting them into the interstices of walls, and the creatures are caught when inebriated. Serpents are carnivorous, and whenever they catch an animal they extract all its juices and eject the creature whole. [And this is done by all other creatures of similar habits, as for instance the spider; only that the spider sucks out the juices of its prey outside, and the serpent does so in its belly.][10] The serpent takes any food presented to him, eats birds and animals, and swallows eggs entire. But after taking his prey he stretches himself

[10]Excised by Dittmeyer.

until he stands straight out to the very tip, and then he contracts and squeezes himself into little compass, so that the swallowed mass may pass down his outstretched body; and this action on his part is due to the tenuity and length of his gullet. Spiders and snakes can both go without food for a long time; and this remark may be verified by observation of specimens kept alive in the shops of the apothecaries.

5 · Of viviparous quadrupeds, such as are fierce and saw-toothed are without exception carnivorous; though, by the way, it is stated of the wolf, but of no other animal, that in extremity of hunger it will eat a certain kind of earth. These carnivorous animals never eat grass except when they are sick, just as dogs bring on a vomit by eating grass and thereby purge themselves.

The solitary wolf is more apt to attack man than the wolf that goes with a pack.

The animal called 'glanus' by some and 'hyaena' by others is as large as a wolf, 594b1 with a mane like a horse, only that the hair is stiffer and longer and extends over the entire length of the chine. It will lie in wait for a man and chase him, [and will inveigle a dog within its reach by making a noise that resembles the retching noise of a man vomiting.][11] It is exceedingly fond of putrefied flesh, and will burrow in a graveyard to gratify this propensity.

The bear is omnivorous. It eats fruit, and is enabled by the suppleness of its body to climb a tree; it also eats vegetables, and it will break up a hive to get at the honey; it eats crabs and ants also, and is carnivorous. It is so powerful that it will attack not only the deer but the wild boar, if it can take it unawares, and also the bull. After coming to close quarters with the bull it falls on its back in front of the animal, and, when the bull proceeds to butt, the bear seizes hold of the bull's horns with its front paws, fastens its teeth into his shoulder, and drags him down to the ground. For a short time together it can walk erect on its hind legs. All the flesh it eats it first allows to become carrion.

The lion, like all other savage and saw-toothed animals, is carnivorous. It devours its food greedily, and often swallows its prey entire without rending it at all; it will then go fasting for two or three days together, being rendered capable of this abstinence by its previous surfeit. It is a spare drinker. It discharges the solid residuum sparingly, about every other day or at irregular intervals, and the substance of it is hard and dry like the excrement of dog. The wind discharged from off its stomach is pungent, and its urine emits a strong odour, a phenomenon which, in the case of dogs, accounts for their habit of sniffing at trees; for the lion, like the dog, lifts its leg to void its urine. It infects the food it eats with a strong smell by breathing on it, and when the animal is cut open an overpowering vapour exhales from its inside.

Some wild quadrupeds feed in lakes and rivers; the seal is the only one that gets its living on the sea. To the former class of animals belong the marten, the otter, and 595a1 the beaver. The beaver is flatter than the otter and has strong teeth; it often at

[11]Excised by Dittmeyer.

night-time emerges from the water and goes nibbling at the bark of the aspens that fringe the riversides. The otter will bite a man, and it is said that whenever it bites it will never let go until it hears a bone crack. The hair of the beaver is rough, intermediate in appearance between the hair of the seal and the hair of the deer.

6 · Saw-toothed animals drink by lapping, as do also some animals with teeth differently formed, as the mouse. Animals whose upper and lower teeth meet evenly drink by suction, as the horse and the ox; the bear neither laps nor sucks, but gulps. Birds, as a rule, drink by suction, but the long-necked birds stop and elevate their heads at intervals; the purple coot is the only one that gulps.

Horned animals, domesticated or wild, and all such as are not saw-toothed, are all frugivorous and graminivorous, save under great stress of hunger. The pig is an exception; it cares little for grass or fruit, but of all animals it is the fondest of roots, owing to the fact that its snout is peculiarly adapted for digging them out of the ground; it is also of all animals the most easily pleased in the matter of food. It takes on fat more rapidly in proportion to its size than any other animal; in fact, a pig can be fattened for the market in sixty days. Pig-dealers can tell the amount of flesh taken on, by having first weighed the animal while it was being starved. Before the fattening process begins, the creature must be starved for three days; (animals in general will take on fat if subjected previously to a course of starvation); after the three days, pig-breeders feed the animal lavishly. Breeders in Thrace, when fattening pigs, give them a drink on the first day; then they miss one, and then two days, then three and four, until the interval extends over seven days. This animal is fattened on barley, millet, figs, acorns, wild pears, and cucumbers. These animals—and other animals that have warm bellies—are fattened by repose. [Pigs also fatten the better by being allowed to wallow in mud. They like to feed in batches of the same age. A pig will give battle even to a wolf.][12] A sixth part of what it weighs when living is made up of hair, blood, and the like. When suckling their young, sows—like all other animals—get attenuated. So much for these animals.

7 · Cattle feed on fruit and grass, and fatten on vegetables that tend to cause flatulency, such as bitter vetch or bruised beans or bean-stalks. [The older ones also will fatten if they be fed up after an incision has been made into their hide, and air blown into it.][13] Cattle will fatten also on barley, in its natural state or winnowed, or on sweet food, such as figs, or pulp from the wine-press,[14] or on elm-leaves. [But nothing is so fattening as the heat of the sun and wallowing in warm waters. If the horns of young cattle be smeared with wax, you may mould them to any shape you please, and cattle are less subject to disease of the hoof if you smear the horns with wax, pitch, or olive oil.][15] Herded cattle suffer more when they are forced to change their pasture-ground by frost than when snow is the cause of change. Cattle grow all the more in size when they are kept from sexual commerce over a number of years; and it is with a view to growth in size that in Epirus the so-called Pyrrhic cattle are

[12] Excised by Dittmeyer. [13] Excised by Dittmeyer.
[14] Reading ἀσταφίσι τοῦ οἰνοῦ. [15] Excised by Dittmeyer.

not allowed intercourse with the bull until they are nine years old; from which circumstance they are nicknamed the 'unbulled' cattle. Of these they say that there are only about four hundred in the world, that they are the private property of the royal family, and that they cannot thrive out of Epirus although people elsewhere have tried.

8 · Horses, mules, and asses feed on fruit and grass, but are fattened chiefly by drink. Just in proportion as beasts of burden drink water, so will they more or less enjoy their food, and a place will give good or bad feeding according as the water is good or bad. Green corn, while ripening, will give a smooth coat; but such corn is injurious if the spikes are hard. The first crop of clover is unwholesome, and so is clover over which ill-scented water runs; for the clover is sure to get the taint of the water. Cattle like clear water for drinking; but the horse in this respect resembles the camel, for the camel likes turbid and thick water, and will never drink from a stream until he has trampled it into a turbid condition. The camel can go without water for as much as four days, but after that when he drinks, he drinks in immense quantities.

9 · The elephant at the most can eat nine Macedonian medimni of barley at one meal; but so large an amount is unwholesome. As a general rule it can take six or seven medimni, five medimni of wheat, and five *mareis* of wine—six cotylae going to the *maris*. An elephant has been known to drink right off fourteen Macedonian *metretae* of water, and another eight *metretae* later in the day.

Camels live for about thirty years; in some exceptional cases they live much longer, and instances have been known of their living to the age of a hundred. The elephant is said by some to live for about two hundred years; by others, for three hundred.

10 · Sheep and goats are graminivorous, but sheep browse assiduously and steadily, whereas goats shift their ground rapidly, and browse only on the tips of the herbage. Sheep are fattened by drinking, and accordingly they give the flocks salt every five days in summer, to the extent of one medimnus to the hundred sheep, and this is found to render a flock healthier and fatter. In fact they mix salt with the greater part of their food; a large amount of salt is mixed into their bran (for the reason that they drink more when thirsty), and in autumn they get cucumbers with a sprinkling of salt on them; this admixture of salt in their food tends also to increase the quantity of milk. If sheep be kept on the move at midday they will drink more copiously towards evening; and if the ewes be fed with salted food as the lambing season draws near they will get larger udders. Sheep are fattened by twigs of the olive or of the oleaster, by vetch, and bran of every kind; and these articles of food fatten all the more if they be first sprinkled with brine. Sheep too will take on flesh all the better if they be first put for three days through a process of starving. In autumn, water from the north is more wholesome for sheep than water from the south. Pasture grounds are all the better if they have a westerly aspect.

Sheep will lose flesh if they be kept overmuch on the move or be subjected to any hardship. In winter time shepherds can easily distinguish the vigorous sheep from the weakly, from the fact that the vigorous sheep are covered with hoar-frost while the weakly ones are quite free of it; the fact being that the weakly ones feeling oppressed with the burden shake themselves and so get rid of it. The flesh of all quadrupeds deteriorates in marshy pastures, and is the better on high grounds. Sheep that have flat tails can stand the winter less well than long-tailed sheep, and short-fleeced sheep than the shaggy-fleeced; and sheep with crisp wool stand the rigour of winter very poorly. Sheep are healthier than goats, but goats are stronger than sheep. [The fleeces and the wool of sheep that have been killed by wolves, as also the clothes made from them, are exceptionally infested with lice.][16]

11 · Of insects, such as have teeth are omnivorous; such as have a tongue feed on liquids only, extracting with that organ juices from all quarters. And of these latter some may be called omnivorous, inasmuch as they feed on every kind of juice, as for instance, the common fly; others are blood-suckers, such as the gadfly and the horse-fly, others again live on the juices of fruits and plants. The bee is the only insect that does not settle on things rotten; it will touch no article of food unless it have a sweet-tasting juice, and it is particularly fond of drinking water if it be found bubbling up clear from a spring.

So much for the food of animals of the various genera.

12 · The habits of animals are all connected with either breeding and the rearing of young, or with the procuring a due supply of food; and these habits are modified so as to suit cold and heat and the variations of the seasons. For all animals have an instinctive perception of the changes of temperature, and, just as men seek shelter in houses in winter, or as men of great possessions spend their summer in cool places and their winter in sunny ones, so also all animals that can do so shift their habitat at various seasons.

Some creatures can make provision against change without stirring from their ordinary haunts; others migrate, quitting Pontus and the cold countries after the autumnal equinox to avoid the approaching winter, and after the spring equinox migrating from warm lands to cool lands to avoid the coming heat. In some cases they migrate from places near at hand, in others they may be said to come from the ends of the world, as in the case of the crane; for these birds migrate from the steppes of Scythia to the marshlands south of Egypt where the Nile has its source. [And it is here that they are said to fight with the pygmies; and the story is not fabulous, but there is in reality a race of dwarfish men, and the horses are little in proportion, and the men live in caves underground.][17] Pelicans also migrate, and fly from the Strymon to the Ister, and breed on the banks of this river. They depart in flocks, and the birds in front wait for those in the rear, owing to the fact that when the flock is passing over the intervening mountain range, the birds in the rear lose sight of their companions in the van.

[16]Excised by Dittmeyer.
[17]Excised by Dittmeyer.

Fishes also in a similar manner shift their habitat now out of the Euxine and now into it. In winter they move from the outer sea in towards land in quest of heat; in summer they shift from shallow waters to the deep sea to escape the heat.

Weakly birds in winter and in frosty weather come down to the plains for warmth, and in summer migrate to the hills because of the heat. The more weakly an animal is the greater hurry will it be in to migrate on account of extremes of temperature, either hot or cold; thus the mackerel migrates in advance of the tunnies, and the quail in advance of the cranes. The former migrates in the month of Boedromion, and the latter in the month of Maemacterion. All creatures are fatter in migrating from cold to heat than in migrating from heat to cold; thus the quail is fatter in autumn than in spring. The migration from cold countries is contemporaneous with the close of the hot season. Animals are in better trim for breeding purposes in spring-time, when they change from hot to cool lands.

Of birds, the crane, as has been said, migrates from one end of the world to the other; they fly against the wind. The story told about the stone is untrue: to wit, that the bird, so the story goes, carries a stone by way of ballast, and that the stone when vomited up is a touchstone for gold.

The cushat and the rock-dove migrate, and never winter in our country, as is the case also with the swallow and the turtle-dove; the common pigeon, however, stays behind. The quail also migrates; only a few quails and turtle-doves may stay behind in sunny districts. Cushats and turtle-doves flock together, both when they arrive and when the season for migration comes round again. When quails come to land, if it be fair weather or if a north wind is blowing, they will pair off and manage pretty comfortably; but if a southerly wind prevail they are greatly distressed owing to the difficulties in the way of flight, for a southerly wind is wet and violent. For this reason bird-catchers trap them in southerly winds but not during fine weather. They fly badly because of their weight; for their body is heavy, and that is why the bird always screams while flying—for the labour is severe. When the quails come from abroad they have no leaders, but when they migrate hence, the glottis flits along with them, as does also the landrail, and the eared owl, and the corncrake. The corncrake calls them in the night, and when the bird-catchers hear the croak of the bird in the night-time they know that the quails are on the move. The landrail is like a marsh bird, and the glottis has a tongue that can project far out of its beak. [The eared owl is like an ordinary owl, only that it has feathers about its ears; by some it is called the night-raven. It is a rogue and a mimic: while it apes the dance of the hunter, his accomplice comes behind and catches it. The common owl is caught by a similar trick.

As a general rule all birds with crooked talons are short-necked, flat-tongued, and disposed to mimicry. The Indian bird, the parrot, which is said to have a man's tongue, answers to this description; and after drinking wine, the parrot becomes more saucy than ever.

Of birds, the following live in flocks—the crane, the swan, the pelican, and the lesser goose.][18]

[18]Excised by Dittmeyer.

13 · Of fishes, some, as has been observed, migrate from the outer seas in towards shore, and from the shore towards the outer seas, to avoid the extremes of 598a1 cold and heat.

Fish living near to the shore are better eating than deep-sea fish. The fact is they have more abundant and better feeding, for wherever the sun's heat can reach vegetation is more abundant, better in quality, and more delicate, as is seen in any ordinary garden. Further, the black shore-weed grows near to shore; the other shore-weed is like wild weed.[19] Besides, the parts of the sea near to shore are subjected to a more equable temperature; and consequently the flesh of shallow-water fishes is more consistent, whereas the flesh of deep water fishes is flaccid and watery.

The following fishes are found near into shore—the synodon, the black bream, the merou, the gilthead, the mullet, the red mullet; the wrasse, the weaver, the callionymus, the goby, and rock-fishes of all kinds. The following are deep-sea fishes—the trygon, the selachia, the white conger, the channa, the erythrinus, and the glaucus. The braize, the sea-scorpion, the black conger, the muraena, and the piper are found alike in shallow and deep waters. These fishes, however, vary for various localities; for instance, the goby and all rock-fish are fat off the coasts of Crete. Again, the tunny is good again after the rising of Arcturus; for then it is free from parasites—that is why it is worse in summer. A number of fish also are found in sea-estuaries; such as the saupe, the gilthead, the red mullet, and, in point of fact, the greater part of the gregarious fishes. The bonito also is found in such waters, as, for instance, off the coast of Alopeconnesus; and most species of fish are found in Lake Bistonis. The coly-mackerel as a rule does not enter the Euxine, but passes the summer in the Propontis, where it spawns, and winters in the Aegean. The tunny, the pelamys, and the bonito penetrate into the Euxine in summer and pass the summer there; as do also the greater part of such fish as congregate in shoals together. And most fish congregate in shoals, and shoal-fishes in all cases have leaders.

Fish penetrate into the Euxine for food. For the feeding is more abundant and better in quality owing to the amount of fresh water, and moreover, the large fishes are fewer—indeed, there is no large fish in the Euxine excepting the dolphin and the 598b1 porpoise, and the dolphin is a small variety; but as soon as you get into the outer sea the big fishes are there. Furthermore, fish penetrate into this sea for the purpose of breeding; for there are regions there favourable for spawning, and the fresh and sweet water has an invigorating effect upon the spawn. After spawning, when the young fishes have attained some size, the parent fish swim out immediately after the rising of the Pleiads. If winter comes in with a southerly wind, they swim out more slowly; but, if a north wind be blowing, they swim out with greater rapidity, from the fact that the breeze is favourable to their own course. And the young fish are caught about this time in the neighbourhood of Byzantium very small in size, as might have been expected from the shortness of their sojourn in the Euxine. The shoals in general are visible both as they quit and enter the Euxine. The

[19] Retaining τοῖς ἀγρίοις—but the text of this sentence is uncertain.

trichiae, however, only can be caught during their entry, but are never visible during their exit; in point of fact, when a trichia is caught in the neighbourhood of Byzantium, the fishermen are particularly careful to cleanse their nets, as they do not often swim out. The reason is that this fish alone swims northwards into the Ister, and then at the point of its bifurcation swims down into the Adriatic. And, as a proof that this theory is correct, the very opposite phenomenon presents itself in the Adriatic; that is to say, that they are not caught in that sea during their entry, but are caught during their exit.

Tunny-fish swim into the Euxine keeping the shore on their right, and swim out of it with the shore upon their left. It is stated that they do so as being naturally weak-sighted, and seeing better with the right eye.

During the daytime shoal-fish continue on their way, but during the night they rest and feed. But if there be moonlight, they continue their journey without resting at all. Some people accustomed to sea-life assert that shoal-fish at the period of the winter solstice never move at all, but keep perfectly still wherever they may happen to have been overtaken by the solstice, and this lasts until the equinox.

The coly-mackerel is caught more frequently on entering than on quitting the Euxine. And in the Propontis the fish is at its best before the spawning season. Shoal-fish, as a rule, are caught in greater quantities as they leave the Euxine, and at that season they are in the best condition. At the time of their entrance they are caught in very plump condition close to shore, but those are in comparatively poor
599a1 condition that are caught farther out to sea. Very often, when the coly-mackerel and the mackerel are met by a south wind in their exit, there are better catches to the southward than in the neighbourhood of Byzantium. So much then for the phenomenon of migration of fishes.

Now the same phenomenon is observed in fishes as in terrestrial animals in regard to hibernation: in other words, during winter fishes take to concealing themselves, and quit their places of concealment in the warmer season. But animals go into concealment by way of refuge against extreme heat, as well as against extreme cold. Sometimes an entire genus will thus seek concealment; in other cases some species will do so and others will not. For instance, the shell-fish seek concealment without exception, as is seen in the case of those dwelling in the sea, the purple murex, the trumpet-shell, and all such like; but though in the case of the detached species the phenomenon is obvious—for they hide themselves, as is seen in the scallop, or they are provided with an operculum on the free surface, as in the case of land snails—in the case of the non-detached the concealment is not so clearly observed. They do not go into hiding at one and the same season; but the snails go in winter, the purple murex and the trumpet-shell for about thirty days at the rising of the Dog-star, and the scallop at about the same period. But for the most part they go into concealment when the weather is either extremely cold or extremely hot.

14 · Insects almost all go into hiding, with the exception of such of them as live in human habitations or perish before the completion of the year. The rest hide in the winter; some of them for several days, others for only the coldest days, as the

bee. For the bee also goes into hiding; and the proof that it does so is that bees never touch the food set before them, and if a bee creeps out of the hive, it is quite transparent, with nothing whatsoever in its stomach; and the period of its rest lasts from the setting of the Pleiads until spring-time.

Animals hide by concealing themselves in warm places, or in places where they have been used to lie concealed.

15 · Several blooded animals hide, such as the tessellates, namely, the serpent, the lizard, the gecko, and the river-crocodile, all of which go into hiding for four months in the depth of winter, and during that time eat nothing. Serpents in general burrow under ground for this purpose; the viper conceals itself under a stone.

A great number of fishes also take this sleep, and notably, the hippurus and coracinus in winter time; for, whereas fish in general may be caught at all periods of the year more or less, these are never caught at all outside a certain fixed period of the year. The muraena also hides, and the sea-perch, and the conger. Rock-fish pair off, male and female, for hiding [just as for breeding];[20] as is observed in the case of the wrasse and the owzel and the perch.

The tunny also takes a sleep in winter in deep waters, and gets exceedingly fat after the sleep. The fishing season for the tunny begins at the rising of the Pleiads and lasts, at the longest, down to the setting of Arcturus; during the rest of the year they are hid and inactive. About the time of hibernation a few tunnies or other hibernating fishes are caught while swimming about, in particularly warm localities and in exceptionally fine weather, or on nights of full moon; for the fishes emerge for a while from their lair in quest for food.

Most fishes are at their best during the hiding-period.

The primas-tunny conceals itself in the mud; this may be inferred from the fact it is not caught, and that it is covered with mud and has its fins damaged. In the spring[21] these tunnies get in motion and proceed towards the coast, coupling and breeding, and the females are now caught full of spawn. At this time, they are considered as in season, but in autumn and in winter as of inferior quality; at this time also the males are full of milt. When the spawn is small, the fish is hard to catch, but it is easily caught when the spawn gets large, as the fish is then infested by its parasite. Some fish burrow for sleep in the sand and some in mud, just keeping their mouths outside.

Most fishes hide, then, during the winter, but crustaceans, the rock-fish, the ray, and the selachia hide only during extremely severe weather, and this may be inferred from the fact that these fishes are not caught when the weather is extremely cold. Some fishes, however, hide during the summer too, as the glaucus; this fish hides in summer for about sixty days. The hake also and the gilthead hide; and we infer that the hake hides over a lengthened period from the fact that it is only caught at long intervals. We are led also to infer that fishes hide in summer

[20]Excised by Dittmeyer.
[21]Reading ἐαρινήν.

from the circumstance that the takes of certain fish are made between the rise and setting of certain constellations: of the dog-star in particular, the sea at this period being upturned. This phenomenon may be observed to best advantage in the Bosporus; for the mud is there brought up to the surface and the fish are brought up along with it. They say also that very often, when the sea-bottom is dredged, more fish will be caught by the second haul than by the first one. Furthermore, after very heavy rains numerous specimens become visible of creatures that at other times are never seen at all or seen only rarely.

16 · A great number of birds also go into hiding; they do not all migrate, as is generally supposed, to warmer countries. Thus, certain birds [as the kite and the swallow][22] when they are not far off from places of this kind, in which they have their permanent abode, betake themselves thither; others, that are at a distance from such places, do not migrate but hide themselves. Swallows, for instance, have been often found in holes, quite denuded of their feathers, and the kite on its first appearance has been seen to fly from out some such hiding-place. And with regard to this hibernation, there is no distinction observed, whether the talons of a bird be crooked or straight; for instance, the stork, the owzel, the turtle-dove, and the lark, all go into hiding. The case of the turtle-dove is the most accepted of all, for we would defy any one to assert that he had anywhere seen a turtle-dove in winter-time; at the beginning of the hiding time it is exceedingly plump, and during this period it moults, but retains its plumpness. Some cushats hide; others, instead of hiding, migrate at the same time as the swallow. The thrush and the starling hide; and of birds with crooked talons the kite and the owl hide for a few days.

17 · Of viviparous quadrupeds the hedgehog and the bear retire into concealment. The fact that the bear hides is well established, but there are doubts as to whether it does so by reason of the cold or from some other cause. About this period the male and the female become so fat as to be hardly capable of motion. The
600b1 female brings forth her young at this time, and remains in concealment until it is time to bring the cubs out; and she brings them out in spring, about three months after the winter solstice. The bear hides for at least forty days; during fourteen of these days it is said not to move at all, but during most of the subsequent days it moves, and from time to time wakes up. A she-bear in pregnancy has either never been caught at all or has been caught very seldom. There can be no doubt but that during this period they eat nothing; for they never emerge from their hiding-place, and further, when they are caught, their belly and intestines are found to be quite empty. It is also said that from no food being taken the gut almost closes up, and that in consequence the animal on first emerging takes to eating arum with the view of opening up and distending the gut.

The dormouse actually hides in a tree, and gets very fat at that period; as does also the white mouse of Pontus.

[22]Excised by Dittmeyer.

[Of animals that hide some slough off what is called their 'old-age'. This name is applied to the outermost skin, and to the casing that envelops the developing organism.][23]

In discussing the case of terrestrial vivipara we stated that the reason for the bear's seeking concealment is disputed. The tessellates for the most part go into hiding, and if their skin is soft they slough off their 'old-age', but not if the skin is shell-like, as is the shell of the tortoise—for the tortoise and the freshwater tortoise belong to the tessellates. Thus, the old-age is sloughed off by the gecko, the lizard, and above all, by serpents; and they slough off the skin in springtime when emerging from their torpor, and again in the autumn. Vipers also slough off their skin both in spring and in autumn, and it is not the case, as some aver, that this species of the serpent family is exceptional in not sloughing. When the serpent begins to slough, the skin peels off at first from the eyes, so that any one ignorant of the phenomenon would suppose the animal were going blind; after that it peels off the head—for in all cases it appears white.[24] The sloughing goes on for a day and a night, beginning with the head and ending with the tail. During the sloughing the skin turns inside out; for the creature emerges just as the embryo from its afterbirth. 601ª1

All insects that slough at all slough in the same way; as the silphe, and the midge, and all the coleoptera, as for instance the cantharus-beetle. They all slough after the period of development; for just as the afterbirth breaks from off the young of the vivipara so the outer husk breaks off from around the young of the vermipara, in the same way both with the bee and the grasshopper. The cicada the moment after issuing from the husk goes and sits upon an olive tree or a reed; after the breaking up of the husk the creature issues out, leaving a little moisture behind, and after a short interval flies into the air and sets a-chirping.

Of marine animals the crayfish and the lobster slough sometimes in the spring, and sometimes in autumn after parturition. Crayfish have been caught occasionally with the parts about the thorax soft, from the shell having there peeled off, and the lower parts hard, from the shell having not yet peeled off there; for they do not slough in the same manner as the serpent. The crayfish hides for about five months. Crabs also slough off their old-age; this is generally allowed with regard to the soft-shelled crabs, and it is said to be the case with the testaceous kind, as for instance with the 'granny' crab. When these animals slough their shell becomes soft all over, and as for the crab, it can scarcely crawl. These animals also do not cast their skins once but often.

So much for the animals that go into hiding, for the times at which, and the ways in which, they go; and so much also for the animals that slough off their old-age, and for the times at which they undergo the process.

18 · Animals do not all thrive at the same seasons, nor do they thrive alike during all extremes of weather. Further, animals of diverse species are in a diverse way healthy or sickly at certain seasons; and, in point of fact, some animals have

[23]Excised by Dittmeyer.
[24]Reading λευκὴ γάρ.

ailments that are unknown to others. Birds thrive in times of drought, both in their general health and in regard to parturition, and this is especially the case with the cushat; fishes, however, with a few exceptions, thrive best in rainy weather; on the contrary, rainy seasons are bad for birds—and so by the way is much drinking—and drought is bad for fishes. Birds of prey, as has been already stated, may in a
601b1 general way be said never to drink at all, though Hesiod appears to have been ignorant of the fact, for in his story about the siege of Nineveh he represents the eagle that presided over the auguries as in the act of drinking; all other birds drink, but drink sparingly, as is the case also with all other spongy-lunged oviparous animals. Sickness in birds may be diagnosed from their plumage, which is ruffled when they are sickly instead of lying smooth as when they are well.

19 · The majority of fishes, as has been stated, thrive best in rainy seasons. Not only have they food in greater abundance at this time, but in a general way rain is wholesome for them just as it is for vegetation—for kitchen vegetables, though artificially watered, nevertheless grow better when rained upon; and the same remark applies even to reeds that grow in marshes, as they hardly grow at all without a rainfall. That rain is good for fishes may be inferred from the fact that most fishes migrate to the Euxine for the summer; for owing to the number of the rivers that discharge into this sea its water is exceptionally fresh, and the rivers bring down a large supply of food. Besides, a great number of fishes, such as the bonito and the mullet, swim up the rivers and thrive in the rivers and marshes. The goby also fattens in the rivers, and, as a rule, countries abounding in lagoons furnish excellent fish. Of types of rain, summer showers are particularly good for most fish; and they benefit when the spring, summer, and autumn are rainy and the winter is fine. As a general rule what is good for men is good for fishes also.

Fishes do not thrive in cold places, and those fishes suffer most in severe winters that have a stone in their head, as the chromis, the basse, the sciaena, and the braize; for owing to the stone they get frozen with the cold, and are thrown up on shore.

Whilst rain is wholesome for most fishes, it is, on the contrary, unwholesome
602a1 for the mullet, the cephalus, and the so-called marinus, for rain superinduces blindness in most of these fishes, and all the more rapidly if the rainfall be superabundant. The cephalus is peculiarly subject to this malady in severe winters; their eyes grow white, and when caught they are in poor condition, and eventually the disease kills them. It would appear that this disease is due to cold even more than to an excessive rainfall; at all events, in many places and more especially in shallows off the coast of Nauplia, in the Argolid, a number of blind fishes have been caught in seasons of severe cold. The gilthead also suffers in winter; the acharnas suffers in summer, and loses condition. The coracine is exceptional among fishes in deriving benefit from drought, and this is due to the fact that heat and drought are apt to come together.

Particular places suit particular fishes: those at home off shore or in the deep sea thrive in those places; those which are ambivalent thrive in both. Some fishes will thrive in one particular spot, and in that spot only. As a general rule it may be said that places abounding in weeds are wholesome; at all events, fishes caught in such places are exceptionally fat: that is, such fishes as inhabit all sorts of localities as well. The fact is that weed-eating fishes find abundance of their special food in such localities, and carnivorous fish find an unusually large number of smaller fish. It matters also whether the wind be from the north or south: the longer fish thrive better when a north wind prevails, and in summer at one and the same spot more long fish will be caught than flat fish with a north wind blowing.

The tunny and the sword-fish are infested with a parasite about the rising of the dog-star; that is to say, about this time both these fishes have a grub beside their fins that is nicknamed the 'gadfly'. It resembles the scorpion in shape, and is about the size of the spider. So acute is the pain it inflicts that the sword-fish will sometimes leap as high out of the water as a dolphin; in fact, it often falls into a boat. The tunny delights more than any other fish in the heat of the sun. It will make for the sand near to shore because of the warmth, or will, because it is warm, disport itself on the surface of the sea.

The fry of little fishes escape by being overlooked, for it is only the larger ones that large fish pursue. The greater part of the spawn and the fry of fishes is destroyed by the heat of the sun, for whatever of them the sun reaches it spoils.

Fishes are caught in greatest abundance before sunrise and after sunset, or, speaking generally, just about sunset and sunrise. Fishermen haul up their nets at these times, and speak of the hauls then made as timely. The fact is, that at these times fishes are particularly weaksighted; at night they are at rest, and as the light grows stronger they see comparatively well.

We know of no pestilential malady attacking fishes, such as those which attack man, and horses and oxen among the quadrupedal vivipara, and certain other animals, domesticated and wild; but fishes do seem to suffer from sickness; and fishermen infer this from the fact that at times fishes in poor condition, and looking as though they were sick, and of altered colour, are caught in a large haul of well-conditioned fish of their own species. So much for sea-fishes.

20 · River-fish and lake-fish also are exempt from diseases of a pestilential character, but certain species are subject to special maladies. For instance, the sheat-fish just before the rising of the dog-star, owing to its swimming near the surface of the water, is liable to sunstroke, and is paralysed by a loud peal of thunder. The carp is subject to the same eventualities, but in a lesser degree. The sheat-fish is destroyed in great quantities in shallow waters by the serpent called the dragon. In the balerus and tilon a worm is engendered about the rising of the dog-star, that sickens these fish and causes them to rise towards the surface, where they are killed by the excessive heat. The chalcis is subject to a very violent malady; lice are engendered underneath their gills in great numbers, and cause destruction among them; but no other species of fish is subject to any such malady.

Mullein kills fish; that is why fishermen use mullein in rivers and ponds—by the Phoenicians it is made use of also in the sea.

There are two other methods employed for catching fish. In winter fishes emerge from the deep parts of rivers—and at all seasons fresh water is tolerably cold. A trench accordingly is dug leading though dry ground into a river, and wattled at the river end with reeds and stones, an aperture being left in the wattling through which the river water flows into the trench; when the frost comes on the fish can be taken out of the trench in weels. Another method is adopted in summer and winter alike. They run across a stream a dam composed of rushwood and stones, leaving a small open space, and in this space they insert a weel in which they catch them when they have removed the stones.[25]

Shell-fish, as a rule are benefited by rainy weather. The purple murex is an exception; if it be placed on a shore near to where a river discharges, it will die within a day after tasting the fresh water. The murex lives for about fifty days after capture; during this period they feed off one another, as there grows on the shell a kind of sea-weed or sea-moss; if any food is thrown to them during this period, it is said to be done to make them weigh more.

To shell-fish in general drought is unwholesome. During dry weather they decrease in size and degenerate in quality; and it is during such weather that the red scallop is found in more than usual abundance. In the Pyrrhaean Strait the scallop was exterminated, partly by the dredging-machine used in their capture, and partly by long-continued droughts. Rainy weather is wholesome to the generality of shell-fish owing to the fact that the sea-water then becomes exceptionally sweet. In the Euxine, owing to the coldness of the climate, shell-fish are not found; nor yet in rivers, excepting a few bivalves. Univalves are very apt to freeze to death in extremely cold weather. So much for animals that live in water.

21 · To turn to quadrupeds, the pig suffers from three diseases, one of which is called branchos, a disease attended with swellings about the windpipe and the
603b1 jaws. It may break out in any part of the body; very often it attacks the foot, and occasionally the ear; the neighbouring parts also soon rot, and the decay goes on until it reaches the lungs, when the animal succumbs. The disease develops with great rapidity, and the moment it sets in the animal gives up eating. The swineherds know but one way to cure it, namely, by complete excision, when they detect the first signs of the disease. There are two other diseases, which are both alike termed craurus. The one is attended with pain and heaviness in the head, and this is the commoner of the two, the other with diarrhoea. The latter is incurable, the former is treated by applying wine to the snout and rinsing the nostrils with wine. Even this disease is very hard to cure; it has been known to kill within three or four days. The animal is chiefly subject to branchos when it gets extremely fat, and when the heat has brought a good supply of figs. The treatment is to feed on mulberries, to give repeated warm baths, and to lance the under part of the tongue.

Pigs with flabby flesh are subject to measles about the legs, neck, and shoulders, for the pimples develop chiefly in these parts. If the pimples are few in

[25]Retaining περιελόντες τοὺς λίθους.

number the flesh is comparatively sweet, but if they be numerous it gets watery and flaccid. The symptoms of measles are obvious, for the pimples show chiefly on the under side of the tongue, and if you pluck the bristles off the chine the skin will appear suffused with blood, and further the animal will be unable to keep its hind-feet at rest. Pigs never take this disease while they are mere sucklings. The pimples may be got rid of by tiphe; and this is useful as food too. The best food for rearing and fattening pigs is chickpeas and figs, but the one thing essential is to vary the food as much as possible, for this animal, like animals in general, delights in a change of diet; and it is said that one kind of food blows the animal out, that another superinduces flesh, and that another puts on fat, and that acorns, though liked by the animal, render the flesh flaccid. Besides, if a pregnant sow eats acorns in great quantities, it will miscarry, as is also the case with the ewe—for acorns quite plainly have that effect on ewes. The pig is the only animal known to be subject to measles.

22 · Dogs suffer from three diseases; rabies, quinsy, and sore feet. Rabies drives the animal mad, and any animal whatever, excepting man, will take the disease if bitten by a dog so afflicted; the disease is fatal to the dog itself, and to any animal it may bite, man excepted. Quinsy also is fatal to dogs; and only a few dogs recover from disease of the feet. The camel, like the dog, is subject to rabies. The elephant, which is reputed to enjoy immunity from all other illnesses, is occasionally subject to flatulency.

23 · Cattle in herds are liable to two diseases, foot-sickness and craurus. In the former their feet suffer from eruptions, but the animal recovers from the disease without even the loss of the hoof. It is found of service to smear the horny parts with warm pitch. In craurus, the breath comes warm at short intervals; in fact, craurus in cattle answers to fever in man. The symptoms of the disease are drooping of the ears and disinclination for food. The animal soon succumbs, and when the carcase is opened the lungs are found to be rotten.

24 · Horses out at pasture are free from all diseases excepting disease of the feet. From this disease they sometimes lose their hooves; but after losing them they grow them soon again, for as one hoof is decaying it is being replaced by another. Symptoms of the malady are a sinking in and wrinkling of the lip in the middle under the nostrils, and a twitching of the right testicle.

Stall-reared horses are subject to very numerous forms of disease. They are liable to a disease called 'eileus'. Under this disease the animal trails its hind-legs under its belly so far forward as almost to fall back on its haunches; if it goes without food for several days and then turns rabid, it may be of service to draw blood, or to castrate the male. The animal is subject also to tetanus: the veins get rigid, as also the head and neck, and the animal walks with its legs stretched out straight. The horse suffers also from abscesses. Another painful illness afflicts them called the 'barley-surfeit'. The symptoms are a softening of the palate and heat of the breath; it is incurable, unless the animal recovers spontaneously.

There is also a disease called nymphia, in which the animal is said to be possessed and droops its head on hearing flute-music; if during this ailment the horse be mounted, it will run off at a gallop until it is pulled. Even with this rabies in full force, it preserves a dejected spiritless appearance; some of the symptoms are a throwing back of the ears followed by a projection of them, great languor, and panting. Heart-ache also is incurable, of which the symptom is pain and loosening of the bowels; and so is displacement of the bladder, which is accompanied by a retention of urine and a drawing up of the hooves and haunches. Neither is there any cure if the animal swallow the grape-beetle, which is about the size of the knuckle-beetle. The bite of the shrewmouse is dangerous to other draught animals as well; it is followed by boils. The bite is all the more dangerous if the mouse be pregnant when she bites, for the boils then burst, but do not burst otherwise. The cicigna—called 'chalcis' by some, and 'zignis' by others—either causes death by its bite or, at all events, intense pain; it is like a small lizard, with the colour of the blind snake. In point of fact, according to experts, the horse and the sheep have pretty well as many ailments as the human species. The drug realgar is extremely injurious to a horse, and to all draught animals; it is given to the animal in a solution of water, the liquid being filtered. The mare when pregnant is apt to miscarry when disturbed by the odour of an extinguished candle; and a similar accident happens occasionally to women in their pregnancy. So much for the diseases of the horse.

The so-called hippomanes grows, as they say, on the foal, and the mare nibbles it off as she licks and cleans the foal. All the curious stories connected with the hippomanes are due to old wives and to the venders of charms. What is called the 'polium' is, as all the accounts state, delivered by the mother before the foal appears.

A horse will recognize the neighing of any other horse with which it may have fought at any previous period. The horse delights in meadows and marshes, and likes to drink muddy water; in fact, if water be clear, the horse will trample in it to make it turbid, will then drink it, and afterwards will wallow in it. The animal is fond of water and of bathing—and this explains the peculiar constitution of the hippopotamus. In regard to water the ox is the opposite of the horse; for if the water be impure or cold, or mixed up with alien matter, it will refuse to drink it.

25 · The ass suffers chiefly from one particular disease which they call 'melis'. It arises first in the head, and a clammy humor runs down the nostrils, thick and red; if it stays in the head the animal may recover, but if it descends into the lungs the animal will die. Of all animals of its kind it is the least capable of enduring extreme cold, which circumstance will account for the fact that the animal is not found on the shores of the Euxine, nor in Scythia.

26 · Elephants suffer from flatulence and then can void neither solid nor liquid residuum. If the elephant swallows earth it suffers from relaxation; but if it

goes on taking it steadily, it will experience no harm. From time to time it takes to swallowing stones. It suffers also from diarrhoea: in this case they administer draughts of lukewarm water and dip its fodder in honey, and either one or the other prescription will prove a costive. When they are exhausted from insomnia, they will be restored to health if their shoulders be rubbed with salt, olive-oil, and warm water; when they have aches in their shoulders they will derive great benefit from the application of roast pork. Some elephants like olive-oil, and others do not. If there is a bit of iron in the inside of an elephant it is said that it will pass out if the animal takes a drink of olive-oil; if the animal refuses olive-oil, they soak a root in the oil and give it the root to swallow.

So much, then, for quadrupeds.

27 · Insects, as a general rule, thrive best in the time of year in which they come into being, especially if the season be moist and warm, as in spring.

In bee-hives are found creatures that do great damage to the combs; for instance, the grub that spins a web and ruins the honey-comb: it is called the 'cleros', and by some the 'pyraustes'. It engenders an insect like itself, of a spider-shape, and brings disease into the swarm. There is another insect resembling the moth that flies about a lighted candle; this creature engenders a brood full of a fine down. It is never stung by a bee, and can only be got out of a hive by fumigation. A caterpillar also is engendered in hives [called a 'borer'][26] with which the bee never interferes. Bees suffer most when flowers are covered with mildew, or in seasons of drought.

All insects die if they be smeared over with oil; and they die all the more rapidly if you smear their head with the oil and lay them out in the sun.

28 · Variety in animal life may be produced by variety of locality: thus in one place an animal will not be found at all, in another it will be small, or short-lived, or will not thrive. Sometimes this sort of difference is observed in closely adjacent districts. Thus, in the territory of Miletus, in one district cicadas are found while there are none in the district adjoining; and in Cephalenia there is a river on one side of which the cicada is found and not on the other. In Pordoselene there is a public road on one side of which the weasel is found but not on the other. In Boeotia the mole is found in great abundance in the neighborhood of Orchomenus, but there are none in Lebadia, though it is in the immediate vicinity, and if a mole be transported from the one district to the other it will refuse to burrow in the soil. The hare cannot live in Ithaca if introduced there; in fact it will be found dead, turned towards the point of the beach where it was landed. The winged ant is not found in Sicily; the croaking frog has only recently appeared in the neighbourhood of Cyrene. In the whole of Libya there is neither wild boar, nor stag, nor wild goat; and in India, according to Ctesias—no very good authority, by the way—there are no swine, wild or tame, but animals that are devoid of blood and tessellates are all of

[26]Excised by Dittmeyer.

immense size there. In the Euxine there are no cephalopods nor testaceans, except a few here and there; but in the Red Sea all the testaceans are exceedingly large. In Syria the sheep have tails a cubit in breadth; the goats have ears a span and a palm long, and some have ears that flap down to the ground; and the cattle have humps on their shoulders, like the camel. In Lycia goats are shorn, just as sheep are in all other countries. In Libya horned animals are born with horns, and not the ram only, as Homer words it, but others as well; in Pontus, on the confines of Scythia, it is the other way about—they are born without horns.

In Egypt animals, as a rule, are larger than in Greece, as the cow and the sheep; but some are less, as the dog, the wolf, the hare, the fox, the raven, and the hawk; others are of pretty much the same size, as the crow and the goat. The difference is attributed to the food, as being abundant in one case and insufficient in another, for instance for the wolf and the hawk; for provision is scanty for the
606b1 carnivorous animals, small birds being scarce; food is scanty also for the hare and for all non-carnivorous animals, because neither the nuts nor the fruit last long.

In many places the climate will account for peculiarities; thus in Illyria, Thrace and Epirus the ass is small, and in Gaul and in Scythia the ass is not found at all owing to the coldness of the climate of these countries. In Arabia the lizard is more than a cubit in length, and the mouse is much larger than our field-mouse, with its hind-legs a span long and its front legs the length of the first finger-joint. In Libya, according to accounts, the length of the serpents is something appalling; some say that they once put ashore and saw the bones of a number of oxen, and that they were sure that the oxen had been devoured by serpents, for, just as they were putting out to sea, serpents came chasing their galleys at full speed and overturned one galley and set upon the crew. Again, lions are more numerous in Libya, and in that district of Europe that lies between the Achelous and the Nessus; the leopard is more abundant in Asia Minor, and is not found in Europe at all. As a general rule, wild animals are at their wildest in Asia, at their boldest in Europe, and most diverse in form in Libya; in fact, there is an old saying, 'Always something fresh in Libya.'

It would appear that in that country animals of diverse species meet, on account of the rainless climate, at the watering-places, and there pair together; and that such pairs will breed if they be nearly of the same size and have periods of gestation of the same length. For they are tamed down in their behaviour towards each other by extremity of thirst. And, by the way, unlike animals elsewhere, they require to drink more in winter-time than in summer; for they acquire the habit of not drinking in summer, owing to the circumstance that there is usually no water
607a1 then; and the mice, if they drink, die. Elsewhere also offspring are born to heterogeneous pairs; thus in Cyrene the wolf and the bitch will couple and breed; and the Laconian hound is a cross between the fox and the dog. They say that the Indian dog is a cross between the tiger and the bitch, not the first cross, but a cross in the third generation; for they say that the first cross is a savage creature. They take the bitch to a lonely spot and tie her up—and many are eaten, unless the beast is eager to mate.

29 · Locality will differentiate habits also: for instance, rugged highlands will not produce the same results as the soft lowlands. The animals of the highlands look fiercer and bolder, as is seen in the swine of Mount Athos; for a lowland boar is no match even for a mountain sow.

Again, locality is an important element in regard to the bite of an animal. Thus, in Pharos and other places, the bite of the scorpion is not dangerous; elsewhere—in Scythia, for instance,—where scorpions are venomous as well as plentiful and of large size, the sting is fatal to man or beast, even to the pig, and especially to the black pig, though the pig is in general most indifferent to the bite of any other creature. If a pig goes into water after being struck, it will surely die. There is great variety in the bites of serpents. The asp is found in Libya; the so-called 'septic' drug is made from the animal, and is the only remedy known for the bite of the original. Among the silphium, also, a snake is found, for the bite of which a certain stone is said to be cure: a stone that is brought from the grave of an ancient king, put into water and drunk off. In certain parts of Italy the bite of the gecko is fatal. But the deadliest of all bites of venomous creatures is when one venomous animal has bitten another; as, for instance, a viper's after it has bitten a scorpion. To the great majority of such creatures man's spittle is fatal. There is a very little snake, by some entitled the 'holy-snake', which is dreaded by even the largest serpents. It is about an ell long, and hairy-looking; whenever it bites an animal, the flesh all round the wound will at once mortify. There is in India a small snake which is exceptional in this respect, that for its bite no specific is known.

30 · Animals also vary as to their condition of health in connexion with 607b1
their pregnancy.

Testaceans, such as scallops and all the oyster-family, and crustaceans, such as the crayfish-family, are best when with spawn. Even in the case of the testacean we speak of spawning; but whereas the crustaceans may be seen coupling and laying their spawn, this is never the case with testaceans. Cephalopods are best in the breeding time, as the calamary, the cuttlefish, and the octopus.

Fishes, when they begin to breed, are nearly all good for the table; but after the female has gone long with spawn they are good in some cases, and in others are out of season. The maenis, for instance, is good at the breeding time. The female of this fish is round, the male longer and flatter; when the female is beginning to breed the male turns black and mottled, and is quite unfit for the table; at this period he is nicknamed the 'goat'.

The fish called the owzel and the thrush have different colours at different seasons, as is the case with certain birds; that is to say, they become black in the spring and after the spring get white again. The phycis also changes its hue: in general it is white, but in spring it is mottled; it is the only sea-fish which is said to make a bed for itself, and the female lays her spawn in this bed. The maenis, as was observed, changes its colour as does the smaris, and in summer-time changes back from whitish to black, the change being especially marked about the fins and gills. The coracine, like the maenis, is in best condition at breeding time; the mullet, the basse, and scaly fishes in general are in bad condition at this period. A few fish are in much the same condition whether with spawn or not, as the glaucus. Old fishes also are bad eating; the old tunny is unfit even for pickling, as a great part of its flesh wastes away with age, and the same is observed in other fishes. The age of a scaly fish may be told by the size and the hardness of its scales. An old tunny has been caught weighing fifteen talents, with the span of its tail two cubits and a palm broad.

608a1 River-fish and lake-fish are best after they have discharged the spawn and the milt; that is, when they have fully recovered. Some are good in the breeding time, as the saperdis, and some bad, as the sheat-fish. As a general rule, the male fish is better eating than the female; but the reverse holds good of the sheat-fish. The eels that are called females are the better—people call them females though they are not so but look different.

BOOK IX

1 · Of the animals that are comparatively obscure and short-lived the characters are not so obvious to our perception as are those of animals that are longer-lived. These latter animals appear to have a natural capacity corresponding to each of the passions of the soul: to good sense or simplicity, courage or timidity, to good temper or to bad, and to other similar dispositions.

Some also are capable of giving or receiving instruction—of receiving it from one another or from man: those that have the faculty of hearing—not merely of hearing sounds but of distinguishing the differences of signs.

In all genera in which the distinction of male and female is found, nature makes a similar differentiation in the characteristics of the two sexes. This differentiation is the most obvious in the case of human kind and in that of the larger animals and the viviparous quadrupeds. For the female is softer in character, is the sooner tamed, admits more readily of caressing, is more apt in the way of learning; as, for instance, in the Laconian breed of dogs the female is cleverer than the male. Of the Molossian breed of dogs, such as are employed in the chase are pretty much the same as those elsewhere; but the sheep-dogs of this breed are superior to the others in size, and in the courage with which they face the attacks of wild animals.

Dogs that are born of a mixed breed between these two kinds are remarkable for courage and endurance of hard labour.

In all cases, excepting those of the bear and leopard, the female is less spirited than the male; in regard to the two exceptional cases, the superiority in courage
608b1 rests with the female. With all other animals the female is softer in disposition, is more mischievous, less simple, more impulsive, and more attentive to the nurture of the young; the male, on the other hand, is more spirited, more savage, more simple and less cunning. The traces of these characteristics are more or less visible

everywhere, but they are especially visible where character is the more developed, and most of all in man.

The fact is, the nature of man is the most rounded off and complete, and consequently in man the qualities above referred to are found most clearly. Hence woman is more compassionate than man, more easily moved to tears, at the same time is more jealous, more querulous, more apt to scold and to strike. She is, furthermore, more prone to despondency and less hopeful than the man, more void of shame, more false of speech, more deceptive, and of more retentive memory. She is also more wakeful, more shrinking, more difficult to rouse to action, and requires a smaller quantity of nutriment.

As was previously stated, the male is more courageous than the female, and more sympathetic in the way of standing by to help. Even in the case of cephalopods, when the cuttlefish is struck with the trident the male stands by to help the female; but when the male is struck the female runs away.

There is enmity between such animals as dwell in the same localities or subsist on the same food. If the means of subsistence run short, creatures of like kind will fight together. Thus it is said that seals which inhabit one and the same district will fight, male with male, and female with female, until one combatant kills the other, or one is driven away by the other; and their young do in like manner.

All creatures are at enmity with the carnivores, and the carnivores with all the rest, for they all subsist on living creatures. Soothsayers take notice of cases where animals keep apart from one another, and cases where they congregate together; calling those that live at war with one another 'dissociates', and those that dwell in peace with one another 'associates'. One may go so far as to say that if there were no lack or stint of food, then those animals that are now feared and are wild by nature would be tame towards man and in like manner towards one another. This is shown by the way animals are treated in Egypt, for owing to the fact that food is constantly supplied to them the very fiercest creatures live peaceably together. The fact is they are tamed by being benefited, and in some places crocodiles are tame to their priestly keeper from being fed by him. And elsewhere also the same phenomenon is to be observed.[1]

The eagle and the snake are enemies, for the eagle lives on snakes; so are the ichneumon and the venom-spider, for the ichneumon preys upon the latter. In the case of birds, there is mutual enmity between the poecilis, the crested lark, the woodpecker, and the chloreus, for they devour one another's eggs; so also between the crow and the owl; for, owing to the fact that the owl is dim-sighted by day, the crow at midday preys upon the owl's eggs, and the owl at night upon the crow's, the one getting the better during the day, the other at night.

There is enmity also between the owl and the wren; for the latter also devours the owl's eggs. In the daytime all other little birds flutter round the owl—a practice which is popularly termed 'admiring him'—buffet him, and pluck out his feathers; in consequence of this habit, birdcatchers use the owl as a decoy for catching little birds of all kinds.

[1]Omitting *καὶ κατὰ μόρια τούτων*.

The so-called presbys is at war with the weasel and the crow, for they prey on her eggs and her brood; and so the turtle-dove with the pyrallis, for they live in the same districts and on the same food; and so with the green woodpecker and the libyus; and so with the kite and the raven, for, owing to his having the advantage from stronger talons and more rapid flight the former can steal whatever the latter is holding, so that it is food also that makes enemies of these. In like manner there is war between birds that get their living from the sea, as between the brenthus, the gull, and the harpe; and so between the buzzard on one side and the toad and snake on the other, for the buzzard preys upon the eggs of the two others; and so between the turtle-dove and the chloreus; the chloreus kills the dove, and the crow kills the so-called drummer-bird.

The aegolius, and birds of prey in general, prey upon the calaris, and consequently there is war between it and them; and so is there war between the gecko-lizard and the spider, for the former preys upon the latter; and so between the woodpecker and the heron, for the former preys upon the eggs and brood of the latter. And so between the aegithus and the ass, owing to the fact that the ass, in passing, rubs its sore parts against the prickles; by so doing, and all the more if it brays, it topples the eggs and the brood out of the nest, the young ones tumble out in fright, and the mother-bird, to avenge this wrong, flies at the beast and pecks at his sore places.

The wolf is at war with the ass, the bull, and the fox, for as being a carnivore, he attacks these other animals; and so for the same reason with the fox and the circus, for the circus, being carnivorous and furnished with crooked talons, attacks and maims the animal. And so the raven is at war with the bull and the ass, for it flies at them, and strikes them, and pecks at their eyes; and so with the eagle and the heron, for the former, having crooked talons, attacks the latter, and the latter usually succumbs to the attack; and so the merlin with the vulture; and the crex with the eleus-owl, the blackbird, and the oriole (of this latter bird some tell the story that he was originally born out of a funeral pyre): the cause of warfare is that the crex injures both them and their young. The nuthatch and the wren are at war with the eagle; the nuthatch breaks the eagle's eggs, so the eagle is at war with it both for this reason and because, as a bird of prey, it carries on a general war all round. The horse and the anthus are enemies, and the horse will drive the bird out of the field where he is grazing: the bird feeds on grass, and sees very dimly; it mimics the whinnying of the horse, flies at him, and tries to frighten him away; but the horse drives the bird away, and whenever he catches it he kills it: this bird lives beside rivers or on marsh ground; it has pretty plumage, and finds its food without trouble. The ass is at enmity with the lizard, for the lizard sleeps in his manger, gets into his nostril, and prevents his eating.

Of herons there are three kinds: the ash-coloured, the white, and the starry heron. Of these the first mentioned submits with reluctance to the duties of incubation, or to union of the sexes; in fact, it screams during the union, and it is said drips blood from its eyes; it lays its eggs also in an awkward manner, not unattended with pain. It is at war with certain creatures that do it injury: with the eagle for robbing it, with the fox for worrying it at night, and with the lark for stealing its eggs.

The snake is at war with the weasel and the pig; with the weasel when they are both at home, for they live on the same food; with the pig for preying on her kind. The merlin is at war with the fox; it strikes and claws it, and, as it has crooked talons, it kills the animal's young. The raven and the fox are good friends, for the raven is at enmity with the merlin; and so when the merlin assails the fox the raven comes and helps the animal. The vulture and the merlin are mutual enemies, as being both furnished with crooked talons. The vulture fights with the eagle, and so 610a1
does the swan; and the swan is often victorious: moreover, of all birds swans are most prone to eating one another.

In regard to wild creatures, some sets are at enmity with other sets at all times; others, as in the case of man and man, under incidental circumstances. The ass and the acanthis are enemies; for the bird lives on thistles, and the ass browses on thistles when they are young and tender. The anthus, the acanthis, and the aegithus are at enmity with one another; it is said that the blood of the anthus will not mix with the blood of the aegithus. The crow and the heron are friends, as also are the sedge-bird and lark, the laedus and the green woodpecker; the woodpecker lives on the banks of rivers and beside brakes, the laedus lives on rocks and hills, and is greatly attached to its nesting-place. The piphinx, the harpe, and the kite are friends; as are the fox and the snake, for both burrow underground; so also are the blackbird and the turtle-dove. The lion and the jackal are enemies, for both are carnivorous and live on the same food.

Elephants fight fiercely with one another, and stab one another with their tusks; of two combatants the beaten one gets completely cowed, and dreads the sound of his conqueror's voice. These animals differ from one another to an extraordinary extent in the way of courage. Indians employ these animals for war purposes, irrespective of sex; the females, however, are less in size and much inferior in point of spirit. An elephant by pushing with his big tusks can batter down a wall, and will butt with his forehead at a palm until he brings it down, when he stamps on it and lays it on the ground. Men hunt the elephant in the following way: they mount tame elephants of approved spirit and proceed in quest of wild animals; when they come up with these they bid the tame brutes to beat the wild ones until they tire the latter completely. Hereupon the driver mounts a wild brute and guides him with the goad; after this the creature soon becomes tame, and obeys guidance. Now when the driver is on their back they are all tractable, but after he has dismounted, some are tame and others vicious; in the case of these latter, they tie their front-legs with ropes to keep them quiet. The animal is hunted whether young or full grown.

Thus we see that in the case of the creatures above mentioned their mutual friendship or enmity is due to the food they feed on and the life they lead.

2 · Of fishes, some swim in shoals together and are friendly to one another; 610b1
such as do not so swim are enemies. Some fishes swarm during the spawning season; others after they have spawned. To state the matter comprehensively, we may say

that the following are shoaling fish: the tunny, the maenis, the goby, the bogue, the horse-mackerel, the coracine, the dentex, the red mullet, the sphyraena, the anthias, the eleginus, the atherine, the sarginus, the gar-fish, the squid, the rainbow-wrasse, the pelamyd, the mackerel, the coly-mackerel. Of these some not only swim in shoals, but go in pairs inside the shoal; the rest all pair, but only swim in shoals at certain periods: that is, as has been said, when they are heavy with spawn or after they have spawned.

The basse and the mullet are bitter enemies, but they shoal together at certain times; for at times not only do fishes of the same species swarm together, but also those whose feeding-grounds are identical or adjacent, if the food-supply be abundant. The grey mullet is often found alive with its tail lopped off, and the conger with all that part of its body removed that lies to the rear of the vent; in the case of the mullet the injury is wrought by the basse, in that of the conger-eel by the muraena. There is war between the larger and the lesser fishes; for the big fishes prey on the little ones. So much on the subject of marine animals.

3 · The characters of animals, as has been observed, differ in respect to timidity, to gentleness, to courage, to tameness, to intelligence, and to stupidity.

The sheep is said to be dull and stupid. Of all quadrupeds it is the most foolish: it will saunter away to lonely places with no object in view; often in stormy weather it will stray from shelter; if it be overtaken by a snowstorm, it will stand still unless the shepherd sets it in motion; it will stay behind and perish unless the shepherd brings up the rams; it will then follow home.

If you[2] catch hold of a goat's beard at the extremity—the beard is of a substance resembling hair—all the companion goats will stand stock still, staring at this particular goat in a kind of dumbfounderment.

You will have a warmer bed in amongst the goats than among the sheep, because the goats will be quieter and will creep up towards you; for the goat is more impatient of cold than the sheep.

Shepherds train sheep to close in together at a clap of their hands, for if, when a thunderstorm come on, a ewe stays behind without closing in, it will miscarry if it
611a1 be with young; consequently if a sudden clap or noise is made, they close in together within the sheepfold by reason of their training.

Even bulls, when they are roaming by themselves apart from the herd, are killed by wild animals.

Sheep and goats lie crowded together, kin by kin. As soon as the sun turns, the herdsmen say that goats lie no longer face to face, but back to back.

4 · Cattle at pasture keep together in their accustomed herds, and if one animal strays away the rest will follow; consequently if the herdsmen lose one particular animal, they at once look out for all the rest.

When mares pasture together in the same field, if one dies the others will take

[2]Reading μιᾶς.

up the rearing of the colt. In point of fact, the mare appears to be singularly prone by nature to maternal fondness; in proof whereof a barren mare will steal the foal from its dam, will tend it with all the solicitude of a mother, but, as it will be unprovided with mother's milk, its solicitude will prove fatal to its charge.

5 · Among wild quadrupeds the hind appears to be pre-eminently intelligent; for example, in its habit of bringing forth its young on the sides of public roads, where the fear of man forbids the approach of wild animals. Again, after parturition, it first swallows the afterbirth, then goes in quest of the seseli shrub, and after eating of it returns to its young. The mother takes its young to her lair, so leading it to know its place of refuge; this lair is a precipitous rock, with only one approach, and there it is said to hold its own against all comers. The male when it gets fat, which it does in a high degree in autumn, disappears, abandoning its usual resorts, apparently under an idea that its fatness facilitates its capture. They shed their horns in places difficult of access or discovery, whence the proverbial expression of 'the place where the stag sheds his horns'; the fact being that, as having parted with their weapons, they take care not to be seen. The saying is that no man has ever seen the animal's left horn; for the creature keeps it out of sight because it possesses some medicinal property.

In their first year stags grow no horns, but only an excrescence indicating where horns will be, this excrescence being short and thick. In their second year they grow their horns for the first time, straight in shape, like pegs and on this account they are called pegs. In the third year the antlers are bifurcate; in the fourth year they are rougher; and so they go on increasing in complexity until the creature is six years old: after this they grow their horns without any differentiation, so that you cannot by observation of them tell the animal's age. But the patriarchs of the herd may be told chiefly by two signs; in the first place they have few teeth or none at all, and, in the second place, they have ceased to grow the pointed tips to their antlers. The forward-pointing tips of the growing horns with which the animal meets attack, are termed its 'defenders'; with these the patriarchs are unprovided, and their antlers merely grow straight upwards. Stags shed their horns annually, in the month of Thargelion; after shedding, they conceal themselves, it is said, during the daytime, and, to avoid the flies, hide in thick copses; during this time, until they have grown their horns, they feed at night-time. The horns at first grow in a kind of skin envelope, and get rough by degrees; when they reach their full size the animal basks in the sun, to mature and dry them. When they need no longer rub them against tree-trunks they quit their hiding-places, from a sense of security based upon the possession of defensive weapons. An Achaeine stag has been caught with a quantity of green ivy grown over its horns, it having grown apparently, as on fresh green wood, when the horns were young and tender. When a stag is stung by a venom-spider or similar insect, it gathers crabs and eats them; it is said to be a good thing for man to drink the juice, but the taste is disagreeable. The hinds after parturition at once swallow the afterbirth, and it is impossible to secure it, for the hind catches it before it falls to the ground: now this substance is supposed to have medicinal properties. When hunted the creatures are caught by singing or pipe-playing on the part of the hunters; they are so pleased with the music that they lie down on the grass. If there be two hunters, one before their eyes sings or plays the pipe, the other keeps out of sight and shoots, at a signal given by the confederate. If the animal has its ears cocked, it can hear well and you cannot escape its ken; if its ears are down, you can.

6 · When bears are running away from their pursuers they push their cubs in front of them, or take them up and carry them; when they are being overtaken they climb up a tree. When emerging from their winter-den, they at once take to eating cuckoo-pint, as has been said, and chew sticks of wood as though they were cutting teeth.

Many other quadrupeds help themselves in clever ways. Wild goats in Crete are said, when wounded by arrows, to go in search of dittany, which is supposed to have the property of ejecting arrows in the body. Dogs, when they are ill, eat some kind of grass and produce vomiting. The panther, after eating panther's-bane, tries to find some human excrement, which is said to heal its pain. This panther's-bane kills lions as well. Hunters hang up excrement in a vessel attached to the boughs of a tree, to keep the animal from straying to any distance; the animal meets its end in leaping up to the branch and trying to get at the medicine. They say that the panther has found out that wild animals are fond of the scent it emits; that, when it goes a-hunting, it hides itself; that the other animals come nearer and nearer, and that by this stratagem it can catch even stags.

The Egyptian ichneumon, when it sees the serpent called the asp, does not attack it until it has called in other ichneumons to help; to meet the blows and bites of their enemy the assailants beplaster themselves with mud, by first soaking in the river and then rolling on the ground.

When the crocodile yawns, the trochilus flies into his mouth and cleans his teeth. The trochilus gets his food thereby, and the crocodile, perceiving that it is being benefitted, does not harm it; but, when it wants it to go, it shakes its neck, lest it should bite the bird.

The tortoise, when it has partaken of a viper, eats marjoram; this action has been actually observed. A man saw a tortoise perform this operation over and over again, and every time it plucked up some marjoram go back to the viper; he thereupon pulled the marjoram up by the roots, and the consequence was the tortoise died. The weasel, when it fights with a snake, first eats wild rue, the smell of which is noxious to the snake. The dragon, when it eats fruit, swallows endive-juice; it has been seen in the act. Dogs, when they suffer from worms, eat the standing corn. Storks, and all other birds, when they get a wound fighting, apply marjoram to the place injured.

Many have seen the locust, when fighting with the snake, get a tight hold of the snake by the neck. The weasel has a clever way of getting the better of birds; it tears their throats open, as wolves do with sheep. Weasels fight desperately with mice-catching snakes, as they both prey on the same animal.

In regard to the perception of hedgehogs, it has been observed in many places that, when the wind is shifting from north to south, and from south to north, they shift the outlook of their earth-holes, and those that are kept in domestication shift over from one wall to the other. The story goes that a man in Byzantium got into high repute for foretelling a change of weather, all owing to his having noticed this habit of the hedgehog.

The marten is about as large as the smaller breed of Maltese dogs. In the thickness of its fur, in its look, in the white of its belly, and in its love of mischief, it resembles the weasel; it is easily tamed; from its liking for honey it is a plague to bee-hives; it preys on birds like the cat. Its genital organ, as has been said, consists of bone: the organ of the male is supposed to be a cure for strangury; doctors scrape it into powder, and administer it in that form.

7 · In a general way in the lives of animals many resemblances to human life may be observed. Acute intelligence will be seen more in small creatures than in large ones, as is exemplified in the case of birds by the nest-building of the swallow. In the same way as men do, the bird mixes mud and chaff together; if it runs short of mud, it souses its body in water and rolls about in the dust with wet feathers; furthermore, just as man does, it makes a bed of straw, putting hard material below for a foundation, and adapting all to suit its own size. Both parents co-operate in the rearing of the young; each of the parents will detect, with practised eye, the young one that has had a helping, and will take care it is not helped twice over; at first the parents will rid the nest of excrement, but, when the young are grown, they will teach their young to shift their position and let their excrement fall over the side of the nest.

Pigeons exhibit other phenomena of a similar kind. In pairing the same male and the same female keep together; and the union is only broken by the death of one of the two parties. At the time of parturition in the female the sympathetic attentions of the male are extraordinary; if the female is afraid on account of the impending parturition to enter the nest, the male will beat her and force her to come in. When the young are born, he will take and masticate pieces of salty earth, will open the beaks of the fledglings, and inject these pieces, thus preparing them betimes to take food. When the male bird is about to expel the young ones from the nest, he cohabits with them all. As a general rule these birds show this conjugal fidelity, but occasionally a female will cohabit with other than her mate. These birds are combative, and quarrel with one another, and enter each other's nests, though this occurs but seldom; at a distance from their nests this quarrelsomeness is less marked, but in the close neighbourhood of their nests they will fight desperately. A peculiarity common to the pigeon, the ring-dove and the turtle-dove is that they do not lean the head back when they are in the act of drinking, but only when they have fully quenched their thirst. The turtle-dove and the ring-dove both have but one mate, and let no other come nigh; both sexes co-operate in the process of incubation. It is difficult to distinguish between the sexes except by an examination of their interiors. Ring-doves are long-lived; cases have been known where such birds were twenty-five years old, thirty years old, and in some cases forty. As they grow old their claws increase in size, and pigeon-fanciers cut the claws; as far as one can see, the birds suffer no other perceptible disfigurement by their increase in age. Turtle-doves and pigeons that are blinded by fanciers for use as decoys live for eight years. Partridges live for about fifteen years. Ring-doves and turtle-doves always build their nests in the same place year after year. The male, as a general rule, is more long-lived than the female; but in the case of pigeons some assert that the male dies before the female, taking their inference from the statements of persons who keep decoy-birds in captivity. Some declare that the male sparrow lives only for a year, pointing to the fact that early in spring the male sparrow has no black beard, but has one later on, as though the black-bearded birds of the last year had all died out; they also say that the females are the longer lived, on the grounds that they are caught in amongst the young birds and that their age is 613b1 rendered manifest by the hardness about their beaks. Turtle-doves in summer live in cold places, and in warm places during the winter; chaffinches affect warm habitations in summer, and cold ones in winter.

8 · Birds of a heavy build, such as quails, partridges, and the like, build no nests; indeed, where they are incapable of flight, it would be of no use if they could do so. After scraping a hole on a level piece of ground—and it is only in such a place that they lay their eggs—they cover it over with thorns and sticks for security against hawks and eagles, and there lay their eggs and hatch them; after the hatching is over, they at once lead the young out from the nest, as they are not able to fly afield for food for them. Quails and partridges, like domestic hens, when they go to rest, gather their brood under their wings. They do not hatch and lay in the same place so that no-one may notice the spot from their sitting a long time in it. When a man comes by chance upon a young brood, and tries to catch them, the hen-bird rolls in front of the hunter, pretending to be palsied; the man every moment thinks he is on the point of catching her, and so she draws him on and on, until every one of her brood has had time to escape; hereupon she returns to the nest and calls the young back. The partridge lays not less than ten eggs, and often lays as many as sixteen. As has been observed, the bird has mischievous and deceitful habits. In the spring-time, a noisy scrimmage takes place, out of which the male-birds emerge each with a hen. Owing to the lecherous nature of the bird, and from a dislike to the hen sitting, the males, if they find any eggs, roll them over and over until they break them in pieces; to provide against this the female goes to a distance and lays the eggs, and often, under the stress of parturition, lays them in any chance spot that offers; if the male bird is near at hand,[3] then to keep the eggs intact she refrains from visiting them. If she is seen by a man, then, just as with her fledged brood, she entices him away from the eggs by showing herself close at his feet until she has drawn him to a distance. When the females have run away and 614a1 taken to sitting, the males in a pack take to screaming and fighting; when thus

[3]Reading κἂν παρῇ ὁ ἀρρήν, ὅπως.

engaged, they have the nickname of 'widowers'. The bird who is beaten follows his victor, and submits to be covered by him only; and the beaten bird is covered by a second one or by any other, only clandestinely without the victor's knowledge; this is so, not at all times, but at a particular season of the year, and with quails as well as with partridges. A similar proceeding takes place occasionally with domestic cocks: for in temples, where cocks are set apart as offerings without hens, they all as a matter of course tread any new-comer. Tame partridges tread wild birds, peck at their heads,[4] and treat them badly. The leader of the wild birds, with a counter-note of challenge, pushes forward to attack the decoy-bird, and after he has been netted, another advances with a similar note. This is what is done if the decoy be a male; but if it be a female that is the decoy and gives the note, and the leader of the wild birds gives a counter one, the rest of the males set upon him and chase him away from the female for making advances to her instead of to them; in consequence of this the male often advances without uttering any cry, so that no other may hear him and come and give him battle; and experienced fowlers assert that sometimes the male bird, when he approaches the female, makes her keep silence, to avoid having to give battle to other males who might have heard him. The partridge has not only the note here referred to, but also a thin shrill cry and other notes. Often the hen-bird rises from off her brood when she sees the male showing attentions to the female decoy; she will give the counter-note and remain still, so as to be trodden by him and divert him from the decoy. The quail and the partridge are so intent upon sexual union that they often come right in the way of the decoy-birds, and not seldom alight upon their heads. So much for the sexual proclivities of the partridge, for the way in which it is hunted, and the general wicked habits of the bird.

As has been said, quails and partridges build their nests upon the ground, and so also do some of the birds that are capable of flight.[5] Further, for instance, of such birds, the lark and the woodcock, as well as the quail, do not perch on a branch, but squat upon the ground.

9 · The woodpecker does not squat on the ground, but pecks at the bark of trees to drive out from under it maggots and gnats; when they emerge, it licks them 614b1
up with its tongue, which is large and flat. It can run up and down a tree in any way, even with the head downwards, like the gecko-lizard. For secure hold upon a tree, its claws are better adapted than those of the daw; it makes its way by sticking these claws into the bark. One species of woodpecker is smaller than a blackbird, and has small reddish speckles; a second species is larger than the blackbird, and a third is not much smaller than a domestic hen. It builds a nest on trees, as has been said, on olive trees amongst others. It feeds on the maggots and ants that are under the bark: it is so eager in the search for maggots that it is said sometimes to hollow a tree out to its downfall. A woodpecker once, in course of domestication, was seen to insert an almond into a hole in a piece of timber, so that it might remain steady under its pecking; at the third peck it split the shell of the fruit, and then ate the kernel.

[4]Reading ἐπικορρίζουσι.
[5]Omitting μή.

10 · Many indications of intelligence are given by cranes. They will fly to a great distance and high up in the air, to command an extensive view; if they see clouds and signs of bad weather they fly down again and remain still. They, furthermore, have a leader in their flight, and patrols that scream on the confines of the flock so as to be heard by all. When they settle down, the main body go to sleep with their heads under their wing, standing first on one leg and then on the other, while their leader, with his head uncovered, keeps a sharp look out, and when he sees anything of importance signals it with a cry.

Pelicans that live beside rivers swallow the large smooth mussel-shells: after cooking them inside the crop that precedes the stomach, they spit them out, so that, now when their shells are open, they may pick the flesh out and eat it.

11 · Of wild birds, the nests are fashioned to meet the exigencies of existence and ensure the security of the young. Some of these birds are fond of their young and take great care of them, others are quite the reverse; some are clever in procuring subsistence, others are not so. Some of these birds build in ravines and
615a1 clefts, and on cliffs, as, for instance, the so-called stone-curlew; this bird is in no way noteworthy for plumage or voice; it makes an appearance at night, but in the daytime keeps out of sight.

The hawk also builds in inaccessible places. Although a carnivore, it will never eat the heart of any bird it catches; this has been observed in the case of the quail, the thrush, and other birds. They modify their method of hunting, for in summer they do not grab their prey as they do at other seasons.

Of the vulture, it is said that no one has ever seen either its young or its nest; on this account Herodorus, the father of Bryson the sophist, says that it belongs to some distant and elevated land—giving as his reason this, and also the fact that many of them suddenly appear without anyone knowing where from. The reason is that the bird has its nest on inaccessible crags, and is found only in a few localities. The female lays one egg as a rule, and two at the most.

Some birds live on mountains or in forests, as the hoopoe and the brenthus; this latter bird finds his food with ease and has a musical voice. The wren lives in brakes and crevices; it is difficult to capture, keeps out of sight, is gentle of disposition, finds its food with ease, and is something of a mechanic. It goes by the nickname of 'old man' or 'king'; and the story goes that for this reason the eagle is at war with him.

12 · Some birds live on the sea-shore, as the wagtail; the bird is of a mischievous nature, hard to capture, but when caught capable of complete domestication; it is a cripple, as being weak in its hinder quarters.

Web-footed birds without exception live near the sea or rivers or pools, as they naturally resort to places adapted to their structure. Several birds, however, with cloven toes live near pools or marshes, as, for instance, the anthus lives by the side of rivers; the plumage of this bird is pretty, and it finds its food with ease. The catarrhactes lives near the sea; when it makes a dive, it will keep under water for as

long as it would take a man to walk a furlong; it is smaller than the common hawk. Swans are web-footed, and live near pools and marshes; they find their food with ease, are good-tempered, are fond of their young, and live to a green old age. If the eagle attacks them they will repel the attack and get the better of their assailant, 615b1
but they are never the first to attack. They are musical, and sing chiefly at the approach of death; at this time they fly out to sea, and men, when sailing past the coast of Libya, have fallen in with many of them out at sea singing in mournful strains, and have actually seen some of them dying.

The cymindis is seldom seen, as it lives on mountains; it is black in colour, and about the size of the hawk called the 'dove-killer'; it is long and slender in form. The Ionians call the bird by this name; Homer in the *Iliad* mentions it in the line:[6]—

Chalcis its name with those of heav'nly birth,
But called *Cymindis* by the sons of earth.

The hybris, said by some to be the same as the eagle-owl, is never seen by daylight, as it is dim-sighted, but during the night it hunts like the eared owl; it will fight the eared owl with such desperation that the two combatants are often captured alive by shepherds; it lays two eggs, and it too builds on rocks and in caverns. Cranes also fight so desperately among themselves as to be caught when fighting, for they will not leave off; the crane too lays two eggs.

13 · The jay has a great variety of notes: indeed, one might almost say it had a different note for every day in the year. It lays about nine eggs; builds its nest on trees, out of hair and tags of wool; when acorns are getting scarce, it lays up a store of them in hiding.

It is a common story of the stork that the old birds are fed by their young. Some tell a similar story of the bee-eater, and declare that the parents are fed by their young not only when growing old, but at an early period, as soon as the young are capable of feeding them; and the parent-birds stay inside the nest. The under part of the bird's wing is pale yellow; the upper part is dark blue, like that of the kingfisher; the tips of the wings are red. About autumn-time it lays six or seven eggs, in overhanging banks where the soil is soft; there it burrows into the ground to a depth of six feet.

The greenfinch, so called from the colour of its belly, is as large as a lark; it lays four or five eggs, builds its nest out of the plant called comfrey, pulling it up by the 616a1
roots, and makes an under-mattress to lie on of hair and wool. The blackbird and the jay build their nests after the same fashion and construct the inside of them from those stuffs. The nest of the penduline tit shows great mechanical skill; it has the appearance of a ball of flax, and the hole for entry is very small.

People who live where the bird comes from say that there exists a cinnamon bird which brings the cinnamon from some unknown localities, and builds its nest

[6] *Iliad* XIV 291.

out of it; it builds on high trees on the slender top branches. They say that the inhabitants attach leaden weights to the tips of their arrows and therewith bring down the nests, and from the debris collect the cinnamon sticks.

14 · The kingfisher is not much larger than the sparrow. Its colour is dark blue, green, and light purple; the whole body and wings, and the parts about the neck, show these colours in a mixed way, without any colour being sharply defined; the beak is light green, long and slender: such, then, is the look of the bird. Its nest is like sea-balls, i.e. the things that go by the name of sea-foam, only the colour is not the same. The colour of the nest is light red, and the shape is that of the long-necked gourd. The nests are larger than the largest sponge, though they vary in size; they are roofed over, and great part of them is solid and great part hollow. If you use a sharp knife it is not easy to cut the nest through; but if you cut it, and at the same time bruise it with your hand, it will soon crumble to pieces, like sea-foam. The opening is small, just enough for a tiny entrance, so that even if the nest capsizes the sea does not enter in; the hollow channels are like those in sponges. It is not known for certain of what material the nest is constructed; it is possibly made of the backbones of the gar-fish; for the bird lives on fish. It also ascends fresh-water streams. It lays generally about five eggs, and lays eggs all its life long, beginning to do so at the age of four months.

616b1 15 · The hoopoe usually constructs its nest out of human excrement. It changes its appearance in summer and in winter, as in fact do the great majority of wild birds. (The titmouse is said to lay a very large quantity of eggs: next to the Libyan ostrich the blackheaded tit is said by some to lay the largest number of eggs; seventeen eggs have been seen; it lays, however, more than twenty; it is said always to lay an odd number. Like others we have mentioned, it builds in trees; it feeds on grubs.) A peculiarity of this bird and of the nightingale is that the outer extremity of the tongue is not sharp-pointed.

The aegithus finds its food with ease, has many young, and walks with a limp. The golden oriole is apt at learning, is clever at making a living, but is awkward in flight and has an ugly plumage.

16 · The reed-warbler makes its living as easily as any other bird, sits in summer in a shady spot facing the wind, in winter in a sunny and sheltered place among reeds in a marsh; it is small in size, with a pleasant note. The so-called chatterer has a pleasant note, beautiful plumage, makes a living cleverly, and is graceful in form; it appears to be alien to our country; at all events it is seldom seen at a distance from its own immediate home.

17 · The crake is quarrelsome, clever at making a living, but in other ways an unlucky bird. The bird called sitta is quarrelsome, but clever and tidy, makes its living with ease, and for its wide learning is called the wizard;[7] it has a numerous

[7]Reading φαρμακίς.

brood, of which it is fond, and lives by pecking the bark of trees. The aegolius-owl flies by night, is seldom seen by day; it too lives on cliffs or in caverns; it feeds on two kinds of food; it has a strong hold on life and is full of resource. The tree-creeper is a little bird, of fearless disposition; it lives among trees, feeds on grubs, makes a living with ease, and has a clear note. The acanthis finds its food with difficulty; its plumage is poor, but its note is musical.

18 · Of the herons, the ashen-coloured one, as has been said, unites with the female not without pain; it is full of resource, carries its food with it, is eager in the quest of it, and works by day; its plumage is poor, and its excrement is always wet. Of the other two species—for there are three in all—the white heron has handsome 617a1
plumage, unites without harm to itself with the female, builds a nest and lays its eggs neatly in trees; it frequents marshes and lakes and plains and meadow land. The speckled heron, which is nicknamed 'the skulker', is said in stories to be of servile origin, and, as its nickname implies, it is the laziest bird of the three species. Such are the habits of herons. The bird that is called the poynx has this peculiarity, that it is more prone than any other bird to peck at the eyes; it is at war with the harpe, as the two birds live on the same food.

19 · There are two kinds of owsels; the one is black, and is found everywhere, the other is quite white, about the same size as the other, and with the same cry. This latter is found on Cyllene in Arcadia, and is found nowhere else. The blue-thrush is like the black owzel, only a little smaller; it lives on cliffs or on tile roofings; it has not a red beak as the black owzel has.

20 · Of thrushes there are three species. One is the missel-thrush; it feeds only on mistletoe and resin; it is about the size of the jay. A second kind is the song-thrush; it has a sharp pipe, and is about the size of the owzel. There is another species called the illas; it is the smallest species of the three, and is less variegated in plumage than the others.

21 · There is a bird that lives on rocks, called the blue-bird. It is comparatively common in Nisyros, and lives in rocky places. It is somewhat smaller than the owzel and a little bigger than the chaffinch. It has large claws, and climbs on the face of the rocks. It is steel-blue all over; its beak is long and slender; its legs are short, like those of the woodpecker.

22 · The oriole is yellow all over; it is not visible during winter, but puts in an appearance about the time of the summer solstice, and departs again at the rising of Arcturus; it is the size of the turtle-dove. The so-called soft-head always settles on one and the same branch, where it falls a prey to the bird-catcher. Its head is big, 617b1
and composed of gristle; it is a little smaller than the thrush; its mouth is strong, small, and round; it is ashen-coloured all over; is fleet of foot, but slow of wing. The bird-catcher usually catches it by help of the owl.

23 · There is also the pardalus. As a rule, it is seen in flocks and not singly; it is ashen-coloured all over, and about the size of the birds last described; it is fleet of foot and strong of wing, and its pipe is loud and high-pitched. The collyrion feeds on the same food as the owzel; is of the same size as the above-mentioned birds; and is trapped usually in the winter. All these birds are found at all times.[8] Further, there are the birds that live as a rule in towns, the raven and the crow. These also are visible at all seasons, never shift their place of abode, and never go into winter quarters.

24 · Of daws there are three species. One is the chough; it is as large as the crow, but has a red beak. There is another, called the 'wolf '; and further there is the little daw, called the 'railer'. There is another kind of daw found in Lydia and Phrygia, which is web-footed.

25 · Of larks there are two kinds. One lives on the ground and has a crest on its head; the other is gregarious, and not sporadic like the first; it is, however, of the same coloured plumage, but is smaller, and has no crest; it is an article of human food.

26 · The woodcock is caught with nets in gardens. It is about the size of a domestic hen; it has a long beak, and in plumage is like the francolin-partridge. It runs quickly, and is pretty easily domesticated. The starling is speckled; it is of the same size as the owsel.

27 · Of the Egyptian ibis there are two kinds, the white and the black. The white ones are found all over Egypt, excepting in Pelusium; the black ones are found in Pelusium, and nowhere else in Egypt.

28 · Of the little horned owls there are two kinds, and one is visible at all seasons, and for that reason has the nickname of 'all-the-year-round owl'; it is not
618a1 sufficiently palatable to come to table; another species makes its appearance sometimes in the autumn, is seen for a single day or at the most for two days, and is regarded as a table delicacy; it scarcely differs from the first species save only in being fatter; it has no note, but the other species has. With regard to their origin, nothing is known from ocular observation; the only fact known for certain is that they are first seen when a west wind is blowing.

29 · The cuckoo, as has been said elsewhere, makes no nest, but deposits its eggs in an alien nest, generally in the nest of the ring-dove, or on the ground in the nest of the hypolais or lark, or on a tree in the nest of the green linnet. It lays only one egg and does not hatch it itself, but the mother-bird in whose nest it has deposited it hatches and rears it; and, as they say, this mother bird, when the young

[8] Reading πάντα διὰ πάντος.

cuckoo has grown big, thrusts her own brood out of the nest and lets them perish; others say that this mother-bird kills her own brood and gives them to the alien to devour, despising her own young owing to the beauty of the cuckoo. Eye-witnesses agree in telling most of these stories, but are not in agreement as to the destruction of the young. Some say that the cuckoo itself comes and devours the brood of the rearing mother; others say that the young cuckoo from its superior size snaps up the food brought before the smaller brood have a chance, and that in consequence the smaller brood die of hunger; others say that, by its superior strength, it actually kills the other ones whilst it is being reared up with them. The cuckoo shows great sagacity in the disposal of its progeny; the fact is, the mother-cuckoo is quite conscious of her own cowardice and of the fact that she could never help her young one in an emergency, and so, for the security of the young one, she makes of him a supposititious child in an alien nest. The truth is, this bird is pre-eminent in the way of cowardice; it allows itself to be pecked at by little birds, and flies away from their attacks.

30 · It has already been stated that the footless bird, which some term the cypselus, resembles the swallow; indeed, it is not easy to distinguish between the two birds, excepting in the fact that the cypselus has feathers on the shank. These birds rear their young in long cells made of mud, and furnished with a hole just big 618b1
enough for entry; they build under cover of some roofing—under a rock or in a cavern—for protection against animals and men.

The so-called goat-sucker lives on mountains; it is a little larger than the owsel, and less than the cuckoo; it lays two eggs, or three at the most, and is of a sluggish disposition. It flies up to the she-goat and sucks its milk, from which habit it derives its name; it is said that, after it has sucked the teat of the animal, the teat dries up and the animal goes blind. It is dim-sighted in the day-time, but sees well enough by night.

31 · In districts where the food would be insufficient for more birds than two, ravens are only found in isolated pairs; when their young are old enough to fly, the parent couple first eject them from the nest, and by and by chase them from the neighbourhood. The raven lays four or five eggs. About the time when the mercenaries under Medius were slaughtered at Pharsalus, the districts about Athens and the Peloponnese were left destitute of ravens, from which it would appear that these birds have some means of intercommunicating with one another.

32 · Of eagles there are several species. One of them, called 'the white-tailed eagle', is found on plains, in groves, and in the neighbourhood of cities; some call it the 'fawn-killer'. It is bold enough to fly to mountains and the interior of forests. The other eagles seldom visit groves or plains. There is another species called the 'plangus'; it ranks second in point of size and strength; it lives in mountain combes and glens, and by marshy lakes, and goes by the name of 'duck-killer' and

'swart-eagle'. It is mentioned by Homer in his account of the visit made by Priam to the tent of Achilles.[9] There is another species with black plumage, the smallest but boldest of all the kinds. It dwells on mountains or in forests, and is called 'the black-eagle' or 'the hare-killer'; it is the only eagle that rears its young thoroughly and takes them out with it. It is swift of flight, is neat and tidy in its habits, without jealousy, fearless, quarrelsome; it is also silent, for it neither whimpers nor screams. There is another species, the percnopterus, very large, with white head, very short wings, long tail-feathers, in appearance like a vulture. It goes by the name of 'mountain-stork' or 'half-eagle'. It lives in groves; has all the bad qualities of the other species, and none of the good ones; for it lets itself be chased and caught by the raven and the other birds. It is clumsy in its movements, has difficulty in procuring its food, preys on dead animals, is always hungry, and at all times whining and screaming. There is another species, called the 'sea-eagle'. This bird has a large thick neck, curved wings, and broad tail-feathers; it lives near the sea, grasps its prey with its talons, and often, from inability to carry it, tumbles down into the water. There is another species called the 'true-bred'; people say that these are the only true-bred birds to be found, that all other birds—eagles, hawks, and the smallest birds—are all spoilt by the interbreeding of different species. The true-bred eagle is the largest of all eagles; it is larger than the phene; is half as large again as the ordinary eagle, and has yellow plumage; it is seldom seen, as is the case with the so-called cymindis. The time for an eagle to be on the wing in search of prey is from midday to evening; in the morning until the market-hour it remains on the nest. In old age the upper beak of the eagle grows gradually longer and more crooked, and the bird dies eventually of starvation; there is a story that the eagle is thus punished because it once was a man and refused entertainment to a stranger. The eagle puts aside its superfluous food for its young; for owing to the difficulty in procuring food day by day, it at times may come back to the nest with nothing. If it catch a man prowling about in the neighbourhood of its nest, it will strike him with its wings and scratch him with its talons. The nest is built not on low ground but on an elevated spot, generally on an inaccessible ledge of a cliff; it does, however, build upon a tree. The young are fed until they can fly; hereupon the parent-birds topple them out of the nest, and chase them completely out of the locality. The fact is that a pair of eagles demands an extensive space for its maintenance, and consequently cannot allow other birds to quarter themselves in close neighbourhood. They do not hunt in the vicinity of their nest, but go to a great distance to find their prey. When the eagle has captured a beast, it tries its weight without attempting to carry it off at once; if on trial it finds the burden too heavy, it will leave it. When it has spied a hare, it does not swoop on it at once, but lets it go on into the open ground; neither does it descend to the ground at one swoop, but goes gradually down from higher flights to lower and lower: these devices it adopts by way of security against the stratagem of the hunter. It alights on high places by reason of the difficulty it experiences in soaring up from the level ground; it flies high in the air to have the more extensive view; hence it is said to be the only bird that resembles the gods.

[9] *Iliad* XXIV 316.

Birds of prey, as a rule, seldom alight upon rock, as the crookedness of their talons prevents a stable footing on hard stone. The eagle hunts hares, fawns, foxes, and in general all such animals as he can master with ease. It is a long-lived bird, and this fact might be inferred from the length of time during which the same nest is maintained in its place.

33 · In Scythia there is found a bird as large as the great bustard. The female lays two eggs, but does not hatch them, but hides them in the skin of a hare or fox and leaves them there, and, when it is not in quest of prey, it keeps a watch on them on a high tree; if any man tries to climb the tree, it fights and strikes him with its wing, just as eagles do.

34 · The owl and the night-raven and all the birds that see poorly in the daytime seek their prey in the night, but not all the night through, but at evening and dawn. Their food consists of mice, lizards, chafers and the like little creatures. The so-called phene is fond of its young, provides its food with ease, fetches food to its nest, and is of a kindly disposition. It rears its own young and those of the eagle as well; for when the eagle ejects its young from the nest, this bird catches them and feeds them. For the eagle ejects the young birds prematurely, before they are able to feed themselves, or to fly. It appears to do so from jealousy; for it is by nature jealous, and is so ravenous as to grab furiously at its food; and when it does grab at its food, it grabs it in large morsels. It is accordingly jealous of the young birds as they approach maturity, since they are getting good appetites, and so it scratches them with its talons. The young birds fight also with one another, to secure a morsel of food or a comfortable position, whereupon the mother-bird beats them and ejects them from the nest; the young ones scream at this treatment, and the phene hearing them catches them as they fall. The phene has a film over its eyes and sees badly, but the sea-eagle is very keen-sighted, and before its young are fledged tries to make them stare at the sun, and beats the one that refuses to do so, and twists him back in the sun's direction; and if one of them gets watery eyes in the process, it kills him, and rears the other. It lives near the sea, and feeds, as has been said, on sea-birds; when in pursuit of them it catches them one by one, watching the moment when the bird rises to the surface from its dive. When a sea-bird, emerging from the water, sees the sea-eagle, he in terror dives under, intending to rise again elsewhere; the eagle, however, owing to its keenness of vision, keeps flying after him until he either drowns the bird or catches him on the surface. The eagle never attacks these birds when they are in a swarm, for they keep him off by raising a shower of water-drops with their wings.

35 · The cepphus is caught by means of sea-foam; the bird snaps at the foam, and consequently fishermen catch it by sluicing with showers of sea-water. These birds grow to be plump and fat; their flesh has a good odour, excepting the hinder quarters, which smell of shore-weed.

36 · Of hawks, the strongest is the buzzard; the next in point of courage is the merlin; and the circus ranks third; other diverse kinds are the asterias, the pigeon-hawk, and the pternis; the broader-winged hawk is called the half-buzzard; others go by the name of hobby-hawk, or sparrow-hawk, or marsh-hawk, or 'toad-catcher'. Birds of this latter species find their food with very little difficulty, and flutter along the ground. Some say that there are ten species of hawks, all differing from one another. One hawk, they say, will strike and grab the pigeon as it rests on the ground, but never touch it while it is in flight; another hawk attacks the pigeon when it is perched upon a tree or any elevation, but never touches it when it is on the ground or on the wing; other hawks attack their prey only when it is on the wing and do not touch it when it is on the ground or perching anywhere else. They say that pigeons can distinguish the various species: so that, when a hawk is an assailant, if it be one that attacks its prey when the prey is on the wing, the pigeon will sit still; if it be one that attacks sitting prey, the pigeon will rise up and fly away.

In Thrace, in the district sometimes called that of Cedripolis, men hunt for little birds in the marshes with the aid of hawks. The men with sticks in their hands go beating at the reeds and brushwood to frighten the birds out, and the hawks show themselves overhead and pursue them down. In fear, they fly down to the ground again, where the men strike them with their sticks and capture them. They give a portion of their booty to the hawks; that is, they throw some of the birds up in the air, and the hawks catch them.

In the neighbourhood of Lake Maeotis, it is said, wolves act in concert with the fishermen, and if the fishermen decline to share with them, they tear their nets in pieces as they lie drying on the shore.

37 · So much for the habits of birds.

In marine creatures, also, one may observe many ingenious devices adapted to the circumstances of their lives. For the accounts commonly given of the so-called fishing-frog are quite true; as are also those given of the torpedo. The fishing-frog hunts little fish with a set of filaments that project in front of its eyes; they are long and thin like hairs, and are round at the tips; they lie on either side, and are used as baits. Accordingly, when the animal stirs up a place full of sand and mud and conceals itself therein, it raises the filaments, and, when the little fish strike against them, it draws them in underneath into its mouth. The torpedo narcotizes the creatures that it wants to catch, overpowering them by the power of shock[10] that is resident in its body, and feeds upon them; it also hides in the sand and mud, and catches all the creatures that swim in its way and come under its narcotizing influence. This phenomenon has been actually observed in operation. The sting-ray also conceals itself, but not exactly in the same way. That the creatures get their living by this means is obvious from the fact that, whereas they are peculiarly slow, they are often caught with mullets in their interior, the swiftest of fishes.

[10]Reading *τῷ τρόμῳ* (but the text is doubtful).

Furthermore, the fishing-frog is unusually thin when he is caught after losing the tips of his filaments, and the torpedo is known to cause a numbness even in human beings. Again, the hake, the ray, the flat-fish, and the angel-fish burrow in the sand, and after concealing themselves angle with the filaments on their mouths, that fishermen call their fishing-rods, and the little creatures on which they feed swim up to the filaments taking them for bits of sea-weed, such as they feed upon.

Wherever an anthias-fish is seen, there will be no dangerous creatures in the vicinity, and sponge-divers will dive in security, and they call these 'holy-fish'. It is a sort of coincidence, like the fact that wherever snails are present you may be sure there is neither pig nor partridge in the neighbourhood; for both pig and partridge eat up the snails.

The sea-serpent resembles the conger in colour and shape, but is of lesser bulk and more rapid in its movements. If it is caught[11] and thrown away, it will bore a hole with its snout and burrow rapidly in the sand; its snout is sharper than that of ordinary serpents. The so-called sea-scolopendra, after swallowing the hook, turns itself inside out until it ejects it, and then it again turns itself outside in. The sea-scolopendra, like the land-scolopendra, will come to a savoury bait; the creature does not bite with its teeth, but stings by contact with its entire body like the so-called sea-nettle. The so-called fox-shark, when it finds it has swallowed the hook, tries to get rid of it as the scolopendra does: it runs up the fishing-line, and bites it off short; it is caught in some districts in deep and rapid waters, with night-lines.

The bonitos swarm together when they espy a dangerous creature, and the largest of them swim round it, and if it touches one of the shoal they try to repel it; they have strong teeth. Amongst other fish, a lamia-shark, after falling in amongst a shoal, has been seen to be covered with wounds.

Of river-fish, the male of the sheat-fish is remarkably attentive to the young. The female after parturition goes away; the male stays and keeps on guard where the spawn is most abundant, contenting himself with keeping off all other little fishes that might steal the spawn, and this he does for forty or fifty days, until the young are sufficiently grown to make away from the other fishes for themselves. The fishermen can tell where he is on guard; for, in warding off the little fishes, he makes a rush in the water and gives utterance to a kind of muttering noise. He is so earnest in the performance of his parental duties that the fishermen at times, if the eggs be attached to the roots of water-plants deep in the water, drag them into as shallow a place as possible; the male fish will still keep by the eggs, and, if it is young, will be caught by the hook when snapping at the little fish that come by; if, however, he be sensible by experience of the danger of the hook, he will still keep by his charge, and with his extremely strong teeth will bite the hook in pieces.

All fishes, both those that wander about and those that are stationary, occupy the districts where they were born or very similar places, for their natural food is found there. Carnivorous fish wander most; and all fish are carnivorous with the

[11]Reading ληφθῇ.

exception of a few, such as the mullet, the saupe, the red mullet, and the chalcis. The so-called pholis gives out a mucous discharge, which envelops the creature in a kind of nest. Of shell-fish, and fish that have no feet, the scallop moves with greatest force and to the greatest distance, impelled along by some internal energy; the murex, and others that resemble it, move hardly at all. Out of the lagoon of Pyrrha all the fishes swim in winter-time, except the sea-gudgeon; they swim out owing to the cold, for the narrow waters are colder than the outer sea, and on the return of the early summer they all swim back again. In the lagoon no scarus is found, nor thritta, nor any other species of the spiny fish, no spotted dogfish, no spiny dogfish, no crayfish, no octopus either of the common or the musky kinds, and certain other fish are also absent; but of fish that are found in the lagoon the white gudgeon is not a marine fish. Of fishes the oviparous are in their prime in the early summer until the spawning time; the viviparous in the autumn, as is also the case with the mullet, the red mullet, and all such fish. All the fishes of the outer sea or of the lagoon bring forth their eggs or young in the lagoon; sexual union takes place in the autumn, and parturition in the spring. With the selachia, the males and females swarm together in the autumn for the sake of sexual union; in the spring they come swimming in, and keep apart until after parturition; the two sexes are often taken linked together in sexual union.

Of cephalopods, the cuttlefish is the most cunning, and is the only species that employs its dark liquid for the sake of concealment as well as from fear: the octopus and calamary make the discharge solely from fear. These creatures never discharge the pigment in its entirety; and after a discharge the pigment accumulates again. The cuttlefish, as has been said, often uses its colouring pigment for concealment; it shows itself in front of the pigment and then retreats back into it; it also hunts with its long tentacles not only little fishes, but often even mullets. The octopus is a stupid creature, for it will approach a man's hand if it be lowered in the water; but it is thrifty in its habits: that is, it lays up stores in its nest, and, after eating up all that is eatable, it ejects the shells and sheaths of crabs and shell-fish, and the skeletons of little fishes. It seeks its prey by so changing its colour as to render it like the colour of the stones adjacent to it; it does so also when alarmed. By some the cuttlefish is said to perform the same trick; that is, they say it can change its colour so as to make it resemble the colour of its habitat. The only fish that can do this is the angel-fish, that is, it can change its colour like the octopus. The octopus as a rule does not live the year out. It has a natural tendency to run off its liquid; for, if kneaded, it keeps losing substance and at last disappears. The female after parturition is peculiarly subject to this: it becomes stupid; if tossed about by waves, it submits impassively; a man, if he dived, could catch it with the hand; it gets covered over with slime, and makes no effort to catch its wonted prey. The male becomes leathery and clammy. As a proof that they do not live into a second year there is the fact that, after the birth of the little octopuses in the late summer or beginning of autumn, it is seldom that a large-sized octopus is visible, whereas a little before this time of year the creature is at its largest. After the eggs are laid, they say that both the male and the female grow so old and feeble that they are preyed upon by little fish, and with ease dragged from their holes; and that this could not have been done previously; they say also that this is not the case with the small and young octopus, but that the young creature is much stronger than the grown-up one. Neither does the cuttlefish live into a second year. The octopus is the only cephalopod that ventures on to dry land; it walks on rough ground and avoids what is smooth; it is firm all over when you squeeze it, excepting in the neck. So much for the cephalopods.[12] 622b1

It is also said that they make a thin rough shell about them like a hard sheath, and that this is made larger as the animal grows larger, and that it comes out of the sheath as though out of a den or dwelling-place.

The nautilus is an octopus, but one peculiar both in its nature and its habits. It rises up from deep water and swims on the surface; it rises with its shell down-turned in order that it may rise the more easily and swim with it empty, but after reaching the surface it shifts the position of the shell. In between its tentacles it has a certain amount of web-growth, resembling the substance between the toes of web-footed birds; only that with these latter the substance is thick, while with the nautilus it is thin and like a spider's web. It uses this structure, when a breeze is blowing, for a sail, and lets down two of its feelers alongside as rudder-oars. If it be frightened, it fills its shell with water and sinks. With regard to the mode of generation and the growth of the shell knowledge from observation is not yet satisfactory; it does not appear to be produced by copulation, but to grow like other shell-fish; neither is it ascertained for certain whether the animal can live when stripped of the shell.

38 · Of all insects, one may almost say of all living creatures, the most industrious are the ant, the bee, the hornet, the wasp, and in point of fact all creatures akin to these; of spiders some are more skilful and more resourceful than others. The way in which ants work is open to ordinary observation; how they all march one after the other when they are engaged in putting away and storing up their food; all this may be seen, for they carry on their work even during bright moonlight nights.

39 · Of spiders and phalangia there are many species. Of the venomous phalangia there are two; one that resembles the so-called wolf-spider, small, speckled, and tapering to a point; it moves with leaps, and is nicknamed 'the flea'; the other kind is large, black in colour, with long front legs; it is heavy in its movements, walks slowly, is not very strong, and never leaps. (Of all the other species wherewith druggists supply themselves, some give a weak bite, and others 623a1 never bite at all. There is another kind, comprising the so-called wolf-spiders.) Of these spiders the small one weaves no web, and the large weaves a rude and poorly built one on the ground or on dry stone walls. It always builds its web over hollow places inside of which it keeps a watch on the end-threads, until some creature gets into the web and begins to struggle, when out the spider pounces. The speckled kind makes a little shabby web under trees.

[12]Dittmeyer marks a lacuna here.

There is a third species of this animal, pre-eminently clever and artistic. It first weaves a thread stretching to all the exterior ends of the future web; then from the centre, which it hits upon with some accuracy, it stretches the warp; on the warp it puts what corresponds to the woof, and then weaves the whole together. It sleeps and stores its food away from the centre, but it is at the centre that it keeps watch for its prey. Then, when any creature touches the web and the centre is set in motion, it first ties and wraps the creature round with threads until it renders it helpless, then lifts it and carries it off, and, if it happens to be hungry, sucks out the life-juices—for that is the way it feeds; but, if it be not hungry, it first mends any damage done and then hastens again to its quest of prey. If something comes meanwhile into the net, the spider at first makes for the centre, and then goes back to its entangled prey as from a fixed starting-point. If any one injures a portion of the web, it recommences weaving at sunrise or at sunset, because it is chiefly at these periods that creatures are caught in the web. It is the female that does the weaving and the hunting, but the male takes a share of the booty captured.

Of the skilful spiders, weaving a substantial web, there are two kinds, the larger and the smaller. The one has long legs and keeps watch while swinging downwards from the web, so that its prey may not be frightened off, but may strike upon the web's upper surface (because of its size, the spider cannot easily hide itself); the less awkwardly formed one lies in wait on the top, using a little hole for a lurking-place. Spiders can spin webs from the time of their birth, not from their interior as an excretion, as Democritus avers, but off their body as a kind of tree-bark, like the creatures that shoot out with their hair, as for instance the porcupine. The creature can attack animals larger than itself, and enwrap them with its threads: it will attack a small lizard, run round and draw threads about its body until it closes the mouth up; then it comes up and bites it.

40 · So much for the spider. Of insects, there is a genus that has no one name, though all are akin to one another in form; it consists of all the insects that construct a honeycomb: to wit, the bee, and all the insects that resemble it in form. There are nine varieties, of which six are gregarious—the bee, the king-bee, the drone-bee, the annual wasp, and, furthermore, the hornet, and the groundwasp; three are solitary—the smaller siren, of a dun colour, the larger siren, black and speckled, and the third, the largest of all, that is called the humble-bee. Now ants never go a-hunting, but gather up what is ready to hand; the spider makes nothing, and lays up no store, but simply goes a-hunting for its food; while the bee—for we shall by and by treat of the other eight varieties—does not go a-hunting, but makes its food and stores it away, for honey is the bee's food. This fact is shown by the bee-keepers' attempt to remove the combs; for the bees, when they are fumigated, and are suffering great distress from the smoke, then devour the honey most ravenously, whereas at other times they are never observed to be so greedy, but apparently are thrifty and disposed to lay by for their future sustenance. They have also another food which is called bee-bread; this is scarcer than honey and has a sweet fig-like taste; this they carry as they do the wax on their legs.

Very remarkable diversity is observed in their methods of working and their general habits. When the hive has been delivered to them clean, they build their waxen cells, bringing in the juice of flowers[13] and the 'tears' of trees, such as willows and elms and such others as are particularly given to the exudation of gum. With this material they besmear the ground-work, to provide against attacks of other creatures; the bee-keepers call this stuff 'stop-wax'.[14] They also narrow by side-building the entrances to the hive if they are too wide. They first build cells for themselves; then for the so-called kings and the drones; for themselves they are always building, for the kings only when the brood of young is numerous, and cells for the drones they build if a superabundance of honey should suggest their doing so. They build the royal cells next to their own, and they are of small bulk; the drones' cells they build near by, and these latter are less in bulk then the bees' cells. They begin building the combs downwards from the top of the hive, and go down and down building many combs connected together until they reach the bottom. The cells, both those for the honey and those also for the grubs, are double-doored; for two cells are ranged about a single base, one pointing one way and one the other, after the manner of a double goblet. The cells that lie at the commencement of the combs and are attached to the hives, to the extent of two or three concentric circular rows, are small and devoid of honey; the cells that are well filled with honey are most thoroughly smeared with wax. At the entry to the hive the aperture of the doorway is smeared with mitys; this substance is a deep black, and is a sort of residual by-product of wax; it has a pungent odour, and is a cure for bruises and suppurating sores. The greasy stuff that comes next is pitch-wax; it has a less pungent odour and is less medicinal than the mitys. Some say that the drones construct combs by themselves in the same hive and in the same comb that they share with the bees; but that they make no honey, but subsist, they and their grubs also, on the honey made by the bees. The drones, as a rule, keep inside the hive; when they go out of doors, they soar up in the air in a stream, whirling round and round in a kind of gymnastic exercise; when this is over, they come inside the hive and feast themselves. The kings never quit the hive, except in conjunction with the entire swarm, either for food or for any other reason. They say that, if a swarm goes astray,[15] it will turn back upon its route and by the aid of scent seek out its leader. It is said that if he is unable to fly he is carried by the swarm, and that if he dies the swarm perishes; and that, if this swarm outlives the king for a while and constructs combs, no honey is produced and the bees soon die out. Bees scramble up the stalks of flowers and rapidly gather the bees-wax with their front legs; the front legs wipe it off on to the middle legs, and these pass it on to the hollow curves of the hind-legs; when thus laden, they fly away home, and one may see plainly that their load is a heavy one. On each expedition the bee does not fly from a flower of one kind to a flower of another, but flies from one violet, say, to another violet, and never meddles with another flower until it has got back to the hive; on reaching the hive they throw

[13]Reading τὸν χυμὸν τῶν ἀνθέων.
[14]Reading κόμμωσιν.
[15]Retaining ὁ ἀφεσμός

off their load, and each bee on his return is accompanied by three or four companions. One cannot well tell what is the substance they gather, nor the exact process of their work. Their mode of gathering wax has been observed on olive-trees, as owing to the thickness of the leaves the bees remain stationary for a considerable while. After this work is over, they attend to the grubs. There is nothing to prevent grubs, honey, and drones being all found in one and the same comb. As long as the leader is alive, the drones are said to be produced apart by themselves; if he be no longer living, they are said to be reared by the bees in their own cells, and under the circumstances to become more spirited: for this reason they are called 'sting-drones', not that they really have stings, but that they have the wish, without the power, to use such weapons. The cells for the drones are larger than the others; sometimes the bees construct cells for the drones apart, but usually they put them in amongst their own; and when this is the case the bee-keepers cut the drone-cells out of the combs. There are several species of bees, as has been said; two of 'kings', the better kind red, the other black and variegated, and twice as big as the working-bee. The best working-bee is small, round, and speckled: another kind is long and like a hornet; another kind is what is called the robber-bee, black and flat-bellied; then there is the drone, the largest of all, but devoid of sting, and lazy. There is a difference between the progeny of bees that inhabit cultivated land and of those from the mountains: the forest-bees are more shaggy, smaller, more industrious and more fierce. Working-bees make their combs all even, with the surface covering quite smooth. Each comb is of one kind only: that is, it contains either honey only, or grubs only, or drones only; if it happen, however, that they make in one and the same comb all these kinds of cells, each separate kind will be built in a continuous row right through.[16] The long bees build uneven combs, with the lids of the cells protuberant, like those of the hornet; grubs and everything else have no fixed places, but are put anywhere; from these bees come inferior kings, a large quantity of drones, and the so-called robber-bee; they produce either no honey at all, or honey in very small quantities. Bees brood over the combs and so mature them; if they fail to do so, the combs are said to go bad and to get covered with a sort of spider's web. If they can keep brooding over the part undamaged, the damaged part simply eats itself away; if they cannot so brood, the entire comb perishes; in the damaged combs small grubs are engendered, which take on wings and fly away. When the combs keep settling down, the bees restore the level surface, and put props underneath the combs to give themselves free passage-room; for if such free passage be lacking they cannot brood, and the cobwebs come on. When the robber-bee and the drone appear, not only do they do no work themselves, but they actually damage the work of the other bees; if they are caught in the act, they are killed by the working-bees. These bees also kill without mercy most of their kings, and especially kings of the inferior sort; and this they do for fear a multiplicity of kings should lead to a dismemberment of the hive. They kill them especially when the hive is deficient in grubs, and a swarm is not likely to take place; under these circumstances they

[16]Reading διὰ τέλους.

destroy the cells of the kings if they have been prepared, on the ground that these kings are always ready to lead out swarms. They destroy also the combs of the drones if a failure in the honey supply be threatening and the hive runs short of provisions; under such circumstances they fight desperately with all who try to take their honey, and eject from the hive all the resident drones; and oftentimes the drones are to be seen sitting apart in the hive. The little bees fight vigorously with the long kind, and try to banish them from the hives; if they succeed, the hive will be unusually productive, but if the bigger bees get left masters of the field they pass the time in idleness, and do no good at all but die out before the autumn. Whenever the working-bees kill an enemy they try to do so out of doors; and whenever one dies indoors, they carry it out of doors also. The so-called robber-bees spoil their own combs, and, if they can do so unnoticed, enter the combs of other bees; if they are 625b1
caught in the act they are put to death. It is no easy task for them to escape detection, for there are sentinels on guard at every entry; and, even if they do escape detection on entering, afterwards from a surfeit of food they cannot fly, but go rolling about in front of the hive, so that their chances of escape are small indeed. The kings are never themselves seen outside the hive except with a swarm in flight: during which time all the other bees cluster around them. When the flight of a swarm is imminent, a monotonous and quite peculiar sound is heard for several days, and for two or three days in advance a few bees are seen flying round the hive; it has never as yet been ascertained, owing to the difficulty of the observation, whether or no the king is among these. When they have swarmed, they fly away and separate off to each of the kings; if a small swarm happens to settle near to a large one, it will shift to join this large one, and if the king whom they have abandoned follows them, they put him to death. So much for the quitting of the hive and the swarm-flight. Separate detachments of bees are told off for diverse operations; that is, some carry flower-produce, others carry water, others smooth and arrange the combs. A bee carries water when it is rearing grubs. No bee ever settles on the flesh of any creature, or ever eats animal food. They have no fixed date for commencing work; but when their provender is forthcoming and they are in comfortable trim, and by preference in summer, they set to work, and when the weather is fine they work incessantly. The bee, when quite young and in fact only three days old, after shedding its chrysalis-case, begins to work if it be well fed. When a swarm is settling, some bees detach themselves in search of food and return back to the swarm. In hives that are in good condition the production of young bees is discontinued only for the forty days that follow the winter solstice. When the grubs are grown, the bees put food beside them and cover them with a coating of wax; and, as soon as the grub is strong enough, he of his own accord breaks the lid and comes out. Creatures that make their appearance in hives and spoil the combs the working-bees clear out, but the other bees from sheer laziness look with indifference on damage done to their produce. When the bee-keepers take out the combs, they 626a1
leave enough food behind for winter use; if it be sufficient in quantity, the occupants of the hive will survive; if it be insufficient, then, if the weather be rough, they die on the spot, but if it be fair, they fly away and desert the hive. They feed on honey

summer and winter; but they store up another article of food resembling wax in hardness, which by some is called bee-bread. Their worst enemies are wasps and the birds named titmice, and furthermore the swallow and the bee-eater. The frogs in the marsh also catch them if they come in their way by the water-side, and for this reason bee-keepers chase the frogs from the ponds from which the bees take water; they destroy also wasps' nests, and the nests of swallows, in the neighbourhood of the hives, and also the nests of bee-eaters. Bees have fear only of one another. They fight with one another and with wasps. Away from the hive they attack neither their own species nor any other creature, but in the close proximity of the hive they kill whatever they get hold of. Bees that sting die from their inability to extract the sting without at the same time extracting their intestines—but not always, for they often recover, if the person stung takes the trouble to press the sting out; but once it loses its sting the bee must die. They can kill with their stings even large animals; in fact, a horse has been known to have been stung to death by them. The kings are the least disposed to show anger or to inflict a sting. Bees that die are removed from the hive, and in every way the creature is remarkable for its cleanly habits; in point of fact, they often fly away to a distance to void their excrement because it is malodorous; and, as has been said, they are annoyed by all bad smells and by the scent of perfumes, so much so that they sting people that use perfumes. They perish from a number of accidental causes, and when their kings become too numerous and try each to carry away a portion of the swarm. The toad also kills bees; he comes to the doorway of the hive, puffs himself out as he sits on the watch, and devours the creatures as they come flying out; the bees can in no way retaliate, but the
626b1 bee-keeper makes a point of killing him. As for the class of bee that has been spoken of as inferior and as constructing its combs so roughly, some bee-keepers say that it is the young bees that act so from inexperience; and the bees of the current year are termed young. The young bees do not sting as the others do; and it is for this reason that swarms may be safely carried, as it is of young bees that they are composed. When honey runs short they expel the drones, and the bee-keepers supply the bees with figs and sweet-tasting articles of food. The elder bees do the indoor work, and are rough and hairy from staying indoors; the young bees do the outer carrying, and are comparatively smooth. They kill the drones also when in their work they are confined for room; the drones live in the innermost recess of the hive. On one occasion, when a hive was in a poor condition, some of the occupants assailed a foreign hive; proving victorious in a combat they took to carrying off the honey; when the bee-keeper tried to kill them, the other bees came out and tried to beat off the enemy but made no attempt to sting the man. The diseases that chiefly attack prosperous hives are first of all the clerus—this consists in a growth of little grubs on the floor, from which, as they develop, a kind of cobweb grows over the entire hive, and the combs decay; another diseased condition is indicated in a lassitude on the part of the bees and in malodorousness of the hive. Bees feed on thyme; and the white thyme is better than the red. In summer the place for the hive should be cool, and in winter warm. They are very apt to fall sick if the plant they are at work on be mildewed. In a high wind they carry a stone by way of ballast to steady them. If a stream be near at hand, they drink from it and from it only, but before they drink

they first deposit their load; if there be not water near at hand, they disgorge their honey as they drink elsewhere, and again make off to work. There are two seasons for making honey, spring and autumn; the spring honey is sweeter, whiter, and in every way better than the autumn honey. Superior honey comes from fresh comb, and from young shoots; the red honey is inferior because of the comb in which it is deposited, just as wine is apt to be spoiled by its cask; consequently, one should have it dried. When the thyme is in flower and the comb is full, the honey does not harden. The honey that is golden in hue is excellent. White honey does not come from thyme pure and simple; it is good as a salve for sore eyes and wounds. Poor honey always floats on the surface and should be skimmed off; the clear honey rests below. When the floral world is in full bloom, then they make wax; consequently you must then take the wax out of the hive, for they go to work on new wax at once. The flowers from which they gather honey are as follows: the spindle-tree, the melilot-clover, king's-spear, myrtle, flowering-reed, withy, and broom. When they work at thyme, they mix in water before sealing up the comb. As has been already stated, they all either fly to a distance to discharge their excrement or make the discharge into one single comb. The little bees, as has been said, are more industrious than the big ones; their wings are battered; their colour is black, and they have a burnt-up aspect. Gaudy and showy bees, like gaudy and showy women, are idle. Bees seem to take a pleasure in listening to a rattling noise; and consequently men say that they can muster them into a hive by rattling with crockery or stones; it is uncertain, however, whether or no they can hear the noise at all, and also whether their procedure is due to pleasure or alarm. They expel from the hive all idlers and unthrifts. As has been said, they differentiate their work; some make wax,[17] some make honey, some make bee-bread, some shape and mould combs, some bring water to the cells and mingle it with the honey, some engage in out-of-door work. At early dawn they make no noise, until some one particular bee makes a buzzing noise two or three times and thereby awakes the rest; hereupon they all fly in a body to work. By and by they return and at first are noisy; then the noise gradually decreases, until at last some one bee flies round about, making a buzzing noise, and apparently calling on the others to go to sleep; then all of a sudden there is silence. The hive is known to be in good condition if the noise heard within it is loud, and if the bees make a flutter as they go out and in; for at this time they are constructing brood-cells. They suffer most from hunger when they recommence work after winter. They become somewhat lazy if the bee-keeper, in drawing the honey, leaves behind too much; still one should leave cells numerous in proportion to the population, for the bees work in a spiritless way if too few combs are left. They become idle also, as being dispirited, if the hive is too big. A hive yields to the bee-keeper six or nine pints of honey; a prosperous hive will yield twelve or fifteen pints, exceptionally good hives eighteen. Sheep and, as has been said, wasps are enemies to the bees. Bee-keepers entrap the latter, by putting a flat dish on the ground with pieces of meat on it; when a number of the wasps settle on it, they cover them with a lid and put the dish and its contents on the fire. It is a good

[17]Reading κηρόν.

thing to have a few drones in a hive, as their presence increases the industry of the workers. Bees can tell the approach of rough weather or of rain; and the proof is that they will not fly far, but even while it is as yet fine they go fluttering about within a restricted space, and the bee-keeper knows from this that they are expecting bad weather. When the bees inside the hive hang clustering to one another, it is a sign that the swarm is about to quit; consequently, bee-keepers, on seeing this, besprinkle the hive with sweet wine. It is advisable to plant about the hives pear-trees, beans, Median-grass, Syrian-grass, yellow pulse, myrtle, poppies, creeping-thyme, and almond-trees. Some bee-keepers sprinkle their bees with flour, and can distinguish them from others when they are at work out of doors. If the spring be late, or if there be drought or blight, then grubs are all the fewer in the hives. So much for the habits of bees.

41 · Of wasps, there are two kinds. Of these kinds one is wild and scarce, lives on the mountains, engenders grubs not underground but on oak-trees, is larger, longer, and blacker than the other kind, is invariably speckled and furnished with a sting, and is remarkably courageous. The pain from its sting is more severe than that caused by the others, for the sting is larger, in proportion to its own larger size. These wild wasps live over into a second year, and in winter time, when oaks are in course of felling, they may be seen coming out and flying away. They lie concealed during the winter, and live in the interior of logs of wood. Some of them are mother-wasps and some are workers, as with the tamer kind; and it is by observation of the tame wasps that one may learn the nature of the mothers and the workers.
628a1 For in the case of the tame wasps also there are two kinds; one consists of leaders, who are called mothers, and the other of workers. The leaders are far larger and milder-tempered than the others. The workers do not live over into a second year, but all die when winter comes on; and this can be proved, for at the commencement of winter the workers become drowsy, and about the time of the winter solstice they are never seen at all. The leaders, the so-called mothers, are seen all through the winter, and live in holes underground; for men when ploughing or digging in winter have often come upon mother-wasps, but never upon workers. The mode of reproduction of wasps is as follows. At the approach of summer, when the leaders have found a sheltered spot, they take to moulding their combs, and construct the so-called *sphecons,*—little nests containing four cells or thereabouts, and in these are produced working-wasps but not mothers. When these are grown up, then they construct other larger combs upon the first, and then again in like manner others; so that by the close of autumn there are numerous large combs, in which the leader, the so-called mother, engenders no longer working-wasps but mothers. These develop high up in the nest as large grubs, in cells that occur in groups of four or rather more, pretty much in the same way as the grubs of the king-bees are produced in their cells. After the birth of the working-grubs in the cells, the leaders do nothing and the workers have to supply them with nourishment; and this is clear from the fact that the leaders of the working-wasps no longer fly out at this time, but rest quietly indoors. Whether the leaders of last year after engendering new leaders are killed by the new brood, and whether this occurs invariably or whether

they can live for a longer time, has not been ascertained by actual observation; neither can we speak from observation as to the age attained by the mother-wasp or by the wild wasps, or as to any other similar phenomenon. The mother-wasp is broad and heavy, fatter and larger than the ordinary wasp, and from its weight not very strong on the wing; these wasps cannot fly far, and for this reason they always rest inside the nest, building and managing its indoor arrangements. The so-called mother-wasps are found in most of the nests; it is a matter of doubt whether or no 628b1
they are provided with stings; in all probability, like the king-bees, they have stings, but never protrude them for offence. Of the ordinary wasps some are destitute of stings, like the drone-bees, and some are provided with them. Those unprovided therewith are smaller and less spirited and never fight, while the others are big and courageous; and these latter, by some, are called males, and the stingless, females. At the approach of winter many of the wasps that have stings appear to lose them; but we have never met an eyewitness of this phenomenon. Wasps are more abundant in times of drought and in wild localities. They live underground, their combs they mould out of rubbish and earth, each comb from a single origin, as if from a root. They feed on certain flowers and fruits, but for the most part on animal food. Some of the tame wasps have been observed when sexually united, but it was not determined whether both, or neither, had stings, or whether one had a sting and the other had not; wild wasps have been seen under similar circumstances, when one was seen to have a sting but the case of the other was left undetermined. The wasp-grub does not appear to come into existence by parturition, for at the outset the grub is too big to be the offspring of a wasp. If you take a wasp by the feet and let him buzz with his wings, wasps that have no stings will fly towards it, and wasps that have stings will not; from which fact it is inferred by some that one set are males and the other females. In the winter, wasps are found in caves, some with stings, and some without. Some build cells, small and few in number; others build many and large ones. The so-called mothers are caught at the change of season, mostly on elm-trees, while gathering a substance sticky and gumlike. A large number of mother-wasps are found when in the previous year wasps have been numerous and the weather rainy; they are captured in precipitous places, or in vertical clefts in the ground, and they all appear to be furnished with stings.

42 · So much for the habits of wasps.

Hornets do not subsist by culling from flowers as bees do, but for the most part on animal food: for this reason they hover about dung; for they chase the large flies, and after catching them lop off their heads and fly away with the rest of the carcases; they are furthermore fond of sweet fruits. Such is their food. They have 629a1
also leaders like bees and wasps; and their leaders are larger in proportion to themselves than are wasp-kings to wasps or bee-kings to bees. The hornet-king, like the wasp-king, lives indoors. Hornets build their nests underground, scraping out the soil like ants; for neither hornets nor wasps go off in swarms as bees do, but successive generations of young keep to the same habitat, and go on enlarging their nest by scraping out more and more of soil. The nest accordingly attains a great size; in fact, from a particularly prosperous nest have been removed three and even four

baskets full of combs. They do not, like bees, store up food, but pass the winter in a torpid condition; the greater part of them die in the winter, but it is uncertain whether that can be said of them all. In the hives of bees several kings are found and they lead off detachments in swarms, but in the hornet's nest only one king is found. When individual hornets have strayed from their nest, they cluster on a tree and construct combs, as may be often seen above-ground, and in this nest they produce a king; when the king is full-grown,[18] he leads them away and settles them along with himself in a nest. With regard to their sexual unions, and the method of their reproduction, nothing is known from actual observation. Among bees both the drones and the kings are stingless, and so are certain wasps, as has been said; but hornets appear to be all furnished with stings: though it would well be worth while to carry out investigation as to whether the hornet-king has a sting or not.

43 · Bumble-bees produce their young under a stone, right on the ground, in a couple of cells or little more; in these cells is found an attempt at honey, of a poor description. The tenthredon is like the hornet, but speckled, and about as broad as a bee. Being epicures as to their food, they fly, one at a time, into kitchens and on to slices of fish and the like dainties. The tenthredon gives birth like the wasp, 629b1 underground, and is very prolific; its nest is much bigger and longer than that of the wasp. So much for the methods of working and the habits of life of the bee, the wasp, and all the other similar insects.

44 · As regards the disposition of animals, as has been previously observed, one may detect great differences in respect to courage and timidity, as also, even among wild animals, in regard to tameness and wildness. The lion, while he is eating, is most ferocious; but when he is not hungry and has had a good meal, he is quite gentle. He is totally devoid of suspicion or nervous fear, is fond of romping with animals that have been reared along with him and to whom he is accustomed, and manifests great affection towards them. In the chase, as long as he is in view, he makes no attempt to run and shows no fear, but even if he be compelled by the multitude of the hunters to retreat, he withdraws deliberately, step by step, every now and then turning his head to regard his pursuers. If, however, he reach wooded cover, then he runs at full speed, until he comes to open ground, when he resumes his leisurely retreat. When, in the open, he is forced by the number of the hunters to run while in full view, he does run at the top of his speed, but without leaping and bounding. This running of his is evenly and continuously kept up like the running of a dog; but when he is in pursuit of his prey and is close behind, he makes a sudden spring upon it. The two statements made regarding him are quite true; the one that he is especially afraid of fire, as Homer pictures him in the line—'and glowing torches, which, though fierce, he dreads,'[19]—and the other, that he keeps a steady eye upon the hunter who hits him, and flings himself upon him. If a hunter hit him, without hurting him, then if with a bound he gets hold of him, he will do him no

[18] Reading ἐπὰν αὐξηθῇ, ἀπάγει.
[19] *Iliad* XI 553.

harm, not even with his claws, but after shaking him and giving him a fright will let him go again. They invade towns and attack human beings when they are grown old and so by reason of old age and the diseased condition of their teeth are unable to pursue their wonted prey. They live to a good old age. The lion who was captured when lame, had a number of his teeth broken; which fact was regarded by some as a proof of the longevity of lions, as he could hardly have been reduced to this condition except at an advanced age. There are two species of lions, the plump, curly-maned, and the long-bodied, straight-maned; the latter kind is courageous, and the former comparatively timid; sometimes they run away with their tail between their legs, like a dog. A lion was once seen to be on the point of attacking a boar, but to run away when the boar stiffened his bristles in defence. It is susceptible of hurt from a wound in the flank, but on any other part of its frame will endure any number of blows, and its head is especially hard. Whenever it inflicts a wound, either by its teeth or its claws, there flows from the wounded parts suppurating matter, quite yellow, and not to be staunched by bandage or sponge; the treatment for such a wound is the same as that for the bite of a dog.

The civet is fond of man's company; it does him no harm and is not much afraid of him, but it is an enemy to the dog and the lion, and consequently is not found in the same habitat with them. The little ones are best. Some say that there are two species of the animal, and some say, three; there are probably not more than three, but, as in the case with certain of the fishes, birds, and quadrupeds, this animal changes in appearance with the change of season. His colour in winter is not the same as it is in summer; in summer the animal is smooth-haired, in winter he is shaggy.

45 · The bison is found in Paeonia on Mount Messapium, which separates Paeonia from Maedica; and the Paeonians call it the *monapos*. It is the size of a bull, but stouter in build than the ox—for it is not long in the body; its skin, stretched tight on a frame, would give sitting room for seven people. In general it resembles the ox in appearance, except that it has a mane that reaches down to the point of the shoulder, as that of the horse; but the hair in its mane is softer than the hair in the horse's mane, and clings more closely. The colour is brown-yellow; the mane reaches down to the eyes, and is deep and thick. The colour of the hair is midway between red and ash-grey, like that of the so-called chestnut horse; it is rough on top, woolly underneath. The animal is not found either very black or very red. It has the bellow of a bull. Its horns are crooked, turned inwards toward each other and useless for purposes of self-defence; they are a span broad, or a little more, and in volume each horn would hold about three pints of liquid; the black colour of the horn is beautiful and bright. The tuft of hair on the forehead reaches down to the eyes, so that the animal sees objects on either flank better than objects right in front. It has no upper teeth, as is the case also with cattle and all other horned animals. Its legs are hairy; it is cloven-footed, and the tail, which resembles that of the ox, seems not big enough for the size of its body. It tosses up dust and digs the ground like the bull. It skin is impervious to blows. Owing to the savour of its flesh it

is sought for in the chase. When it is wounded it runs away, and stops only when thoroughly exhausted. It defends itself against an assailant by kicking and projecting its excrement to a distance of eight yards; this device it can easily adopt over and over again, and the excrement is so pungent that the hair of hunting-dogs is burnt off by it. It is only when the animal is disturbed or alarmed that the dung has this property; when the animal is undisturbed it has no blistering effect. So much for the shape and habits of the animal. When the season comes for parturition the mothers give birth to their young in troops upon the mountains. Before dropping their young they scatter their dung about the place, making a kind of circular rampart around them; for the animal has the faculty of ejecting excrement in most extraordinary quantities.

46 · Of all wild animals the most easily tamed and the gentlest is the elephant. It can be taught a number of things, and it understands them; as, for instance, it can be taught to kneel in presence of the king. It is very sensitive, and possessed of an intelligence superior to that of other animals. When the male has had sexual union with the female, and the female has conceived, the male has no further intercourse with her.

Some say that the elephant lives for two hundred years; others, for one hundred and twenty; that the female lives nearly as long as the male; that they reach their prime about the age of sixty, and that they are sensitive to inclement weather and frost. The elephant is found by the banks of rivers, but he is not a river animal; he can make his way through water, as long as the tip of his trunk can be above the surface, for he blows with his trunk and breathes through it. The animal is a poor swimmer owing to the heavy weight of his body.

47 · The male camel declines intercourse with its mother; if his keeper tries compulsion, he evinces disinclination. On one occasion, when there was no stallion at hand, the keeper covered over the mother and put her foal to her; but, when after the intercourse[20] the wrapping had been removed, though the operation was
631a1 completed, still by and by he bit his keeper to death. A story goes that the king of Scythia had a highly-bred mare, and that all her foals were splendid; that wishing to mate the best of the young males with the mother,[21] he had him brought to the stall for the purpose; that the young horse declined; that, after the mother's head had been concealed in a wrapper he, in ignorance, had intercourse; and that, when immediately afterwards the wrapper was removed and the head of the mare was rendered visible, the young horse ran away and hurled himself down a precipice.

48 · Among the sea-fishes many stories are told about the dolphin, indicative of his gentle and kindly nature, and of manifestations of passionate attachment to boys, in and about Tarentum, Caria, and other places. The story goes that, after a dolphin had been caught and wounded off the coast of Caria, a shoal of

[20]Retaining *ὀχεύσαντος*.
[21]Reading *τούτων* for *τούτον*, and rejecting *γεννηθέντα*.

dolphins came into the harbour and stopped there until the fisherman let his captive go free; whereupon the shoal departed. A shoal of young dolphins is always, by way of protection, followed by a large one. On one occasion a shoal of dolphins, large and small, was seen, and certain of them, going at a little distance away, appeared swimming in underneath a little dead dolphin when it was sinking, and supporting it on their backs, trying out of compassion to prevent its being devoured by some other beast. Incredible stories are told regarding the rapidity of movement of this creature. It appears to be the fleetest of all animals, marine and terrestrial, and it can leap over the masts of large vessels. This is chiefly manifested when they are pursuing a fish for food; then, if the fish endeavours to escape, they pursue him in their hunger down to deep waters; but, when the return swim is getting too long, they hold in their breath, as though calculating the length of it, and then draw themselves together and shoot up like arrows, trying to make the long ascent rapidly in order to breathe, and in the effort they spring right over a ship's masts if a ship be in the vicinity. This same phenomenon is observed in divers, when they have plunged into deep water; that is, they pull themselves together and rise with a speed proportional to their strength. Dolphins live together in pairs, male and female. It is not known for what reason they run themselves aground on dry land; at all events, it is said that they do so at times, and for no reason.

49 · Just as with all animals a change of action follows a change of circumstance, so also a change of character follows a change of action, and often some portions of the physical frame undergo a change, as occurs in the case of birds. Hens, for instance, when they have beaten the cock in a fight, will crow like the cock and endeavour to tread him; the crest rises up on their head and the tail-feathers on the rump, so that it becomes difficult to recognize that they are hens; in some cases there is a growth of small spurs. On the death of a hen a cock has been seen to undertake the maternal duties, leading the chickens about and providing them with food, and so intent upon these duties as to cease crowing and indulging in his sexual propensities. Some cock-birds are congenitally so feminine that they will submit to other males who attempt to tread them.

50 · Some animals change their form and character, not only at certain ages and at certain seasons, but in consequence of being castrated; and all animals possessed of testicles may be submitted to this operation. Birds have their testicles inside, and oviparous quadrupeds close to the loins; and of viviparous animals that walk some have them inside, and most have them outside, but all have them at the lower end of the belly. Birds are castrated at the rump at the part where the two sexes unite in copulation. If you burn this twice or thrice with hot irons, then, if the bird be full-grown, his crest grows sallow, he ceases to crow, and foregoes sexual activity; but if you cauterize the bird when young, none of these male attributes or propensities will come to him as he grows up. The case is the same with men: if you mutilate them in boyhood, the later-growing hair never comes, and the voice never changes but remains high-pitched; if they be mutilated in early manhood, the late

growths of hair quit them except the growth on the groin, and that diminishes but does not entirely depart. The congenital growths of hair never fall out, for a eunuch never goes bald. In the case of all castrated or mutilated male quadrupeds the voice changes to the feminine voice. All other quadrupeds when castrated, unless the operation be performed when they are young, invariably die; but in the case of boars, and in their case only, the age at which the operation is performed produces no difference. All animals, if operated on when they are young, become bigger and better looking than their unmutilated fellows; if they be mutilated when full-grown, they do not take on any increase of size. If stags be mutilated when, by reason of their age, they have as yet no horns, they never grow horns at all; if they be mutilated when they have horns, the horns remain unchanged in size, and the animal does not lose them. Calves are mutilated when a year old; otherwise, they turn out uglier and smaller. Steers are mutilated in the following way: they turn the animal over on its back, cut a little off the scrotum at the lower end, and squeeze out the testicles, then push back the roots of them as far as they can, and stop up the incision with hair to give an outlet to suppurating matter; if inflammation ensues, they cauterize the scrotum and put on a plaster. If a full-grown bull be mutilated, he can still apparently generate off-spring. The ovaries of sows are excised with the view of quenching in them sexual appetites and of stimulating fatness. The sow has first to be kept two days without food, and, after being hung up by the hind legs, it is operated on; they cut the lower belly, about the place where the boars have their testicles, for it is there that the ovary grows, adhering to the two divisions of the womb; they cut off a little piece and stitch up the incision. Female camels are mutilated when they are wanted for war purposes, and are mutilated to prevent their being got with young. Some of the inhabitants of the interior have as many as three thousand camels: when they run, they run, in consequence of the length of their stride, much quicker than the horses of Nisaea. As a general rule, mutilated animals grow to a greater length than the unmutilated.

632b1 All animals that ruminate derive profit and pleasure from the process of rumination, as they do from the process of eating. It is the animals that lack the upper teeth that ruminate, such as cattle, sheep, and goats. In the case of wild animals no observation has yet been made, except in the case of animals that are occasionally domesticated, such as the stag, and it chews the cud. All animals that ruminate generally do so when lying down on the ground. They carry on the process to the greatest extent in winter, and stall-fed ruminants carry it on for about seven months in the year; beasts that go in herds, as they get their food out of doors, ruminate to a lesser degree and over a lesser period. Some ambidentates also ruminate; as, for instance, the Pontic mice, and the fish which from the habit is by some called 'the Ruminant', as well as other fish.

Long-limbed animals have loose faeces, and broadchested animals vomit with comparative facility, and these remarks are, in a general way, applicable to quadrupeds, birds, and men.

49B · A considerable number of birds change according to season the colour of their plumage and their note; as, for instance, the owzel becomes yellow instead of black, and its note gets altered, for in summer it has a musical note and in winter a discordant chatter. The thrush also changes its colour; about the throat it is marked in winter with speckles, in summer spotted: however, it never alters its note. The nightingale, when the hills are taking on verdure, sings continually for fifteen days and fifteen nights; afterwards it sings, but not continuously.[22] As summer advances it has a different song, not so varied as before, nor so quick and modulated, but simple; it also changes its colour, and in Italy about this season it goes by a different name. It goes into hiding, and is consequently visible only for a brief period.

The redbreast and the so-called redstart change into one another; the former is a winter bird, the latter a summer one, and the difference between them is practically limited to the coloration of their plumage. In the same way with the beccafico and the blackcap; these change into one another. The beccafico appears about autumn, and the blackcap as soon as autumn has ended. These birds, also, 633a1
differ from one another only in colour and note; that it is the same bird is shown by the fact that at the period when the change is in progress each one has been seen with the change as yet incomplete and not yet gone over to the other kind. It is not so very strange that in these cases there is a change in note and in plumage, for even the ring-dove ceases to coo in winter, and recommences cooing when spring comes in; in winter, however, when fine weather has succeeded to very stormy weather, this bird has been known to give its cooing note, to the astonishment of the experts. As a general rule, birds sing most loudly and most diversely in the pairing season. The cuckoo changes its colour, and its note is not[23] clearly heard for a short time previous to its departure. It departs about the rising of the dog-star, and it reappears from springtime to the rising of the dog-star. At the rise of this star the bird called by some oenanthe disappears, and reappears when it is setting: thus keeping clear at one time of cold, and at another time of heat. The hoopoe also changes its colour and appearance, as Aeschylus has represented in the following lines:—

> The Hoopoe, witness to his own distress,
> Is clad by Zeus in variable dress:—
> Now a brave mountain-bird, with knightly crest,
> Now in the white hawk's silver plumage drest;
> For, timely changing, on the hawk's white wing
> He greets the apparition of the Spring.
> Thus twofold form and colour are conferred,
> In youth and age, upon the selfsame bird.
> The spangled raiment marks his youthful days,
> The argent his maturity displays;
> And when the fields are yellow with ripe corn
> Again his particoloured plumes are worn.
> But evermore, in sullen discontent,
> He seeks the lonely hills, in self-sought banishment.

[22]Reading *ταχεῖαν*. [23]Retaining *οὐ*.

Of birds, some take a dust-bath, some take a water-bath, and some take neither the one bath nor the other. Birds that do not fly but keep on the ground take the dust-bath, as for instance the hen, the partridge, the francolin, the lark, the pheasant; some of the straight-taloned birds, such as live on the banks of a river, in marshes, or by the sea, take a water-bath; some birds take both the dust-bath and the water-bath, as for instance the pigeon and the sparrow; of the crooked-taloned birds the greater part take neither. So much for the ways of the above-mentioned,—but some birds have a peculiar habit of making a noise at their hinder quarters, as, for instance, the turtle-dove; and they make a violent movement of their tails at the same time that they produce this sound.

BOOK X[1]

1 · As a man and a woman advance in age, they may continue to have intercourse with one another and yet produce no children; the cause of this is to be found sometimes in both partners, sometimes in one only. First, in the case of the female, the state of the womb must be considered so that if the cause lies there the womb may receive treatment, and if it does not attention may be paid to another one of the causes.

Now in the case of any other part, it is plain that[2] it is healthy if it performs its function satisfactorily and gives no pain and is not exhausted after functioning: e.g. an eye is healthy when it does not produce pus and can see and after seeing is not disturbed and incapable of seeing again. Thus the womb too is healthy if it does not cause pain and performs its proper function satisfactorily and after functioning is not incapacitated or exhausted.

It is said that even a womb not in good condition may nevertheless be able to perform its function well and painlessly, if it is not impaired in respect of its function—just as nothing prevents[3] an eye from seeing accurately even when not all its parts are in a good condition or there is a stye in it. Similarly, if a womb is in good condition in its essential region, it will not be harmed with regard to its function.

Now if the womb is to be in good condition, it must, first of all, not move from place to place but be in a uniform position; but it must be able to move further away without being affected or giving pain, and not be too insensitive to the touch. It is not difficult to decide if this is the case. That the womb should have such a character is clear from the following considerations: if it does not come close enough, it will not be capable of drawing matter up (for the place from which it must receive the matter will be distant from it); but if it remains close and is not capable of receding further away, it will be less responsive because of being continually touched, so that it will not open quickly—something which it must do vigorously and with prompt obedience.

[1]Translated by Jonathan Barnes.
[2]Reading ὅτι for εἰ.
[3]Reading οὐδὲν κωλύει for ἰσχύει.

The womb must have these characteristics, and a womb which lacks them requires some form of treatment. In addition, menstruation must occur properly, i.e. at equidistant intervals and not irregularly, and with the body in a healthy state; for when it occurs in this way it indicates that the womb is well adapted to opening and to receiving fluid from the body whenever the body provides it. When menstruation occurs too frequently or too infrequently or irregularly, and the rest of the body is healthy and does not act as a contributory cause, this condition must be due to the womb: either the womb is unresponsive and so does not open at the proper time and admits only a little fluid, or else it draws in too much because of some inflammation, thus showing that it requires treatment—just like the eyes, the bladder, the stomach, and the rest. For all these parts, when inflamed, draw in the fluid which is naturally secreted in those places, but not in the proper condition or amount. Similarly, when the womb releases too much fluid, that indicates an inflamed condition—if the fluid is similar to but more abundant than what is normal. If it is dissimilar from and more putrid than that which flows in healthy women, then that is quite clearly an affliction; for certain pains will necessarily appear as symptoms when the womb is not in the right condition. (But even in healthy women the 'whites' flow in putrid form, in some cases at the start of the menstrual period but usually at its end.) If a woman's menstrual fluids are more putrid than those of healthy women, or are disorderly—too much or too little—she is in need of treatment; for these conditions are obstacles to reproduction. But if the periods are simply irregular and not equidistant, the condition is less of an impediment, although it indicates that the state of the womb is changing and not always remaining uniform. That condition can harm women who are of good constitution with regard to conception, but it is not a disease; it is the sort of condition which will right itself even without treatment, provided that the woman 634b1
herself does not do anything to exacerbate it.

If the menstrual flow changes in frequency or in amount while the rest of the body is not in a constant state but sometimes more moist and sometimes more dry, then the womb is not the cause but is bound itself to follow the state of the body, admitting and releasing its fluids in proportion. If the womb does this when the body is healthy but changing, no treatment is required; and if the body is in poor health, and the womb either releases too little (because the residue is expended elsewhere, where the body ails) or ejects too much (because the body discharges there), then this signifies not that the womb itself requires treatment, but that the body does. For when the menstrual flow changes with the condition of the body, that shows that the cause does not lie in the womb but that the womb remains healthy.

The womb is sometimes weaker, sometimes stronger; it is sometimes more moist, sometimes more dry. The menstrual flow is greater when the body of the womb is greater, less when it is less, more watery when it is moist, more bloody when it is dry. The flow begins with milky 'whites', which remain odourless; but the rest of it is red, becoming whiter at the end when the flow is just about to cease.[4] The 'whites' then have an odour, but not of putrefaction—it is more acrid and heavy—nor of pus; and there is no decay, though there is a high temperature, when the signs

[4] Retaining καταλήξεως.

occur in this way. Women in whom menstruation occurs in this fashion have their wombs in the right state for reproduction.

2 · We must first see if these conditions are satisfactorily met, and then consider the condition of the neck of the womb. This must be straight, otherwise the womb will not draw the semen into itself; for women too emit into the region in front of the womb, as is clear when they have complete erotic dreams. For then that part needs treatment, being in a moist state just as if they had been with a man—for the man too emits here, into the same place and not into the inside of the womb. But when emission takes place here, the womb, like a nose, draws it in with the breath. That is why women may conceive while copulating in any of the positions; for in every case[5] the semen is emitted, both by them and by men, into the region in front of the womb, whereas if it were emitted into the womb, they would not conceive after every form of copulation.

But if the womb does not look straight forward, but inclines towards the buttocks or the groin or the abdomen, it is impossible to conceive for the aforementioned reason—it could not draw up the semen. If the womb is firmly set in such a position, either by nature or as the result of disease, the condition is incurable; but if there is a rupture, either natural or caused by some disease which has contracted the womb as the result of inflammation, the condition. . .[6]

If a woman is going to become pregnant, the neck of the womb must, as we have said, be straight; and in addition the womb must open properly. By properly I mean that it should be such that when menstruation begins the neck is softer to the touch than before and is not noticeably dilated. But if. . .[7] when it is in this state, the first signs, the 'whites', should show themselves. When the signs are somewhat fleshy in colour, the womb will be noticeably distended without any pain, whether it is touched or not, and it will neither be unresponsive nor have its neck in an unusual condition. When menstruation ceases, the neck should be very dilated and dry (but not hard) for a full day and a half or even for two days. For when menstruation occurs in this way, it indicates that the womb is in a proper condition and is performing its function, and also, because the neck is not immediately distended but becomes soft, that it relaxes at the same time as the rest of the body, and does not impede but first expels the fluid from the neck itself; but when the body emits a greater amount, it is distended—and that is a mark of a healthy condition of the neck. When the signs have ceased, the womb indicates, by not closing up at once, that. . .[8] it is becoming empty, dry, and parched, and that there is nothing left in the passage.

Thus the womb, having the power to draw up the semen, indicates that it is in a proper condition to conceive during intercourse whenever it is in that state without pain or insensitivity. And it is good that the neck is not in an unusual condition; for

[5]Reading πάντως for παντελῶς, and omitting ⟨ὁπωσοῦν⟩ ἐχούσης.

[6]Text uncertain.

[7]There appears to be a lacuna in the text at this point.

[8]Text uncertain.

this indicates that there is nothing to prevent the womb from closing up when necessary.

3 · These, then, are the points to observe in order to tell whether or not the neck of the womb is in the right condition. As to the womb itself, it should behave as follows after menstruation: first, the woman should dream that she is with a man and her emissions should come easily, as if she were actually having intercourse—and the more often this happens the better; and when she wakes up she should sometimes need the treatment she requires when she has actually had intercourse with a man, and sometimes be dry. But this dryness should not continue long; but later, after waking, she should grow moist again, sometimes quickly, sometimes more slowly, . . .[9] and the moisture should be of the sort which occurs after she has 635b1
had intercourse with a man. For all this indicates that the womb can receive what it is offered, and that the cotyledons can draw up and retain what they receive and will not readily give it up.

Again, wind should be produced without any affliction, as in the stomach, and this should be released, whether in large or small quantity, without disease; for this shows that the womb is not more solid than it should be and that it is not unresponsive, either by nature or by disease, but can make room for the growth of whatever it receives. And[10] it also possesses elasticity. When this does not occur, the womb is either too close-textured or too insensitive, whether by nature or by disease. That is why it cannot nourish the embryo but may actually destroy it—when the embryo is still small, if the condition is severe, when it is larger if less severe; and if the condition is very mild, offspring are produced in a rather poor state, as though nourished in a poor container.

Again, the right and the left parts of the womb should be level to the touch; and so too with the rest. And during intercourse with a man, the womb should become moist, but not often nor excessively. This affection is a sort of local sweating—just as we often emit saliva at the mouth on the approach of food and when we are talking or working too hard; again, tears fall from our eyes when we look at objects that are too bright, or under the influence of cold or great heat which those organs master when they are somewhat moist.[11] Similarly, the womb too grows moist during its work, when it is in a somewhat moist condition. This occurs even in wombs which are naturally in an excellent state. Hence women always need treatment, in greater or less degree, just as the mouth needs to spit. But in some there is so much moisture that they cannot draw up the man's emission in a pure form, because it is mixed with the moisture from the woman.

In addition to those affections, one should observe what happens when a woman dreams she is having intercourse with a man, and what state she is in when she wakes up—e.g. is she weaker?) is she always so, or[12] sometimes so and sometimes not so? or is she sometimes actually stronger? If not, is the womb drier at first, later growing moist? For this should occur if the woman is fertile. For the

[9]Text uncertain. [10]Retaining δέ.
[11]Retaining ἧς κρατεῖ. [12]Reading ἤ for μή.

exhaustion indicates that the body is continually emitting semen, and the woman who has emissions and . . .[13] is made weaker. That this affection is not accompanied by any disease indicates that the emission occurs naturally and in the right manner.
636a1 Otherwise, the weakness would be morbid. If sometimes she becomes stronger, and her womb is dry and then grows moist, that is a sign that her body as a whole is receiving and absorbing, and that it is not the womb only but the body too which is strong. For it is by breath that the womb draws in what comes to it from outside, as we said earlier. For the woman emits not into the womb but at the place where the man's emission also falls. And everything done by the breath is done by strength; hence it is clear that in such women the body too has the power of drawing matter up.

Some women suffer from what is known as wind-pregnancy: that too is something which women should not experience. The affection is of the following sort: when they are with a man, they neither clearly emit the semen nor become pregnant; and so it is called a wind-pregnancy. The cause of the affection is the womb, when it is too dry. For having drawn the fluid up into itself, it ejects it;[14] but the fluid dries up and, becoming reduced in quantity, it leaves the womb but is not observed to do so because there is little of it. When the womb is severely affected in this way, and becomes excessively dry, it loses the fluid quickly and the woman is quickly seen not to be pregnant. But if it does not do this very quickly, the woman seems to be pregnant during the intervening time until the womb loses whatever it holds in itself. Such women soon experience symptoms similar to those of genuine pregnancy; and if the condition lasts for a long time, the womb expands, so that the woman seems evidently pregnant until the fluid leaves; and then it becomes just as it was before. They ascribe this affection to the supernatural. It can be treated unless the woman is naturally of this sort[15] and suffers severely from the affection. It is an indication that women are[16] of this nature if they plainly do not emit when they have received from the man and yet do not conceive.

4 · The womb is also impeded if it suffers from spasms. Spasms occur either if the womb is distended by inflammation or if in child-birth a large quantity of fluid suddenly collects and the neck does not open—then spasms are caused by the distention. It is an indication that the womb does not suffer from spasms if it clearly is not inflamed when performing its functions; for if it suffered from spasms it would sometimes become inflamed.

Again, if there is a growth on the neck and the neck is severely ulcerated, that impedes conception. It is an indication that this is not so if the womb is seen to open
636b1 and close properly during menstruation and sexual intercourse.

Again, in some women the neck is somehow knitted together, sometimes from birth, sometimes as the result of disease. This is in some cases curable, in others not. The condition is not difficult to recognise; for the woman is unable to receive anything of what she should or to emit anything. Hence if she is seen to receive from the man and to emit, it is clear that she does not suffer from the affection.

[13]Text uncertain. [14]Omitting Dittmeyer's οὐκ.
[15]Omitting Dittmeyer's ἢ. [16]Omitting μή.

When a woman is not impeded in any of these ways but is in the condition we have said she should be in, then unless the man is a cause of childlessness or they are capable of having children together but are not in harmony by having their emissions at the same time but differ widely, they will have children.

5 · There are various signs by which you can tell that the man is not responsible; and it is very easy[17] to tell this if he has intercourse with other women and produces children. And it is a sign that they do not keep pace with one another if, although all the conditions described are met, he does not produce children.[18] For it is plain that this alone is the cause; for if the woman too contributes something to the semen and to the process of generation, it is plain that the partners must keep pace with one another. Thus if the man ejaculates quickly and the woman with difficulty (for women are for the most part slower), that prevents conception; and that is why partners who do not produce children with one another *do* produce children when they meet with partners who keep pace with them during intercourse. For if the woman is excited and prepared and has the appropriate thoughts, and the man has previously been pained and has grown cold, they must necessarily then keep pace with one another.

Again, it sometimes happens that women who have had erotic dreams and men who have made love are more vigorous—not in strength but in health. This occurs when a large quantity of semen has gathered at the place from which it is emitted: if it is then ejected, women do not become weaker; for they are not always exhausted after ejection, provided that what remains is sufficient. Nor are they exhausted if what is ejected is useless—indeed,[19] they are actually more at ease, as though relieved of a surplus. That is why they become more vigorous, not through strength but through lightness. (But when an emission detracts from an amount which the body needs, then it makes them weaker. But this is quickly over if the body is otherwise in good health and of an age which quickly produces semen; for semen is something which can grow and which does grow quickly.)[20] And it is then especially that women conceive without realising it; for they do not think that they have conceived if they are not aware of their emission, and they actually suppose that the emissions must occur in both partners, the man and the woman, at the same time. Unnoticed conception occurs especially in women who think that it is impossible to conceive unless they become dry and the fluid they have received has plainly been absorbed. But it sometimes happens that both the woman and the man emit more than she can absorb and more than enough for conception. Thus when enough is drawn up but a great quantity remains, they conceive without realising it. That such a thing is possible and that conception does not require all the semen is shown by those animals that produce many young from a single act of copulation, and by the generation of twins when they develop from a single act. For it is clear that generation did not require all the semen, but that the region received a part of it and left a much larger part behind. (Again, if many young are generated by a single act of copulation—something which evidently occurs in the case of pigs, and sometimes

[17]Text uncertain. [18]Reading *γεννῶν* for *γεννῶσιν*.
[19]Reading *ἀλλά* for *ἅμα* ⟨*δέ*⟩. [20]Text uncertain.

with twins—it is clear that the semen does not proceed from the whole body but that it divides up according to each form.) For it is possible for some to be separated off from the whole, and for the whole to be divided into many parts; but[21] it is impossible for it to act as a whole on different parts at the same time.

Again, the woman emits into the area in front of the neck of the womb, where the man too emits when he has intercourse. For from there the womb draws it up with the aid of the breath, as with the mouth or the nostrils. For everything that is not pulled forward by instruments either is light and has a nature such as to travel upwards or else is drawn upwards from that place by breath. That is why women take care that the place is as dry as it was before the act took place.

The path along which the semen passes in women is of the following nature: they possess a tube—like the penis of the male, but inside of the body—and they breathe through this by a small duct which is placed above the place through which women urinate. That is why, when they are eager to make love, this place is not in the same state as it was before they were excited. Now the semen escapes from this tube, and the area in front of the womb is much larger than the path by which the semen escaped into this region. In this respect the part is like a nose; for the nose has a duct leading inside to the larynx and outside to the air: in the same way this place too has a very small and narrow duct outside[22]—just large enough to let the air out—whereas that which leads to the region in front of the womb is broad and open; just as in the nose the passage leading to the air is larger than that leading to the mouth and larynx. Similarly, in women the duct leading to the area in front of the womb is larger and broader than the one leading out.[23]

Whatever is contributed to this place produces the same affections,[24] because the woman too emits generative material. And if the causes are the same the results are the same. For those who think that one thing can be the cause either of disease or of death do not[25] consider the last factor in the direction of the principles, which they should look to. For in some cases all the primary causes are the same,[26] in some none are, and in others[27] some are the same and some are not. Thus the results follow as they should: in some cases the affections passed through are all the same; in others most are the same, when most causes are the same; in others a few; and in others none, when none are.[28]

6 · It is clear when animals need to be covered. For they pursue the males—e.g. the domestic hen pursues the cock and squats beneath him if he is not excited. Other animals do this too. So if the same affections are evident in all animals as far as mating goes, it is clear that the same causes are present too. Now female *birds* desire not only to receive but also to emit. An indication of this is the

[21]Reading *ὡς δὲ πᾶν ἅμα*.
[22]Retaining *ἔξω*. [23]Retaining *ἔξω*.
[24]Omitting Dittmeyer's *πίστιν τῇ ὑπάρξει*.
[25]Omitting ⟨*ἕτερον πρὸ*⟩ *ἑτέρου*, and adding *οὐ* before *θεωροῦσι*.
[26]Reading *πάντα ταὐτά* for *ταῦτα*. [27]Reading *τοῖς* for *τῶν*.
[28]The text of this whole paragraph is uncertain.

fact that if a male is not about she squats under another female and becomes pregnant and produces a wind-egg, thereby showing that she wants then to emit, and actually emitting—as happens when a man has intercourse with another male. Other animals do this too: a woman once made the test on singing crickets, which she caught while they were still young and then reared—when they had grown they became spontaneously pregnant. From this it is clear that every female contributes something to the semen, if it has been seen to occur in the case of one genus. For a wind-egg differs from a fertile egg only in the fact that it does not generate an animal; and that is because it did not come from both partners. That is why not all male emissions seem to be fertile, but some are infertile, when they are not harmonised in the right way from both partners.

Again, women have erotic dreams, and after the dream they experience the same conditions as when they have been with a man—relaxation and incapacity. Thus it is clear, if they are seen to emit something while dreaming, that they also contribute something then; for after the dream the same region is moist, and they need to give themselves the same treatment as they do when they have been with a man. Thus it is clear that there is an emission of semen from both partners if the semen is going to be fertile.

The womb does not emit into itself, but outside, where the man too emits; and it then draws it from there into itself. How is it, then, that some females generate by themselves, as birds produce wind-eggs, and others do not, e.g. horses and sheep? Is it because birds emit into the womb, there being no external place into which they—or the males—can emit? That is why if no cock is mating with it, the hen spills its semen onto the ground. But in quadrupeds there is another place outside the womb into which both the female and the male emit. What in other creatures is mixed together with the other fluids and does not take form in the womb, which it does not enter, is in the case of birds received into the womb and concocted by it into a sort of body which is like an animal in other respects but is not an animal because an animal must proceed from both partners.

7 · We can determine whether those women tell the truth who say that when they have erotic dreams they wake up dry. For it is clear that the womb draws the fluid upwards; so why do females not produce offspring by themselves, since they draw up the male semen too when it is mixed with their own? Why do they not also draw up their own semen unmixed, if it extends into the outer part? . . .

. . .[29] to whom this affection occurs during pregnancy.[30] For they give birth to what is called a 'mole': it happened once to a woman who had been with a man and thought she had conceived; the bulk of her womb increased and at first everything else happened in the expected way. But when the time came for the birth, she did not give birth, nor did the bulk become less, but she continued in that state for three or four years, until she fell ill of dysentery and, having been in some danger from it, gave birth to a sizable lump of flesh of the sort they call a mole. In some women this

[29]There is a lacuna in the text here.
[30]Omitting ἔτη πολλά.

condition persists until they grow old and die. Does this condition come about because of heat, when the womb happens to be hot and dry and therefore apt to draw matter into itself in such a way as to draw anything into itself and conserve it there? For it is when women are in this state and there is no mixture from both partners but, like a wind-egg, matter is received from one only, that the so-called moles occur; and they are neither animals (for they do not come from both partners) nor yet inanimate (for what was received was animate), as in the case of wind-eggs. They remain for a considerable time, both because of the condition of the womb, and because, in the case of birds which produce many eggs in themselves, the womb is distended by them and the eggs are pushed forward and laid; and once the womb is opened the last one comes out too. For there is nothing holding them in; but the body itself, having become prone to emission when it was being filled up, can no longer give the womb the power to hold on to the eggs. In viviparous animals, because their power changes as the embryo grows and they require different food at different times, the womb becomes inflamed and brings about the birth at the appointed time. But the lump of flesh, since it is not an animal, is always uniform; and that is why it does not weigh down the womb or make it inflamed. Hence in some women the affliction lasts until they die, unless some fortunate weakness strikes them, as it did the woman who was afflicted with dysentery.

But does the condition occur because of heat, as we said, or rather because of moisture (for the growth is a sort of mucus)?[31] or when the womb is not so cold as to expel it nor yet so hot as to concoct it? That is why the condition lasts so long, just as some things remain boiling for a long time while others boil quickly for a limited period. Wombs of that sort, being very slow[32] take a long time.

Again, since it is not an animal, it does not move and so does not bring on labour; for it is the movement of the ligaments which is labour, and the embryo produces it because it is alive. And the hardness of the thing[33] is the result of parboiling; for it becomes so hard that it cannot be cut with an axe. Now things that are boiled, and all things that are concocted, become soft; but things that have been parboiled are unconcocted and hard.

Many doctors are unaware of this, and call an affliction a mole on the basis of similarity, if they merely see the belly extended without any sign of dropsy and the menstrual flow suspended as the affliction continues. But that is wrong: in fact, the so-called moles occur rarely. Sometimes there is a fluxion of cold, moist and watery residues, sometimes of thicker residues, into the region of the belly, if the region is of such a nature or is in such a condition. For these provide neither pain[34] nor heat because of their coldness; and as they grow, some to a greater extent and some to a less, they do not induce any other disease apart from themselves but remain inactive like a sort of deformity. The failure to menstruate occurs because the residues are being expended here, just as happens in women who are nursing (for they too either

[31]Omitting Dittmeyer's ὅτε, and reading οἶν μύξα.
[32]Reading ἀργότατοι.
[33]Retaining πράγματος.
[34]Reading ὀδύνημα παρέχει.

do not menstruate at all or do so only a little). Sometimes there is a fluxion from the flesh into the region between the womb and the belly, and that seems to be a mole when in fact it is not. It is not difficult to diagnose a mole, if she touches the womb. For if it is compact and not expanded, it is plain that it does not suffer from the affliction. But if it is in the same condition as when it contains a child, then it will be hot and dry[35] because the fluids have been diverted towards the inside; and the neck will be in the same condition as when they are pregnant. But if the mass is anything else, it will be cold to the touch and not dry and the neck will always be uniform.

[35]Reading *παιδίον ἔχει [μύλην], θερμή τε καὶ [ψυχρὰ καὶ] ξηρά.*

PARTS OF ANIMALS

W. Ogle

BOOK I

639a1 1 · Every study and investigation, the humblest and the noblest alike, seems to admit of two kinds of proficiency; one of which may be properly called educated knowledge of the subject, while the other is a kind of acquaintance with it. For an educated man should be able to form a fair judgement as to the goodness or badness of an exposition. To be educated is in fact to be able to do this; and the man of general education we take to be such. It will, however, of course, be understood that we only ascribe universal education to one who in his own individual person is thus able to judge nearly all branches of knowledge, and not to one who has a like ability merely in some special subject. For it is possible for a man to have this competence in some one branch of knowledge.

It is plain then that, in the science which inquires into nature, there must be certain canons, by reference to which a hearer shall be able to criticize the method of a professed exposition, quite independently of the question whether the statements made be true or false. Ought we, for instance (to give an illustration of what I mean), to begin by discussing each separate substance—man, lion, ox, and the like—taking each kind in hand independently of the rest, or ought we rather to lay down the attributes which they have in common in virtue of some common element of their nature? For genera that are quite distinct present many identical phenomena, sleep, for instance, respiration, growth, decay, death, and other similar affections and conditions that may remain; for at present it is an obscure and indeterminate business to discuss them. Now it is plain that if we deal with each species independently of the rest, we shall frequently be obliged to repeat the same statements over and over again; for horse and dog and man present every one of the phenomena just enumerated. A discussion therefore of the attributes of each such species separately would necessarily involve frequent repetitions as to characters, themselves identical but recurring in animals specifically distinct. (Very possibly also there may be other characters which, though they present specific differences, yet come under one and the same category. For instance, flying, swimming,
639b1 walking, creeping, are plainly specifically distinct, but yet are all forms of animal

TEXT: A.L. Peck, Loeb, London/Cambridge, Mass., 1937

progression.) We must, then, have some clear understanding as to the manner in which our investigation is to be conducted; whether, I mean, we are first to deal with the common or generic characters, and afterwards to take into consideration special peculiarities; or whether we are to start straight off with the particular species. For as yet no definite rule has been laid down in this matter. So also there is a like uncertainty as to another point now to be mentioned. Ought the student of nature follow the plan adopted by the mathematicians in their astronomical demonstrations, and after considering the phenomena presented by animals, and their several parts, proceed subsequently to treat of the causes and the reason why; or ought he to follow some other method? Furthermore, the causes concerned in natural generation are, as we see, more than one. There is the cause for the sake of which, and the cause whence the beginning of motion comes. Now we must decide which of these two causes comes first, which second. Plainly, however, that cause is the first which we call that for the sake of which. For this is the account of the thing, and the account forms the starting-point, alike in the works of art and in works of nature. For the doctor and the builder define health or house, either by the intellect or by perception, and then proceed to give the accounts and the causes of each of the things they do and of why they should do it thus. Now in the works of nature the good and that for the sake of which is still more dominant than in works of art, nor is necessity a factor with the same significance in them all; though almost all writers try to refer their accounts to this, failing to distinguish the several ways in which necessity is spoken of. For there is absolute necessity, manifested in eternal phenomena; and there is hypothetical necessity, manifested in everything that is generated as in everything that is produced by art, be it a house or what it may. For if a house or other such final object is to be realized, it is necessary that first this and then that shall be produced and set in motion, and so on in continuous succession, until the end is reached, for the sake of which each prior thing is produced and exists. So also is it with the productions of nature. The mode of necessity, however, and the mode of demonstration are different in natural science from what they are in the theoretical sciences (we have spoken of this elsewhere). For in the latter the starting-point is that which is; in the former that which is to be. For since health, or a man, is of such and such a character, it is necessary for this or that to exist or be produced; it is not the case that, since this or that exists or has been produced, that of necessity exists or will exist. Nor is it possible to trace back the necessity of demonstrations of this sort to a starting-point, of which you can say that, since this exists, that exists. These however, again, are matters that have been dealt with in another treatise, where it was stated where necessity is present, where it is reciprocal and for what reason.[1]

Another matter which must not be passed over without consideration is, whether the proper subject of our exposition is that with which the earlier writers concerned themselves, namely, the way each thing is naturally generated, or rather the way it *is*. For there is no small difference between these two views. The best course appears to be that we should follow the method already mentioned—begin

[1] See *On Generation and Corruption* II 9–11.

with the phenomena presented by each group of animals, and, when this is done, proceed afterwards to state the causes of those phenomena—in the case of generation too. For in house building too, these things come about because the form of the house is such and such, rather than its being the case that the house is such and such because it comes about thus. For the generation is for the sake of the substance and not this for the sake of the generation. Empedocles, then, was in error when he said that many of the characters presented by animals were merely the results of incidental occurrences during their development; for instance, that the backbone is as it is because it happened to be broken owing to the turning of the foetus in the womb. In so saying he overlooked the fact that propagation implies a creative seed endowed with certain powers. Secondly, he neglected another fact, namely, that the parent animal pre-exists, not only in account, but actually in time. For man is generated from man; and thus it is because the parent is such and such that the generation of the child is thus and so. [The same statement holds good also for those which are apparently spontaneous, as also for the products of art. For the same result as is produced by art may occur spontaneously. e.g. health. Those things whose agent is pre-existent, such as the statuary's art, cannot possibly be produced spontaneously. Art indeed consists in the account of the product without its matter. So too with chance products; for they are produced in the same way as products of art.][2]

The fittest mode, then, of treatment is to say, a man has such and such parts, because the essence of man is such and such, and because they are necessary conditions of his existence, or, if we cannot quite say this then the next thing to it, namely, that it is either quite impossible for a man to exist without them, or, at any rate, that it is good that they should be there. And this follows: because man is such and such the process of his development is necessarily such as it is; and therefore this part is formed first, that next; and after a like fashion should we explain the generation of all other works of nature.

Now that with which the ancient writers, who first philosophized about nature, busied themselves, was the material principle and the material cause. They inquired what this is, and what its character; how the universe is generated out of it, and by what motor influence, whether, for instance, by strife or love or mind or spontaneous action, the substratum of matter being assumed to have of necessity a certain nature—fire, for instance, to have a hot nature, earth a cold one; the former to be light, the latter heavy. For even the genesis of the universe is thus explained by them. After a like fashion do they deal also with the development of plants and of animals. They say, for instance, that the water contained in the body causes by its currents the formation of the stomach and the other receptacles of food or of excretion; and that the breath by its passage breaks open the outlets of the nostrils; air and water being the materials of which bodies are made; for all represent nature as composed of such or similar substances.

But if men and animals and their several parts are natural phenomena, then the natural philosopher must take into consideration flesh, bone, blood, and all the

[2] Excised by Peck.

other homogeneous parts; not only these, but also the heterogeneous parts, such as face, hand, foot; and must examine how each of these comes to be what it is, and in virtue of what force. For it is not enough to say what are the stuffs out of which an animal is formed, to state, for instance, that it is made of fire or earth—if we were discussing a couch or the like, we should try to determine its form rather than its matter (e.g. bronze or wood), or if not, we should give the matter of the *whole*. For a couch is such and such a form embodied in this or that matter, or such and such a matter with this or that form; so that its shape and structure must be included in our description. For the formal nature is of greater importance than the material nature.

Does, then, configuration and colour constitute the essence of the various animals and of their several parts? For if so, what Democritus says will be correct. For such appears to have been his notion. At any rate he says that it is evident to every one what form it is that makes the man, seeing that he is recognizable by his shape and colour. And yet a dead body has exactly the same configuration as a living one; but for all that is not a man. So also no hand of bronze or wood or constituted in any but the appropriate way can possibly be a hand in more than name. For like a physician in a painting, or like a flute in a sculpture, it will be unable to perform its function. Precisely in the same way no part of a dead body, such I mean as its eye or its hand, is really an eye or a hand. What he says, then, is too simple—it is much the same as if a woodcarver were to insist that the hand he had cut out was really a hand. Yet the physiologists, when they give an account of the development and causes of the animal form, speak very much like such a craftsman. What are the forces by which the hand or the body was fashioned into its shape? The woodcarver will perhaps say, by the axe or the auger; the physiologist, by air and by earth. Of these two answers the woodcarver's is the better. For it is not enough for him to say that by the stroke of his tool this part was formed into a concavity, that into a flat surface; but he must state the reasons why he struck his blow in such a way as to effect this, and for the sake of what he did so; namely, that the piece of wood should develop eventually into this or that shape. It is plain, then, that they are wrong, and that the true method is to state what the characters are that distinguish the animal—to explain what it is and what are its qualities—and to deal after the same fashion with its several parts; in fact, to proceed in exactly the same way as we should do, were we dealing with the form of a couch.

If now the form of the living being is the soul, or part of the soul, or something that without the soul cannot exist; as would seem to be the case, seeing at any rate that when the soul departs, what is left is no longer an animal, and that none of the parts remain what they were before, excepting in mere configuration, like the animals that in the fable are turned into stone; if, I say, this is so, then it will come within the province of the natural scientist to inform himself concerning the soul, and to treat of it, either in its entirety, or, at any rate, of that part of it which constitutes the essential character of an animal; and it will be his duty to say what a soul or this part of a soul is; and to discuss the attributes that attach to this essential character, especially as nature is spoken of—and is—twofold, as matter and as substance; nature as substance including both the motor cause and the final cause.

Now it is in the latter of these two senses that either the whole soul or some part of it constitutes the nature of an animal; and inasmuch as it is the presence of the soul that enables matter to constitute the animal nature, much more than it is the presence of matter which so enables the soul, the inquirer into nature is bound to treat of the soul rather than of the matter. For though the wood of which they are made constitutes the couch and the tripod, it only does so because it is potentially such and such a form.

What has been said suggests the question, whether it is the whole soul or only some part of it, the consideration of which comes within the province of natural science. Now if it be of the whole soul that this should treat, then there is no place for any other philosophy beside it. For as it belongs in all cases to one and the same science to deal with correlated subjects—one and the same science, for instance, deals with sensation and with the objects of sense—and as therefore the intelligent soul and the objects of intellect, being correlated, must belong to one and the same science, it follows that natural science will have to include everything in its province. But perhaps it is not the whole soul, nor all its parts collectively, that constitutes the source of motion; but there may be one part, identical with that in plants, which is the source of growth, another, namely the sensory part, which is the source of change of quality, while still another, and this not the intellectual part, is the source of locomotion. For other animals than man have the power of locomotion, but in none but him is there intellect. Thus then it is plain that it is not of the whole soul that we have to treat. For it is not the whole soul that constitutes the animal nature, but only some part or parts of it. Moreover, it is impossible that any abstraction can form a subject of natural science, seeing that everything that nature makes is for the sake of something. For just as art is present in the products of art, so in the things themselves there is evidently an analogous cause or principle derived like the hot and the cold from the environing universe. And that the heaven, if it had an origin, was generated and is maintained by such a cause, there is therefore even more reason to believe, than that mortal animals so originated. For order and definiteness are much more plainly manifest in the celestial bodies than in our own frame; while change and chance are rather characteristic of the perishable things of earth. Yet there are some who, while they allow that every animal exists and was generated by nature, nevertheless hold that the heaven was constructed to be what it is by chance and spontaneity; the heaven, in which not the faintest sign of chance or of disorder is discernible. Again, whenever there is plainly some final end, to which a motion tends should nothing stand in the way, we always say that the one is for the sake of the other; and from this it is evident that there must be something of the kind, corresponding to what we call nature. For a given seed does not give rise to any chance living being, nor spring from any chance one; but each springs from a definite parent. And thus it is that from which the seed comes which is the origin and fabricator of its offspring. For these it is by nature, the offspring being at any rate that which in nature will spring from it. At the same time the offspring is prior to the seed; for the seed is a coming into being, the end a substance. Prior, however, to both is the organism from which the seed was derived. For we speak of seeds in two ways, mentioning that from which it comes and that to which it gives rise: it is both the seed of that from which it came, of the horse, for instance, and the seed of the organism that will eventually arise from it, of the mule, for example—the seed of both, though in different ways as here set forth. Moreover, the seed is potentially something, and the relation of potentiality to actuality we know.

There are then two causes, namely, necessity and the final end. For many things are produced, simply as the results of necessity. It may, however, be asked, of what mode of necessity are we speaking when we say this. For it can be of neither of those two modes which are set forth in the philosophical treatises. There is, however, the third mode, in such things at any rate as are generated. For instance, we say that food is necessary in neither of the two modes, but because an animal cannot possibly do without it. This third mode is what may be called hypothetical necessity. For if a piece of wood is to be split with an axe, the axe must of necessity be hard; and, if hard, must of necessity be made of bronze or iron. Now exactly in the same way the body, since it is an instrument—for both the body as a whole and its several parts individually are for the sake of something—if it is to do its work, must of necessity be of such and such a character, and made of such and such materials.

It is plain then that there are two modes of causation, and that both of these must, so far as possible, be taken into account, or that at any rate an attempt must be made to include them both; and that those who fail in this tell us in reality nothing about nature. For nature of an animal is a first principle rather than matter. There are indeed passages in which even Empedocles hits upon this, and following the guidance of fact, finds himself constrained to speak of the ratio as constituting the substance and nature of things. Such, for instance, is the case when he explains what is a bone. For he does not say it is this one element, or those two or three elements, or a compound of all the elements, but states the ratio of their combination. As with a bone, so manifestly is it with the flesh and all other similar parts.

The reason why our predecessors failed to hit on this method of treatment was, that they were not in possession of the notion of essence, nor of any definition of substance. The first who came near it was Democritus, and he was far from adopting it as a necessary method in natural science, but was merely brought to it by constraint of facts. In the time of Socrates a nearer approach was made to the method. But at this period men gave up inquiring into nature, and philosophers diverted their attention to political science and to the virtues which benefit mankind.

Of the method itself the following is an example. In dealing with respiration we must show that it takes place for such or such a final object; and we must also show that this and that part of the process is necessitated by this and that other stage of it. By necessity we shall sometimes mean that the requisite antecedents must be there, if the final end is to be reached; and sometimes that things are thus and so by nature. For the alternate discharge and re-entrance of heat and the inflow of air are necessary—that is necessary; and as the internal heat resists in the process of cooling, the entrance and exit of the external air occur.

In the foregoing we have an example of the method which we must adopt, and also an example of the kind of phenomena, the causes of which we have to investigate.

2 · Some writers propose to reach the ultimate forms of animal life by dividing the genus into two differences. But this method is often difficult, and often impracticable.

Sometimes one differentia is sufficient by itself, and the others are mere surplusage. Thus in the series Footed, Two-footed, Cleft-footed, the last term alone is significant, and to append the others is only an idle iteration.

Again it is not permissible to break up a natural group, Birds for instance, by putting its members under different bifurcations, as is done in the published dichotomies, where some birds are ranked with animals of the water, and others placed in a different class. The group Birds and the group Fishes happen to be named, while other natural groups have no names; for instance, the groups that we may call Sanguineous and Bloodless are not known popularly by any one name. If such natural groups are not to be broken up, the method of dichotomy cannot be employed, for it necessarily involves such breaking up and dislocation. The group of the Many-footed, for instance, would have some of its kinds distributed among land animals, others among water animals.

3 · Again, privative terms inevitably form one branch of dichotomous division, as we see in the proposed dichotomies. But privative terms in their character of privatives admit of no subdivision. For there can be no specific forms of a negation, of Featherless for instance or of Footless, as there are of Feathered and of Footed. Yet a generic differentia must be subdivisible; for otherwise what is there that makes it generic rather than specific? There are to be found generic, that is specifically subdivisible, differentiae; Feathered for instance and Footed. For feathers are divisible into Barbed and Unbarbed, and feet into Manycleft, and Twocleft, like those of animals with bifid hoofs, and Uncleft or Undivided, like those of animals with solid hoofs. Now even with differentiae capable of this specific subdivision it is difficult enough so to make the classification that each animal shall be comprehended in some one subdivision and in not more than one (e.g. winged and wingless; for some are both—e.g. ants, glowworms, and some others); but far more difficult, impossible, is it to do this, if we start with a dichotomy into two contradictories. For each differentia must be presented by some species. There must
643a1 be some species, therefore, under the privative heading. Now specifically distinct animals cannot present in their substance a common undifferentiated element, but any apparently common element must really be differentiated. (Bird and Man for instance are both Two-footed, but their two-footedness is diverse and differentiated. And if they are sanguineous they must have some difference in their blood, if their blood is part of their substance.) From this it follows that one differentia will belong to two species; and if that is so, it is plain that a privative cannot be a differentia.

Again, if the species are indivisible and the differentiae are indivisible, and if no differentia be common to several groups, the number of differentiae must be equal to the number of species. If a differentia though not divisible could yet be common to several groups, then it is plain that in virtue of that common differentia specifically distinct animals would fall into the same division. It is necessary then, if the differentiae, under which are ranged all the indivisible groups, are specific characters, that none of them shall be common; for otherwise, as already said, specifically distinct animals will come into one and the same division. But no one indivisible group must be included in more than a single division; different groups must not be included in the same division; and every group must be found in some division. It is plain then that we cannot get at the indivisible species of the animal, or any other, kingdom by bifurcate division. If we could, the number of ultimate differentiae would equal the number of indivisible animal species. For assume an order of beings whose prime differentiae are White and Non-white. Each of these branches will bifurcate, and their branches again, and so on till we reach the differentiae, whose number will be four or some other power of two, and will also be the number of the ultimate species.

(A species is constituted by the combination of differentia and matter. For no part of an animal is purely material or purely immaterial; nor can a body, independently of its condition, constitute an animal or any of its parts, as has repeatedly been observed.)

Further, the differentiae must be elements of the substance, and not merely essential attributes. Thus if Figure is the term to be divided, it must not be divided into figures whose angles are equal to two right angles, and figures whose angles are together greater than two right angles. For it is only an attribute of a triangle that its angles are equal to two right angles.

Again, the bifurcations must be opposites, for opposites are different from one another—e.g. White and Black, Straight and Bent; and if we characterize one branch by either term, we must characterize the other by its opposite, and not, for example, characterize one branch by a colour, the other by an inclination.

Furthermore, living beings cannot be divided by the functions common to body and soul, by Flying, for instance, and Walking, as we see them divided in the dichotomies already referred to. For some groups, Ants for instance, fall under both divisions, some ants flying while others do not. Similarly as regards the division into Wild and Tame; for it also would involve the disruption of a species into different groups. For in almost all species in which some members are tame, there are other members that are wild. Such, for example, is the case with Men, Horses, Oxen, Dogs in India, Pigs, Goats, Sheep: groups which if they have the same name, have not been divided, and which, if single, prove that Wildness and Tameness do not amount to specific differences. And whatever differentia we take as a basis of division the same difficulty will occur.

We must attempt to recognize the natural groups, following the indications afforded by the instincts of mankind, which led them for instance to form the class of Birds and the class of Fishes, each of which groups combines a multitude of differentiae, and is not defined by a single one as in dichotomy. The method of dichotomy is either impossible (for it would put a single group under different divisions or contrary groups under the same division), or it only furnishes a single differentia for each species, which either alone or in combination has to constitute the ultimate species.

If, again, they do not take a differentia of the differentia, they are bound to make their division continuous only in the sense in which a sentence is one by conjunction. For instance, suppose we have the bifurcation Feathered and Featherless, and then divide Feathered into Wild and Tame, or into White and Black. Tame and White are not a differentiation of Feathered, but are the commencement of an independent bifurcation, and are here by accident.

As we said then, we must define at the outset by a multiplicity of differentiae. If we do so, privative terms will be available, which are unavailable to the dichotomist.

The impossibility of reaching the definition of any of the ultimate forms by dichotomy of the larger group, as some propose, is manifest also from the following considerations. It is impossible that a single differentia, either by itself or in combination shall express the whole of a species. [In saying a single differentia by itself I mean one which has no differentia as Cleft-footed; in saying a single differentia in combination I mean, to give an instance, Many-cleft-footed as related to Cleft-footed.][3] The very continuity of a series of successive differentiae in a division is intended to show that the whole is a unity. But one is misled by the usages of language into imagining that it is merely the final term of the series [Many-cleft-footed or Two-footed for instance][4] that constitutes the whole differentia. [and that Footed Cleft-footed, are superfluous][5] Now it is evident that such a series cannot consist of many terms. For if one divides and subdivides, one soon reaches the final differential term, [but for all that will not have got to the ultimate division, that is, to the species.][6] Suppose, for example, Man to be the animal to be defined; the single differentia will be Cleft-footed, either by itself or with its antecedents, Footed and Two-footed. Now if man was nothing more than a Cleft-footed animal, this single differentia would duly represent his essence. But seeing that this is not the case, more differentiae than this one will necessarily be required to define him; and these cannot come under one division; for each single branch of a dichotomy ends in a single differentia, and cannot possibly include several differentiae belonging to one and the same animal.

It is impossible then to reach any of the ultimate animal forms by dichotomous division.

4 · It deserves inquiry why a single name denoting a higher group was not invented by mankind, as an appellation to comprehend the two groups of Water animals and Winged animals. For even these have certain attributes in common. However, the present nomenclature is just. Groups that only differ in degree, and in the more or less of an identical element that they possess, are aggregated under a single class; groups whose attributes are only analogous are separated. For instance,

[3]Excised by Peck. [4]Excised by Peck. [5]Excised by Peck. [6]Excised by Peck.

bird differs from bird by gradation, or by excess and defect—some birds have long feathers, others short ones. Bird and Fish only agree in having analogous organs; for what in the bird is feather, in the fish is scale. It is not easy to do this in all cases; for in most animals what is common is so by analogy.

Since the ultimate species are substances and individuals which do not differ in species are found in them (e.g. Socrates, Coriscus), we must either describe the universal attributes first or else say the same thing many time over, as I said. (The universal attributes are common; for we call universal those which belong to more than one subject.)

One may wonder which of two courses to follow. For on the one hand it may be urged that as the ultimate species represent substances, it will be well, if practicable, to examine these ultimate species separately, as Man, and Bird—for this genus contains species: about *every* indivisible species, then, e.g. Sparrow, Crane, and the like.

On the other hand, however, this course would involve repeated mention of the same attribute, as the same attribute is common to many species, and so far would be somewhat irrational and tedious. Perhaps, then, it will be best to treat generically the universal attributes of the groups that have a common nature and contain closely allied subordinate forms, whether they are groups recognized by popular usage, such as Birds and Fishes, or groups not popularly known by a common appellation, but composed of closely allied subordinate groups; and only to deal individually with the attributes of a single species, when such species—man, for instance, and any other such, if such there be—are not of that sort.

It is generally similarity in the shape of particular organs, or of the whole body, that has determined the formation of the larger groups. It is in virtue of such a similarity that Birds, Fishes, Cephalopoda, and Testacea have been made to form each a separate class. For within the limits of each such class, the parts do not differ in that they have no nearer resemblance than that of analogy—such as exists between the bone of man and the spine of fish—but differ merely in respect of such corporeal conditions as largeness smallness, softness hardness, smoothness roughness, and other similar oppositions, or, in one word, in respect of degree.

We have now touched upon the canons for criticizing the method of natural science, and have considered what is the most systematic and easy course of investigation; we have also dealt with division, and the mode of conducting it so as best to attain the ends of science, and have shown why dichotomy is either impracticable or inefficacious for its professed purposes.

Having laid this foundation, let us pass on to our next topic.

5 · Of substances constituted by nature some are ungenerated, imperishable, and eternal, while others are subject to generation and decay. The former are excellent and divine, but less accessible to knowledge. The evidence that might throw light on them, and on the problems which we long to solve respecting them, is furnished but scantily by sensation; whereas respecting perishable plants and animals we have abundant information, living as we do in their midst, and ample

data may be collected concerning all their various kinds, if only we are willing to take sufficient pains. Both departments, however, have their special charm. The scanty conceptions to which we can attain of celestial things give us, from their excellence, more pleasure than all our knowledge of the world in which we live; just as a half glimpse of persons that we love is more delightful than an accurate view of other things, whatever their number and dimensions. On the other hand, in certitude and in completeness our knowledge of terrestrial things has the advantage. Moreover, their greater nearness and affinity to us balances somewhat the loftier interest of the heavenly things that are the objects of the higher philosophy. Having already treated of the celestial world, as far as our conjectures could reach, we proceed to treat of animals, without omitting, to the best of our ability, any member of the kingdom, however ignoble. For if some have no graces to charm the sense, yet nature, which fashioned them, gives amazing pleasure in their study to all who can trace links of causation, and are inclined to philosophy. Indeed, it would be strange if mimic representations of them were attractive, because they disclose the mimetic skill of the painter or sculptor, and the original realities themselves were not more interesting, to all at any rate who have eyes to discern the causes. We therefore must not recoil with childish aversion from the examination of the humbler animals. Every realm of nature is marvellous: and as Heraclitus, when the strangers who came to visit him found him warming himself at the furnace in the kitchen and hesitated to go in, is reported to have bidden them not to be afraid to enter, as even in that kitchen divinities were present, so we should venture on the study of every kind of animal without distaste; for each and all will reveal to us something natural and something beautiful. Absence of haphazard and conduciveness of everything to an end are to be found in nature's works in the highest degree, and the end for which those works are put together and produced is a form of the beautiful.

If any person thinks the examination of the rest of the animal kingdom an unworthy task, he must hold in like disesteem the study of man. For no one can look at the elements of the human frame—blood, flesh, bones, vessels, and the like—without much repugnance. Moreover, when any one of the parts or structures, be it which it may, is under discussion, it must not be supposed that it is its material composition to which attention is being directed or which is the object of the discussion, but rather the total form. Similarly, the true object of architecture is not bricks, mortar, or timber, but the house; and so the principal object of natural philosophy is not the material elements, but their composition, and the totality of the substance, independently of which they have no existence.

The course of exposition must be first to state the essential attributes common to whole groups of animals, and then to attempt to give their explanation. Many groups, as already noticed, present common attributes, that is to say, in some cases absolutely identical—feet, feathers, scales, and the like; while in other groups the affections and organs are analogous. For instance, some groups have lungs, others have no lung, but an organ analogous to a lung in its place; some have blood, others have no blood, but a fluid analogous to blood, and with the same office. To treat of the common attributes separately in connexion with each individual group would involve, as already suggested, useless iteration. For many groups have common attributes. So much for this topic.

As every instrument and every bodily member is for the sake of something, viz. some action, so the whole body must evidently be for the sake of some complex action. Thus the saw is made for sawing, for sawing is a function, and not sawing for the saw. Similarly, the body too must somehow or other be made for the soul, and each part of it for some subordinate function, to which it is adapted.

We have, then, first to describe the common functions, and those which belong to a genus or to a species. By 'common' I mean those which belong to all animals; by 'to a genus', those of animals whose differences from one another we see to be matters of degree—Bird is a genus. Man is a species, and so is everything not differentiated into subordinate groups. In the first case the common attributes may be called analogous, in the second generic, in the third specific.

When a function is ancillary to another, a like relation manifestly obtains between the organs which discharge these functions; and similarly, if one function is prior tc and the end of another, their respective organs will stand to each other in the same relation. Thirdly, there are functions which are the necessary consequences of others.

Instances of what I mean by functions and affections are Reproduction, Growth, Copulation, Waking, Sleep, Locomotion, and other similar animal actions. Instances of what I mean by parts are Nose, Eye, Face, and other so-called members; and similarly for the rest. So much for the method to be pursued. Let us now try to set forth the causes of all these things, both common and special, and in so doing let us follow that order of exposition which conforms, as we have indicated, to the order of nature.

BOOK II

1 · The nature and the number of the parts of which animals are severally composed are matters which have already been set forth in detail in the book of *Histories* about animals. We have now to inquire what are the causes that in each case have determined this composition, a subject quite distinct from that dealt with in the *Histories*.

Now there are three degrees of composition; and of these the first in order, as all will allow, is composition out of what some call the elements, such as earth, air, water, fire. Perhaps, however, it would be more accurate to say composition out of the elementary forces; nor indeed out of all of these, as said elsewhere in previous treatises. For wet and dry, hot and cold, form the material of all composite bodies; and all other differences are secondary to these, such differences, that is, as heaviness or lightness, density or rarity, roughness or smoothness, and any other such properties of bodies as there may be. The second degree of composition is that by which the homogeneous parts of animals, such as bone, flesh, and the like, are constituted out of the primary substances. The third and last stage is the composition which forms the heterogeneous parts, such as face, hand, and the rest.

Now the order of development and the order of substance are always the inverse of each other. For that which is posterior in the order of development is antecedent in the order of nature, and that is genetically last which in nature is first.

(That this is so is manifest by induction; for a house does not exist for the sake of bricks and stones, but these materials for the sake of the house; and the same is the case with the materials of other bodies. And the same thing can be shown by argument. For generation is a process from something to something, from a principle to a principle—from the primary efficient cause, which is something already endowed with a certain nature, to some definite form or similar end; for man generates man, and plant generates plant, in each case out of the underlying material.)

646b1 In order of time, then, the material and the generative process must necessarily be anterior; but in logical order the substance and form of each being precedes the material. This is evident if one only tries to define the process of formation. For the definition of house-building includes that of the house; but the definition of the house does not include that of house-building; and the same is true of all other productions. So that it must necessarily be that the elementary material exists for the sake of the homogeneous parts, seeing that these are genetically posterior to it, just as the heterogeneous parts are posterior genetically to them. For these heterogeneous parts have reached the end and goal, having the third degree of composition, in which development often attains its final term.

Animals, then, are composed of homogeneous parts, and are also composed of heterogeneous parts. The former, however, exist for the sake of the latter. For the active functions and operations of the body are carried on by these; that is, by the heterogeneous parts, such as the eye, the nostril, the whole face, the fingers, the hand, and the whole arm. But inasmuch as there is a great variety in the functions and motions not only of the whole animal but also of the individual organs, it is necessary that the substances out of which these are composed shall present a diversity of powers. For some purposes softness is advantageous, for others hardness; some parts must be capable of extension, others of flexion. Such powers, then, are distributed separately to the different homogeneous parts, one being soft another hard, one wet another dry, one viscous another brittle; whereas each of the heterogeneous parts presents a combination of multifarious powers. For the hand, to take an example, requires one power to enable it to effect pressure, and another for simple prehension. For this reason the instrumental parts of the body are compounded out of bones, sinews, flesh, and the like, but not these latter out of the former.

So far, then, as has yet been stated, the relations between these two orders of parts are determined by a final cause. We have, however, to inquire whether necessity may not also have a share in the matter; and it must be admitted that these mutual relations could not from the very beginning have possibly been other than they are. For heterogeneous parts can be made up out of homogeneous parts, either from a plurality of them, or from a single one, as is the case with some of the viscera which, varying in configuration, are yet, to speak broadly, formed from a single homogeneous substance; but that homogeneous substances should be formed out of a combination of heterogeneous parts is clearly an impossibility—for then a homogeneous thing would consist of many heterogeneous things. For these causes, then, some parts of animals are simple and homogeneous, while others are composite and heterogeneous; and dividing the parts into the instrumental and the sensitive, each one of the former is, as before said, heterogeneous, and each one of the latter homogeneous. For each sense is confined to a single order of sensibles, and its organ must be such as to admit that order. But that which is endowed with a property potentially acted on by that which has the like property actually, so that the two are the same in kind, and if the latter is single so also is the former. Thus it is that while no physiologists ever dream of saying of the hand or face or other such part that one is earth, another water, another fire, they couple each separate sense-organ with a separate element, asserting this one to be air and that other to be fire.

Sensation, then, is confined to the simple or homogeneous parts. But, as might reasonably be expected, the organ of touch, though still homogeneous, is yet the least simple of all the sense-organs. For touch more than any other sense appears to be correlated to several distinct kinds of objects, and to recognize more than one category of contrasts, heat and cold, for instance, dry and wet, and other similar oppositions. Accordingly, the organ which deals with these varied objects is of all the sense-organs the most corporeal, being either the flesh, or the substance which in some animals takes the place of flesh.

Now as there cannot possibly be an animal without sensation, it follows as a necessary consequence that every animal must have some homogeneous parts; for these alone are capable of sensation, the heterogeneous parts serving for the active functions. Again, as the sensory faculty, the motor faculty, and the nutritive faculty are all lodged in one and the same part of the body, as was stated in a former treatise, it is necessary that the part which is the primary seat of these principles shall on the one hand, in its character of general sensory recipient, be one of the simple parts; and on the other hand shall, in its motor and active character, be one of the heterogeneous parts. For this reason it is the heart which in sanguineous animals constitutes this central part, and in bloodless animals it is that which takes the place of a heart. For the heart, like the other viscera, divides into homogeneous parts; but it is at the same time heterogeneous in virtue of its definite configuration. And the same is true of the other so-called viscera, which are indeed formed from the same material as the heart. For all these viscera have a sanguineous character owing to their being situated upon vascular ducts and branches. For just as a stream of water deposits mud, so the various viscera, the heart excepted, are, as it were, deposits from the stream of blood in the vessels. And as to the heart, the very starting-point of the vessels, and the actual seat of the force by which the blood is first fabricated, it is as one would naturally expect, constituted out of the selfsame nutriment which it originates. Such, then, are the reasons why the viscera are of sanguineous aspect; and why in one point of view they are homogeneous, in another heterogeneous.

2 · Of the homogeneous parts of animals, some are soft and moist, others hard and dry; and of the former some are moist permanently, others only so long as they are in the living body. Such are blood, serum, lard, suet, marrow, semen, bile, milk when present, flesh, and their various analogues. For the parts enumerated are not to be found in all animals, some animals only having parts analogous to them. Of the hard and dry homogeneous parts bone, fish-spine, sinew, blood-vessel, are examples. The last of these points to a sub-division that may be made in the class of homogeneous parts. For in some of them the whole and a portion of the whole in one sense are designated by the same term—as, for example, is the case with blood-vessel and bit of blood-vessel—while in another sense they are not; but a portion of a heterogeneous part, such as face, in no sense has the same designation as the whole.

First, both the moist parts and the dry parts have causes of many kinds. Thus one set of homogeneous parts represent the material; for each separate organ is constructed of bones, sinews, flesh, and the like; which contribute either to its substance or to the proper discharge of its function. A second set are the nutriment of the first, and are moist; for all growth comes from moisture; while a third set are the residue of the second. Such, for instance, are the dregs of the solid nutriment, and—in animals that have a bladder—those of the liquid.

Even the individual homogeneous parts present variations, which are in each case for the sake of the better. The variations of the blood may be selected to illustrate this. For different bloods differ in their degrees of thinness or thickness, of clearness or turbidity, of coldness or heat; and this whether we compare the bloods from different parts of the same individual or the bloods of different animals. For all the differences just enumerated distinguish the blood of the upper and of the lower halves of the body; and one section of animals is sanguineous, while the other has no blood, but only something resembling it in its place. The thicker and the hotter blood is, the more conducive is it to strength, while in proportion to its thinness and its coldness is its suitability for sensation and intelligence. A like distinction exists also in the fluid which is analogous to blood. This explains how it is that bees and other similar creatures are of a more intelligent nature than many sanguineous animals; and that, of sanguineous animals, those are the most intelligent whose blood is thin and cold. Best of all are those whose blood is hot, and at the same time thin and clear. For such are suited alike for the development of courage and of intelligence. Accordingly, the upper parts are superior in these respects to the lower, the male superior to the female, and the right side to the left. As with the blood so also with the other parts, homogeneous and heterogeneous alike. For here also such variations as occur must be held either to be related to the substance and the functions of the several animals, or, in other cases, to be matters of better or worse. Two animals, for instance, may have eyes. But in one these eyes may be of fluid consistency, while in the other they are hard; and in one there may be eyelids, in the other no such appendages. In both cases the difference contributes to greater accuracy of vision.

As to why all animals must of necessity have blood or something of a similar character, and what the nature of blood may be, these are matters which can only be considered when we have first discussed hot and cold. For the natural properties of many substances are referable to these two elementary principles; and it is a matter of frequent dispute what animals or what parts of animals are hot and what cold. For some maintain that water animals are hotter than such as live on land, asserting that their natural heat counterbalances the coldness of their medium; and again, that bloodless animals are hotter than those with blood, and females than males. Parmenides, for instance, and some others declare that women are hotter than men, and that it is the warmth and abundance of their blood which causes their menstrual flow, while Empedocles maintains the opposite opinion. Again, comparing the blood and the bile, some speak of the former as hot and of the latter as cold, while others invert the description. If there be this endless disputing about hot and cold, which of all things that affect our senses are the most distinct, what are we to think as to the rest?

The explanation of the difficulty appears to be that things are called hotter in several ways; for each appears to have something to say, although they are at odds 648b1 with one another. There ought, then, to be some clear understanding as to the sense in which natural substances are to be termed hot or cold, dry or moist. For it appears manifest that these are properties on which even life and death are largely dependent, and that they are moreover the causes of sleep and waking, of maturity and old age, of health and disease; while no similar influence belongs to roughness and smoothness, to heaviness and lightness, nor, in short, to any other such properties of matter. That this should be so is but in accordance with rational expectation. For hot and cold, dry and moist, as was stated in a former treatise, are the principles of the natural elements.

Is then the term hot used in one way or in many? To answer this we must ascertain what special effect is attributed to a hotter substance, and if there be several such, how many these may be. A body then is in one sense said to be hotter than another, if it imparts a greater amount of heat to an object in contact with it. In a second sense, that is said to be hotter which causes the keener sensation when touched, and especially if the sensation be attended with pain. This criterion, however, would seem sometimes to be a false one; for occasionally it is the condition of the individual that causes the sensation to be painful. Again, of two things, that is the hotter which the more readily melts a fusible substance, or sets on fire an inflammable one. Again, of two masses of one and the same substance, the larger is said to have more heat than the smaller. Again, of two bodies, that is said to be the hotter which takes the longer time in cooling, as also we call that which is rapidly heated hotter in its nature than that which is long about it—as we call something contrary if it is at a distance, similar if it is nearby. The term hotter is used then in all the various senses that have been mentioned, and perhaps in still more. Now it is impossible for one body to be hotter than another in all these different fashions.

Boiling water for instance, though it is more scalding than flame, yet has no power of burning or melting combustible or fusible matter, while flame has. So again this boiling water is hotter than a small fire, and yet gets cold more rapidly and completely. For in fact fire never becomes cold; whereas water invariably does so. Boiling water, again, is hotter to the touch than oil; yet it gets cold and solid more rapidly than this other fluid. Blood, again, is hotter to the touch than either water or oil, and yet coagulates before them. Iron, again, and stones and other similar bodies are longer in getting heated than water, but when once heated burn other substances with a much greater intensity. Another distinction is this. In some of the bodies which are called hot the heat is derived from without, while in others it belongs to the bodies themselves; and it makes a most important difference whether the heat has the former or the latter origin. For one of them comes close to being hot accidentally and not in its own right—as if, finding that some man in a fever was a musician, one were to say that musicians are hotter than healthy men. Of that which is hot *per se* and that which is hot *per accidens*, the former is the slower to cool, while not rarely the latter is the hotter to the touch. The former again is the more burning of the two—flame, for instance, as compared with boiling water—while the latter, as the boiling water, which is hot *per accidens*, is the more heating to the touch. From all this it is clear that it is no simple matter to decide which of two bodies is the hotter. For the first may be the hotter in one sense, the second the hotter in another. Indeed in some of these cases it is impossible to say simply even whether a thing is hot or not. For the actual substratum may not itself be hot, but may be hot when coupled with heat as an attribute, as would be the case if one attached a single name to hot water or hot iron. It is after this manner that blood is hot. In such cases—in those, that is, in which the substratum owes its heat to an external influence—it is plain that cold is not a mere privation, but a fact of nature.

There is no knowing but that even fire may be another of these cases. For the substratum of fire may be smoke or charcoal, and though the former of these is always hot, smoke being an uprising vapour, yet the latter becomes cold when it is extinguished, as also would oil and pinewood under similar circumstances. But even substances that have been burnt nearly all possess some heat, cinders, for example, and ashes, the waste-products of animals, and, among the excretions, bile; because some residue of heat has been left in them after their combustion. It is in another sense that pinewood and fat substances are hot; namely, because they rapidly assume the actuality of fire.

Heat appears to cause both coagulation and melting. Now such things as are formed merely of water are solidified by cold, while such as are formed of nothing but earth are solidified by fire. Hot substances again are solidified by cold, and, when they consist chiefly of earth, the process of solidification is rapid, and the resulting substance is insoluble; but, when their main constituent is water, the solid matter is again soluble. What kinds of substances, however, admit of being solidified, and what are the causes of solidification, are questions that have already been dealt with more precisely in another treatise.

Now what is hot and what sort of thing is hotter are determined in a variety of ways, and those features do not belong to everything in the same way: rather, we 649b1
must specify that this substance is hotter *per se,* though that other is often hotter *per accidens;* or again, that this substance is potentially hot, that other actually so; or again, that this substance is hotter in the sense of causing a greater feeling of heat when touched, while that other is hotter in the sense of producing flame and burning. The term hot being used in all these various senses, it plainly follows that the term cold will also be used with like multiplicity.

So much then as to hot and cold, hotter and colder.

3 · In natural sequence we have next to treat of dry and moist. These terms are used in various senses. Sometimes, for instance, they denote things that are potentially, at other times things that are actually, dry or moist. Ice for example, or any other solidified fluid, is spoken of as being actually and accidentally dry while potentially and essentially it is moist. Similarly earth and ashes and the like, when mixed with water, are actually and accidentally moist, but potentially and essentially are dry. Now separate the constituents in such a mixture and you have on the one hand the watery components, which take their shape from their container, and these are both actually and potentially moist, and on the other hand the earthy components, and these are all dry; and it is to bodies of this sort that the term 'dry' is most properly and absolutely applicable. So also the opposite term 'moist' is strictly and absolutely applicable in an analogous way. The same remark applies also to hot bodies and to cold.

These distinctions, then, being laid down, it is plain that blood is hot in *one* way;[7] for it is spoken of as boiling water would be were it denoted by a single term. But the substratum of blood, that which it is while it is blood is not hot. Blood then in a certain sense is essentially hot, and in another sense is not so. For heat is included in the definition of blood, just as whiteness is included in the definition of a white man; but so far as blood becomes hot from some external influence, it is not hot essentially.

As with hot and cold, so also is it with dry and moist. We can therefore understand how some substances are hot and moist so long as they remain in the living body, but become perceptibly cold and coagulate so soon as they are separated from it; while others are hot and consistent while in the body, but when withdrawn undergo a change to the opposite condition, and become cold and moist. Of the former blood is an example, of the latter bile; for while blood solidifies, yellow bile becomes more moist. We must attribute to such substances the possession of opposite properties in a greater or less degree.

In what sense, then, the blood is hot and in what sense fluid, and how far it 650a1
partakes of the opposite properties, has now been fairly explained. Now since everything that grows must take nourishment, and nutriment in all cases consists of moist and dry substances, and since it is by the force of heat that these are

[7]Omitting, with Peck, οἷον τί ἦν αὐτῷ τὸ αἵματι εἶναι.

concocted and changed, it follows that all living things, animals and plants alike, must on this account, if on no other, have a natural source of heat; and this, like the working of the food,[8] must belong to many parts. For first of all there is the mouth and the parts inside the mouth, on which the first share in the duty clearly devolves, in such animals at least as live on food which requires disintegration. The mouth, however, does not actually concoct the food, but merely facilitates concoction; for the subdivision of the food into small bits facilitates the action of heat upon it. After the mouth come the upper and the lower abdominal cavities, and here it is that concoction is effected by the aid of natural heat. Again, just as there is a channel for the admission of the unconcocted food into the stomach, namely the mouth, and in some animals the so-called oesophagus, which is continuous with the mouth and reaches to the stomach, so must there also be other channels by which the nutriment shall pass out of the stomach and intestines into the body at large, and to which these cavities shall serve as a kind of manger. For plants get their food from the earth by means of their roots; and this food is already elaborated when taken in, which is the reason why plants produce no excrement, the earth and its heat serving them in the place of a stomach. But animals, with scarcely an exception, and conspicuously all such as are capable of locomotion, are provided with a stomachal sac, which is as it were an internal substitute for the earth. They must therefore have some instrument which shall correspond to the roots of plants, with which they may absorb their food from this sac, so that the proper end of the successive stages of concoction may be attained. The mouth then, its duty done, passes over the food to the stomach, and there must necessarily be something to receive it in turn from this. This something is furnished by the blood-vessels, which run throughout the whole extent of the mesentery from its lowest part right up to the stomach. A description of these will be found in the *Anatomies* and in the *Natural History*. Now as there is a receptacle for the entire matter taken as food, and also a receptacle for its excremental residue, and again a third receptacle, namely the vessels, which serve as such for the blood, it is plain that this blood must be the final nutritive material in such animals as have it; while in bloodless animals the same is the case with the analogous stuff. This explains why the blood diminishes in quantity when no food is taken, and increases when much is consumed, and also why it becomes healthy and unhealthy according as the food is of the one or the other character. These facts, then, and others of a like kind, make it plain that the purpose of the blood in sanguineous animals is to subserve the nutrition of the body. They also explain why no more sensation is produced by touching the blood than by touching one of the excretions or the food, whereas when the flesh is touched sensation is produced. For the blood is not continuous nor united by growth with the flesh, but simply lies in its receptacle, that is in the heart and vessels. The manner in which the parts grow at the expense of the blood, and indeed the whole question of nutrition, will find a more suitable place for exposition in the treatise on generation, and in other writings. For our present purpose all that need be said is that the blood

[8] Reading καὶ αὕτη ὥσπερ αἱ ἐργασίαι.

exists for the sake of nutrition, that is the nutrition of the parts; and with this much let us therefore content ourselves.

4 · What are called fibres are found in the blood of some animals but not of all. There are none, for instance, in the blood of deer and of roes; and for this reason the blood of such animals as these never coagulates. For one part of the blood consists mainly of water and therefore does not coagulate, this process occurring only in the other and earthy constituent, that is to say in the fibres, while the fluid part is evaporating.

Some at any rate of the animals with watery blood have a keener intellect. This is due not to the coldness of their blood, but rather to its thinness and purity; neither of which qualities belongs to the earthy matter. For the thinner and purer its fluid is, the more easily affected is an animal's sensibility. Thus it is that some bloodless animals are more intelligent than some among the sanguineous kinds. Such for instance, as already said, is the case with the bee and the tribe of ants, and whatever other animals there may be of a like nature. At the same time too great an excess of water makes animals timorous. For fear chills the body; so that in animals whose heart contains so watery a mixture the way is prepared for the operation of this emotion. For water is congealed by cold. This also explains why bloodless animals are, as a general rule, more timorous than such as have blood, so that they remain motionless, when frightened, and discharge their excretions, and in some instances change colour. Such animals, on the other hand, as have thick and abundant fibres in their blood are of a more earthy nature, and of a choleric temperament, and liable to bursts of passion. For anger is productive of heat; and solids, when they have been made hot, give off more heat than fluids. The fibres therefore, being earthy and solid, are turned into so many hot embers in the blood and cause ebullition in the fits of passion.

This explains why bulls and boars are so choleric and so passionate. For their blood is exceedingly rich in fibres, and the bull's at any rate coagulates more rapidly than that of any other animal. If these fibres are taken out of the blood, it will no longer coagulate; just as the watery residue of mud will not coagulate after removal of the earth—for the fibres consist of earth. But if the fibres are left the fluid coagulates, as also does mud, under the influence of cold. For when the heat is expelled by the cold, the fluid, as has been already stated, passes off with it by evaporation, and the residue is dried up and solidified, not by heat but by cold. So long, however, as the blood is in the body, it is kept fluid by animal heat.

The character of the blood affects both the temperament and the sensory faculties of animals in many ways. This is indeed what might reasonably be expected, seeing that the blood is the material of which the whole body is made. For nutriment supplies the material, and the blood is the ultimate nutriment. It makes then a considerable difference whether the blood be hot or cold, thin or thick, turbid or clear.

The watery part of the blood is serum; and it is watery, either owing to its not being yet concocted, or owing to its having become corrupted; so that one part of the serum is the resultant of a necessary process, while another part is for the sake of the blood.

5 · The differences between lard and suet correspond to differences of blood. For both are blood concocted into these forms as a result of abundant nutrition, being that surplus blood that is not expended on the fleshy part of the body, and is of an easily concocted and well-nourished character. This is shown by the greasiness of these substances; for such grease in fluids is due to a combination of air and fire. It follows from what has been said that no non-sanguineous animals have either lard or suet; for they have no blood. Among sanguineous animals those whose blood is dense have suet rather than lard. For suet is of an earthy nature, that is to say, it contains but a small proportion of water and is chiefly composed of earth; and this it is that makes it coagulate, just as the fibrous matter of blood coagulates, or broths which contain such fibrous matter. Thus it is that non-ambidentate horned animals possess suet. For the very fact that they have horns and huckle-bones shows that their composition is rich in this earthy element; for all such appurtenances are solid and earthy in character. On the other hand in those hornless animals that are ambidentate and possess toes, there is no suet, but in its place lard; and this, not being of an earthy character, neither coagulates nor splits when it dries.

Both lard and suet when present in moderate amount are beneficial; for they contribute to health and strength, while they are no hindrance to sensation. But when they are present in great excess, they are injurious and destructive. For were the whole body formed of them it would perish. For an animal is an animal in virtue of its sensory part, that is in virtue of its flesh, or of the substance analogous to flesh. But the blood, as before stated, is not sensitive; as therefore is neither lard nor suet, seeing that they are concocted blood. Were then the whole body composed of these substances, it would be utterly without sensation. Such animals, again, as are excessively fat age rapidly. For so much of their blood is used in forming fat, that they have but little left; and when there is but little blood the way is already open for decay. For decay may be said to be deficiency of blood, the scantiness of which renders it liable, like all bodies of small bulk, to be affected by any chance excess of heat or cold. For the same reason fat animals are less fertile than others. For that part of the blood which should go to form semen and seed is used up in the production of lard and suet, which are nothing but concocted blood; so that in these animals there is either no residue at all, or only a scanty amount.

6 · So much then for blood and serum, and for lard and suet. Each of these, and their causes, have been described.

The marrow also is of the nature of blood, and not, as some think, the germinal force of the semen. That this is the case is quite evident in very young animals. For in the embryo the marrow of the bones has a blood-like appearance, which is but natural, seeing that the parts are all constructed out of blood, and that it is on blood that the embryo is nourished. But, as the young animal grows up and ripens into maturity, the marrow changes its colour, just as do the parts and the viscera. For the viscera also in animals, so long as they are young, have each and all a blood-like look, owing to the large amount of this fluid which they contain.

In those animals which contain lard, the marrow is greasy and lard-like; but when the blood is converted by concoction into suet, and does not assume the form of lard, then the marrow also has a suety character. In those animals, therefore, that have horns and are not ambidentate, the marrow has the character of suet; while it takes the form of lard in those that are ambidentate and have the foot divided into toes. What has been said hardly applies to the spinal marrow. For it is necessary that this shall be continuous and extend without break through the whole backbone, inasmuch as this bone consists of separate vertebrae. But were the spinal marrow either greasy or of suet, it could not hold together in such a continuous mass as it does, but would either be too fluid or too frangible.

There are some animals that can hardly be said to have any marrow. These are those whose bones are strong and solid, as is the case with the lion. For in this animal the marrow is so utterly insignificant that the bones look as though they had none at all. However, as it is necessary that animals shall have bones or something analogous to them, such as the fish-spines of water-animals, it is also a matter of necessity that some of these bones shall contain marrow; for the substance contained within the bones is the nutriment out of which these are formed. Now the universal nutriment, as already stated, is blood; and it is reasonable that marrow should be suety or fatty. For the blood within the bone, owing to the heat which is developed in it from its being thus surrounded, undergoes concoction, and self-concocted blood is suet or lard. So also it is easy to understand why, in those animals that have strong and compact bones, some of these should be entirely void of marrow, while the rest contain but little of it; for here the nutriment is spent in forming the bones.

Those animals that have fish-spines in place of bones have no other marrow than that of the backbone. For in the first place they have naturally but a small amount of blood; and secondly the only hollow fish-spine is that of the backbone. In this then marrow is formed; this being the only spine in which there is space for it, and, moreover, being the only one which owing to its division into parts requires a connecting bond. This too is the reason why the marrow here, as already mentioned, is somewhat different from that of other bones. For, having to act the part of a clasp, it must be of glutinous character and at the same time sinewy so as to admit of stretching.

Such then are the reasons for the existence of marrow, in those animals that have any, and such its nature. It is evidently the surplus of the sanguineous nutriment apportioned to the bones and fish-spines, which has undergone concoction owing to its being enclosed within them.

7 · From the marrow we pass on in natural sequence to the brain. For there are many who think that the brain itself consists of marrow, and that it forms the commencement of that substance, because they see that the spinal marrow is continuous with it. In reality the two may be said to be utterly opposite to each other in character. For of all the parts of the body there is none so cold as the brain;

whereas the marrow is of a hot nature, as is plainly shown by its fat and greasy character. Indeed this is the very reason why the brain and spinal marrow are continuous with each other. For, wherever the action of any part is in excess, nature so contrives as to set by it another part with an excess of contrary action, so that the excesses of the two may counterbalance each other. Now that the marrow is hot is clearly shown by many indications. The coldness of the brain is also manifest enough even to the touch; and, secondly, of all the fluid parts of the body it is the driest and the one that has the least blood; for in fact it has no blood at all in its proper substance. Thus brain is not residual matter, nor yet is it one of the parts which are continuous with each other; but it has a character peculiar to itself, as might indeed be expected. That it has no continuity with the organs of sense is plain from simple inspection, and is still more clearly shown by the fact, that, when it is touched, no sensation is produced; in which respect it resembles the blood of animals and their excrement. The purpose of its presence in animals is no less than the preservation of the whole body. For some writers assert that the soul is fire or some such force. This, however, is but a crude assertion; and it would perhaps be better to say that the soul is incorporate in some substance of a fiery character. The reason for this being so is that of all substances there is none so suitable for ministering to the operations of the soul as that which is possessed of heat. For nutrition and the imparting of motion are offices of the soul, and it is by heat that these are most readily effected. To say then that the soul is fire is much the same thing as to confound the auger or the saw with the carpenter or his craft, simply because the work is done when the two are near one another. So far then this much is plain, that all animals must necessarily have a certain amount of heat. But as all influences require to be counterbalanced, so that they may be reduced to moderation and brought to the mean (for in the mean, and not in either extreme, lies their substance and account), nature has contrived the brain as a counterpoise to the region of the heart with its contained heat, and has given it to animals to moderate the latter, combining in it the properties of earth and water. For this reason it is, that every sanguineous animal has a brain; whereas no bloodless creature has such an organ, unless indeed it be, as the octopus, by analogy. For where there is no blood, there in consequence is but little heat. The brain, then, tempers the heat and seething of the heart. In order, however, that it may itself have a moderate amount of heat, branches run from both blood-vessels, that is to say from the great vessel and from what is called the aorta, and end in the membrane which surrounds the brain; while at the same time, in order to prevent any injury from the heat, these encompassing vessels, instead of being few and large, are numerous and small, and their blood scanty and clear, instead of being turbid and thick. We can now understand why fluxes have their origin in the head, and occur whenever the parts about the brain have more than a due proportion of coldness. For when the nutriment steams upwards through the blood-vessels, its refuse portion is chilled by the influence of this region, and forms fluxes of phlegm and serum. We must suppose, to compare small things with great, that the like happens here as occurs in the production of showers. For when vapour steams up from the earth and is carried by the heat into the upper regions, so soon as it reaches the cold air that is above the earth, it condenses again into water owing to the refrigeration, and falls back to the earth as rain. These, however, are matters which may be suitably considered in the Principles of Diseases, so far as natural philosophy has anything to say to them.

It is the brain again—or, in animals that have no brain, the part analogous to it—which is the cause of sleep. For either by chilling the blood that streams upwards after food, or by some other similar influences, it produces heaviness in the region in which it lies (which is the reason why drowsy persons hang the head), and causes the heat to escape downwards in company with the blood. It is the accumulation of this in excess in the lower region that produces sleep, taking away the power of standing upright from those animals to whom that posture is natural, and from the rest the power of holding up the head. These, however, are matters which have been separately considered in the treatises on Sensation and on Sleep.

That the brain is a compound of earth and water is shown by what occurs when it is boiled. For, when so treated, it turns hard and dry, inasmuch as the water is evaporated by the heat, and leaves the earthy part behind. Just the same occurs when pulse and other fruits are boiled. For these also are hardened and become altogether earthy, because the water which enters into their composition is driven off and leaves the earth, which is their main constituent, behind.

Of all animals, man has the largest brain in proportion to his size; and it is larger in men than in women. This is because the region of the heart and of the lung is hotter and richer in blood. This again explains why man, alone of animals, stands erect. For the heat, overcoming any opposite inclination, makes growth take its own line of direction, which is from the centre of the body upwards. It is then as a counterpoise to his excessive heat that there is this superabundant fluidity and coldness; and it is again owing to this superabundance that the cranial bone which some call the *bregma* is the last to become solidified; so long does evaporation continue to occur through it under the influence of heat. Man is the only sanguineous animal in which this takes place. Man, again, has more sutures in his skull than any other animal, and the male more than the female. The explanation is again to be found in the greater size of the brain, which demands free ventilation, proportionate to its bulk. For if the brain be either too moist or too dry, it will not perform its office, but in the one case will freeze the blood, and in the other will not cool it at all; and thus will cause disease, madness, and death. For the cardiac heat and the centre of life is most delicate in its sympathies, and is immediately sensitive to the slightest change or affection of the blood on the outer surface of the brain.

The fluids which are present in the animal body from the first have now nearly all been considered. Amongst those that appear only at a later period are the residua of the food, which include the deposits of the belly and also those of the bladder. Besides these there is the semen and the milk, in those animals which are of such a nature as to have them. Of these fluids, the excremental residua of the food may be suitably discussed by themselves, when we come to examine and consider the subject of nutrition. Then will be the proper time to explain in what animals they are found, and what are the reasons for their presence. Similarly all questions concerning the semen and the milk may be dealt with in the treatise on Generation, for the former of these fluids is the very starting-point of the generative process, and the latter exists for the sake of generation.

8 · We have now to consider the remaining homogeneous parts, and will begin with flesh, and with the substance that, in animals that have no flesh, takes its place. The reason for so beginning is that flesh forms in animals both a principle and a body in itself. Its right to this precedence can also be demonstrated logically. For an animal is by our definition something that has sensibility and chief of all the primary sensibility, which is that of touch; and it is the flesh, or analogous substance, which is the organ of this sense—either the primary organ, in the same way as the pupil is the organ of sight, or it is the organ and the medium through which the object acts combined, comparable to the pupil with the whole transparent medium attached to it. Now in the case of the other senses it was impossible for nature to unite the medium with the sense-organ, nor would such a junction have served any purpose; but in the case of touch she was compelled by necessity to do so. For of all the sense-organs that of touch is the only one that has corporeal substance, or at any rate it is more corporeal than any other.

It is obvious also to sense that it is for the sake of this that all the other parts exist. By the other parts I mean the bones, the skin, the sinews, and the blood-vessels, and, again, the hair and the various kinds of nails, and anything else there may be of a like character. Thus the bones are a contrivance to give security to the soft parts, to which purpose they are adapted by their hardness; and in animals that have no bones the same office is fulfilled by some analogous substance, as by fish-spine in some fishes, and by cartilage in others.

Now in some animals this supporting substance is situated within the body, while in some of the bloodless species it is placed on the outside. The latter is the case in all the Crustacea, as the crabs and the crayfish; it is the case also in the Testacea, as for instance in the several species known by the general name of oysters. For in all these animals the fleshy substance is within, and the earthy matter, which holds the soft parts together and keeps them from injury, is on the outside. For the shell not only enables the soft parts to hold together, but also, as the animal is bloodless and so has but little natural warmth, surrounds it, as a chaufferette does the embers, and keeps in the smouldering heat. Similar to this seems to be the arrangement in another kind of animals, namely the tortoises and the several kinds of water-tortoise. But in Insects and in Cephalopods the plan is entirely different, there being moreover a contrast between these two themselves. For in neither of these does there appear to be any bony or earthy part, worthy of notice, distinctly separated from the rest of the body. Thus in the Cephalopods the main bulk of the body consists of a soft flesh-like substance, or rather of a substance which is intermediate between flesh and sinew, so as not to be so readily destructible as actual flesh. For it is soft like flesh, while it admits of stretching like the sinew. It splits not longitudinally, but into circular segments, like flesh, this being the most advantageous condition, so far as strength is concerned. These animals have also a part inside them corresponding to the spinous bones of fishes. For instance, in the cuttle-fishes there is what is known as the pounce, and in the calamaries there is the so-called pen. In the octopus, on the other hand, there is no such internal part, because the body, or, as it is termed in them, the head, forms but a short sac, whereas it is of considerable length in the other two; and it was this length which led nature to assign to them their hard support, so as to ensure their straightness and inflexibility; just as she has assigned to sanguineous animals their bones or their fish-spines, as the case may be. To come now to Insects. In these the arrangement is quite different from that of the Cephalopods and from that which obtains in sanguineous animals, as indeed has been already stated. For in an insect there is no distinction into soft and hard parts, but the whole body is hard, the hardness, however, being of such a character as to be more flesh-like than bone, and more earthy and bone-like than flesh. The purpose of this is to make the body of the insect less liable to get broken into pieces.

9 · There is a resemblance between the osseous and the vascular systems; for each has a central part in which it begins, and each forms a continuous whole. For no bone in the body exists as a separate thing in itself, but each is either a portion of what may be considered a continuous whole, or at any rate is linked with the rest by contact and by attachments; so that nature may use adjoining bones either as though they were actually continuous and formed a single bone, or, for purposes of flexure, as though they were two and distinct. And similarly no blood-vessel has in itself a separate individuality; but they all form parts of one whole. For an isolated bone, if such there were, would in the first place be unable to perform the office for the sake of which bones exist; for, were it discontinuous and separated from the rest by a gap, it would be perfectly unable to produce either flexure or extension; nor only so, but it would actually be injurious, acting like a thorn or an arrow lodged in the flesh. Similarly if a vessel were isolated, and not continuous with the vascular origin, it would be unable to retain the blood within it in a proper state. For it is the warmth derived from this origin that hinders the blood from coagulating; indeed the blood, when withdrawn from its influence, becomes manifestly putrid. Now the origin of the blood-vessels is the heart, and the origin of the bones, in all animals that have bones, is what is called the backbone. With this all the other bones of the body are in continuity; for it is the backbone that holds together the whole length of an animal and preserves its straightness. But since it is necessary that the body of an animal shall bend during locomotion, this is one in virtue of the continuity of its parts, yet by its division into vertebrae is made to consist of many segments. It is from this that the bones of the limbs, in such animals as have these parts, proceed, and with it they are continuous, some having their extremities adapted to each other, either by the one being hollowed and the other rounded, or by both being hollowed and including between them a hucklebone, as a connected bolt, so as to allow of flexure and extension. For without some such arrangement these movements would be utterly impossible, or at any rate would be performed badly. There are some joints, again, in which the lower end of the one bone and the upper end of

the other are alike in shape; and cartilaginous pieces are interposed in the joint, to serve as a kind of padding, and prevent the two extremities from grating against each other.

Round about the bones, and attached to them by thin fibrous bands, grow the fleshy parts, for the sake of which the bones themselves exist. For just as an artist, when he is moulding an animal out of clay or other soft substance, takes first some solid body as a basis, and round this moulds the clay, so also has nature acted in fashioning the animal body out of flesh. Thus we find all the fleshy parts, with one exception, supported by bones, which serve, when the parts are organs of motion, to facilitate flexure, and, when the parts are motionless, act as a protection. The ribs, for example, which enclose the chest are intended to ensure the safety of the heart and neighbouring viscera. The exception is the belly. The walls of this are in all animals devoid of bones; in order that there may be no hindrance to the expansion which necessarily occurs in this part after a meal, nor, in females, any interference with the growth of the foetus, which is lodged here.

Now the bones of viviparous animals, of such, that is, as are not merely externally but also internally viviparous, vary but very little from each other in point of strength. For they are all much greater, in proportion to the size of their bodies, than the non-viviparous animals. For in some places many Vivipara grow to an enormous size, as is the case in Libya and in hot and dry countries generally. But the greater the bulk of an animal, the stronger, the bigger, and the harder, are the supports which it requires; and this requirement will be most marked in those that live a life of rapine. Thus it is that the bones of males are harder than those of females; and the bones of flesh-eaters, that get their food by fighting, are harder than those of others. Of this the lion is an example; for so hard are its bones, that, when struck, they give off sparks, as though they were stones. It may be mentioned also that the dolphin, inasmuch as it is viviparous, is provided with bones and not with fish-spines.

In those sanguineous animals, on the other hand, that are not viviparous, the bones present successive slight variations of character. Thus in birds there are bones, but these are not so strong as the bones of the Vivipara. Then come the oviparous fishes, where there is fish-spine. In the serpents too the bones have the character of fish-spine, excepting in the very large species, where the solid foundation of the body requires to be stronger, in order that the animal itself may be strong, the same reason prevailing as in the case of the Vivipara. Lastly, in the Selachia, as they are called, the fish-spines are replaced by cartilage. For it is necessary that the movements of these animals shall be of an undulating character; and this again requires the framework that supports the body to be made of a pliable and not of a brittle substance. Moreover, nature has used all the earthy matter on the skin; and she is unable to allot to many different parts one and the same superfluity of material. Even in viviparous animals many of the bones are cartilaginous. This happens in those parts where it is to the advantage of the surrounding flesh that its solid base shall be soft and mucilaginous. Such, for instance, is the case with the ears and nostrils; for in projecting parts brittle substances would soon get broken. Cartilage and bone are indeed fundamentally the same thing, the differences between them being merely matters of degree. Thus neither cartilage nor bone, when once cut off, grows again. Now the cartilages of these land animals are without marrow, that is without any distinctly separate marrow. For the marrow, which in bones is distinctly separate, is here mixed up with the whole mass, and gives a soft and mucilaginous consistence to the cartilage. But in the Selachia the backbone, though it is cartilaginous, yet contains marrow; for here it stands in the stead of a bone.

Very nearly resembling the bones to the touch are such parts as nails, hoofs, claws, horns, and the beaks of birds, all of which are intended to serve as means of defence. For the organs which are made out of these substances, and which are called by the same names as the substances themselves, the organ hoof, for instance, and the organ horn, are contrivances to ensure the preservation of the animals to which they severally belong. In this class too must be reckoned the teeth, which in some animals have but a single function, namely the mastication of the food, while in others they have an additional office, namely to serve as weapons; as is the case with all animals that have sharp interfitting teeth or that have tusks. All these parts are necessarily of a solid and earthy character; for the value of a weapon depends on such properties. Hence it is that all such parts are more developed in four-footed vivipara than in man. For there is always more earth in the composition of these animals than in that of the human body. However, not only all these parts but such others as are nearly connected with them, skin for instance, bladder, membrane, hairs, feathers, and their analogues, and any other similar parts that there may be, will be considered farther on with the heterogeneous parts. There we shall inquire into the causes which produce them, and into the goals of their presence severally in the bodies of animals. For, as with the heterogeneous parts, so with these, it is from a consideration of their functions that alone we can derive any knowledge of them. The reason for dealing with them at all in this part of the treatise, and classifying them with the homogeneous parts, is that both the organs and their parts have the same name; and of all these substances flesh and bone form the basis. Semen and milk were also passed over when we were considering the homogeneous fluids. For the treatise on Generation affords a more suitable place for their examination, seeing that the former of the two is a principle of the thing generated, while the latter is its nourishment.

10 · Let us now make, as it were, a fresh beginning, and consider the heterogeneous parts, taking those first which are the first in importance. For in all animals, at least in all the perfect kinds, there are two parts more essential than the rest, namely the part which serves for the ingestion of food, and the part which serves for the discharge of its residue. For without food growth and even existence is impossible. (As for plants, though they also are included by us among things that have life, yet are they without any part for the discharge of waste residue. For the food which they absorb from the ground is already concocted, and they give off instead their seeds and fruits.) And in all there is a third part, intermediate between these two, in which is situated the principle of life. Plants, again, inasmuch as they are without locomotion, present no great variety in their heterogeneous parts. For,

where the functions are but few, few also are the organs required to effect them. The configuration of plants is a matter then for separate consideration. Animals, however, that not only live but perceive, present a greater multiformity of parts, and this diversity is greater in some animals than in others, being most varied in those to whose share has fallen not mere life but life of high degree. Now such an animal is man. For of all living beings with which we are acquainted man alone partakes of the divine, or at any rate partakes of it in a fuller measure than the rest. For this reason, then, and also because his external parts and their forms are more familiar to us than those of other animals, we must speak of man first; and this the more fitly, because in him alone do the natural parts hold the natural position; his upper part being turned towards that which is upper in the universe. For, of all animals, man alone stands erect.

In man, then, the head is destitute of flesh; this being the necessary consequence of what has already been stated concerning the brain. There are, indeed, some who hold that the life of man would be longer than it is, were his head more abundantly furnished with flesh; and they account for the absence of this substance by saying that it is intended to add to the perfection of sensation. For the brain they assert to be the organ of sensation; and sensation, they say, cannot penetrate to parts that are too thickly covered with flesh. But neither part of this statement is true. On the contrary, were the region of the brain thickly covered with flesh, the very purpose for which animals are provided with a brain would be directly contravened. For the brain would itself be heated to excess and so unable to cool any other part. Again, the brain cannot be the cause of any of the sensations, seeing that it is itself as utterly without feeling as any one of the excretions. These writers see that certain of the senses are located in the head, and are unable to discern the reason for this; they see also that the brain is the most peculiar of all the animal organs; and out of these facts they form an argument, by which they link sensation and brain together. It has, however, already been clearly set forth in the treatise on Sensation, that it is the region of the heart that constitutes the sensory centre. There also it was stated that two of the senses, namely touch and taste, are manifestly in immediate connexion with the heart; and that as regards the other three, namely hearing, sight, and the centrally placed sense of smell, it is the character of their sense-organs which causes them to be lodged as a rule in the head. Vision is so placed in all animals. But such is not invariably the case with hearing or with smell. For fishes and the like hear and smell, and yet have no visible organs for these senses in the head; a fact which demonstrates the accuracy of the opinion here maintained. Now that vision, whenever it exists, should be in the neighbourhood of
656b1 the brain is but what one would rationally expect. For the brain is moist and cold, and vision is of the nature of water, water being of all transparent substances the one most easily confined. Moreover it cannot but necessarily be that the more precise senses will have their precision rendered still greater if ministered to by parts that have the purest blood. For the motion of the heat of blood destroys sensory activity. For these reasons the organs of these senses are lodged in the head.

It is not only the fore part of the head that is destitute of flesh, but the hind part also. For, in all animals that have a head, it is this head which more than any other part requires to be held up. But, were the head heavily laden with flesh, this would be impossible; for nothing so burdened can be held upright. This is an additional proof that the absence of flesh from the head is not for the sake of brain sensation. For there is no brain in the hinder part of the head, and yet this is as much without flesh as is the front.

In some animals hearing as well as vision is lodged in the region of the head. Nor is this without a rational explanation. For what is called the empty space is full of air, and the organ of hearing is, as we say, of the nature of air. Now there are channels which lead from the eyes to the blood-vessels that surround the brain; and similarly there is a channel which leads back again from each ear and connects it with the hinder part of the head. [But no part that is without blood is endowed with sensation, as neither is the blood itself, but only some one of the parts that are formed of blood. That is why in the Sanguinea no bloodless part is capable of sensation, nor is the blood itself; for it is no part of the animals.][9]

The brain in all animals that have one is placed in the front part of the head; because the direction in which sensation acts is in front; and because the heart, from which sensation proceeds, is in the front part of the body; and lastly because the instruments of sensation are the blood-containing parts, and the cavity in the posterior part of the skull is destitute of blood-vessels.

As to the position of the sense-organs, they have been arranged by nature in the following well-ordered manner. The organs of hearing are so placed as to divide the circumference of the head into two equal halves; for they have to hear not only sounds which are directly in a line with themselves, but sounds from all quarters. The organs of vision are placed in front, because sight is exercised only in a straight line, and moving as we do in a forward direction it is necessary that we should see before us, in the direction of our motion. Lastly, the organs of smell are placed with good reason between the eyes. For as the body consists of two parts, a right half and a left, so also each organ of sense is double. In the case of touch this is not apparent, the reason being that the primary organ of this sense is not the flesh or analogous part, but lies internally. In the case of taste, which is merely a modification of touch and which is placed in the tongue, the fact is more apparent than in the case of touch, but still not so manifest as in the case of the other senses. However, even in taste it is evident enough; for in some animals the tongue is plainly forked. The double character of the sensations is, however, more conspicuous in the other organs of sense. For there are two ears and two eyes, and the nostrils, though joined together, are also two. Were these latter otherwise disposed, and separated from each other as are the ears, neither they nor the nose in which they are placed would be able to perform their office. For in such animals as have nostrils olfaction is effected by means of inspiration, and the organ of inspiration is placed in front and in the middle line. This is the reason why nature has brought the two nostrils together and placed them as the central of the three sense-organs, setting them side by side on a level with each other, to avail themselves of the inspiratory motion. In other animals than man the arrangement of these sense-organs is also such as is adapted in each case to the special requirements.

[9]Excised by Peck.

11 · For instance, in quadrupeds the ears stand out freely from the head and are set to all appearance above the eyes. Not that they are in reality above the eyes; but they seem to be so, because the animal does not stand erect, but has its head hung downwards. This being the usual attitude of the animal when in motion, it is of advantage that its ears shall be high up and movable; for by turning themselves about they can the better take in sounds from every quarter.

12 · In birds, on the other hand, there are only the auditory passages. This is because their skin is hard and because they have feathers instead of hairs, so that they have not got the proper material for the formation of ears. Exactly the same is the case with such oviparous quadrupeds as are clad with scaly plates, and the same explanation applies to them. There is also one of the vivipara, namely the seal, that has no ears but only the auditory passages. The explanation of this is that the seal is a deformed quadruped.

13 · Men, and Birds, and Quadrupeds, viviparous and oviparous alike, have their eyes protected by lids. In the Vivipara there are two of these; and both are used also in the act of blinking; whereas the oviparous quadrupeds, and the heavy-bodied birds as well as some others, use only the lower lid to close the eye; while birds blink by means of a membrane that issues from the corner of the eye. The reason for the eyes being thus protected is that they are of fluid consistency, in order to ensure keenness of vision. For had they been covered with hard skin, they would, it is true, have been less liable to get injured by anything falling into them from without, but they would not have been sharp-sighted. It is then to ensure keenness of vision that the skin over the pupil is fine and delicate; while the lids are for protection from injury. It is as a still further safeguard that all these animals blink, and man most of all; this action (which is not performed from deliberate intention but from a natural instinct) serving to keep objects from falling into the eyes; and being more frequent in man than in the rest of these animals, because of the greater delicacy of his skin. These lids are made of a roll of skin; and it is because they are made of skin and contain no flesh that neither they, nor the foreskin, unite again when once cut.

As to the oviparous quadrupeds, and such birds as close the eye with the lower lid, it is the hardness of the skin of their heads which makes them do so. For such birds as have heavy bodies are not made for flight; and so the materials which would otherwise have gone to increase the growth of the feathers are diverted thence, and used to augment the thickness of the skin. Birds therefore of this kind close the eye with the lower lid; whereas pigeons and the like use both. Oviparous quadrupeds are covered with scaly plates; and these in all their forms are harder than hairs, so that the skin also to which they belong is harder than the skin of hairy animals. In these animals, then, the skin on the head is hard, and so does not allow of the formation of an upper eyelid, whereas lower down the integument is of a flesh-like character, so that the lower lid can be thin and extensible.

The act of blinking is performed by the heavy-bodied birds by means of the membrane already mentioned, and not by this lower lid. For in blinking rapid motion is required, and such is the motion of this membrane, whereas that of the lower lid is slow. It is from the corner of the eye that is nearest to the nostrils that the membrane comes. For it is better to have one starting-point than two; and in these birds this starting-point is the junction of eye and nostrils, an anterior starting-point being preferable to a lateral one. Oviparous quadrupeds do not blink in like manner as the birds; for, living as they do on the ground, they are free from the necessity of having eyes of fluid consistency and of keen sight, whereas these are essential requisites for birds, inasmuch as they have to use their eyes at long distances. This too explains why birds with talons, that have to search for prey by eye from aloft, and therefore soar to greater heights than other birds, are sharp-sighted; while common fowls and the like, that live on the ground and are not made for flight, have no such keenness of vision. For there is nothing in their mode of life which imperatively requires it.

Fishes and Insects and the hard-skinned Crustacea present certain differences in their eyes, but none of them have eyelids. As for the hard-skinned Crustacea it is utterly out of the question that they should have any; for an eyelid, to be of use, requires the action of the skin to be rapid. These animals then have hard eyes in default of this protection, just as though the lid were attached to the surface of the eye, and the animal saw through it. Inasmuch, however, as such hardness must necessarily blunt the sharpness of vision, nature has endowed the eyes of Insects, and still more those of Crustacea, with mobility (just as she has given some quadrupeds movable ears), in order that they may be able to turn to the light and catch its rays, and so see more plainly. Fishes, however, have eyes of a fluid consistency. For animals that move much about have to use their vision at considerable distances. For land animals, the air is transparent enough. But the water in which fishes live is a hindrance to sharp sight, though it has this advantage over the air, that it does not contain so many objects to knock against the eyes. For this reason, nature, which makes nothing in vain, has given no eyelids to fishes, while to counterbalance the opacity of the water she has made their eyes of fluid consistency.

14 · All animals that have hairs on the body have lashes on the eyelids; but birds and animals with scale-like plates, being hairless, have none. The Libyan ostrich, indeed, is furnished with eyelashes. This exception, however, will be explained hereafter. Of hairy animals, man alone has lashes on both lids. For in quadrupeds there is a greater abundance of hair on the back than on the under side of the body; whereas in man the contrary is the case, and the hair is more abundant on the front surface than on the back. The reason for this is that hair is intended to serve as a protection to its possessor. Now, in quadrupeds the back requires more protection, and their underside, though more noble is smooth because of their inclined posture. But in man, owing to his upright attitude, the anterior and posterior surfaces of the body are on an equality as regards need of protection. Nature therefore has assigned the protective covering to the nobler of the two surfaces; for invariably she brings about the best arrangement of such as are

possible. This then is the reason that there is no lower eyelash in any quadruped; though in some a few scattered hairs sprout out under the lower lid. This also is the reason that they never have hair in the armpits, nor on the pubes, as man has. Their hair, then, instead of being collected in these parts, is either thickly set over the whole dorsal surface, as is the case for instance in dogs, or, sometimes, forms a mane, as in horses and the like, or as in the male lion, where the mane is still more ample. So, again, whenever there is a tail of any length, nature decks it with hair, with long hair if the stem of the tail be short, as in horses, with short hair if the stem be long, regard also being had to the condition of the rest of the body. For nature invariably gives to one part what she subtracts from another. Thus when she has covered the general surface of an animal's body with an excess of hair, she leaves a deficiency in the region of the tail. This, for instance, is the case with bears.

No animal has so much hair on the head as man. This, in the first place, is the necessary result of the fluid character of his brain, and of the presence of so many sutures in his skull. For wherever there is the most fluid and the most heat, there also must necessarily occur the greatest outgrowth. But, secondly, in order to protect the head, by preserving it from excess of either heat or cold. And as the brain of man is larger and more fluid than that of any other animal, it requires a proportionately greater amount of protection. For the more fluid a substance is, the more readily does it get excessively heated or excessively chilled, while substances of an opposite character are less liable to such affections.

These, however, are matters which by their close connexion with eyelashes have led us to digress from our real topic, namely the cause to which these lashes owe their existence. We must therefore defer any further remarks we may have to make on these matters till the proper occasion arises.

15 · Both eyebrows and eyelashes exist for the protection of the eyes; the former that they may shelter them, like the eaves of a house, from any fluids that trickle down from the head; the latter to act like the palisades which are sometimes placed in front of enclosures, and keep out any objects which might otherwise get in. The brows are placed over the junction of two bones, which is the reason that in old age they often become so bushy as to require cutting. The lashes are set at the terminations of small blood-vessels. For the vessels come to an end where the skin itself terminates; and, in all places where these endings occur, the exudation of moisture of a corporeal character actually necessitates the growth of hairs, unless there be some operation of nature which interferes, by diverting the moisture to another purpose.

16 · Viviparous quadrupeds, as a rule, present no great variety of form in the organ of smell. In those of them, however, whose jaws project forwards and taper to a narrow end, so as to form what is called a snout, the nostrils are placed in this projection, there being no other available plan; while, in the rest, there is a more definite demarcation between nostrils and jaws. But in no animal is this part so peculiar as in the elephant, where it attains an extraordinary size and strength. For

the elephant uses its nostril as a hand; this being the instrument with which it conveys food, fluid and solid alike, to its mouth. With it, too, it tears up trees, coiling 659a1 it round their stems. In fact it applies it generally to the purposes of a hand. For the elephant has the double character of a land animal, and of one that lives in swamps. Seeing then that it has to get its food from the water, and yet must necessarily breathe, inasmuch as it is a land animal and has blood; seeing, also, that its excessive weight prevents it from passing rapidly from water to land, as some other sanguineous vivipara that breathe can do, it becomes necessary that it shall be suited alike for life in the water and for life on dry land. Just then as divers are sometimes provided with instruments for respiration, through which they can draw air from above the water, and thus may remain for a long time under the sea, so also have elephants been furnished by nature with their lengthened nostril; and, whenever they have to traverse the water, they lift this up above the surface and breathe through it. For the elephant's trunk, as already said, is a nostril. Now it would have been impossible for this nostril to have such a form had it been hard and incapable of bending. For its very length would then have prevented the animal from supplying itself with food, being as great an impediment as the horns of certain oxen, that are said to be obliged to walk backwards while they are grazing. It is therefore soft and flexible, and, being such, is made, in addition to its own proper functions, to serve the office of the fore-feet; nature in this following her wonted plan of using one and the same part for several purposes. For in polydactylous quadrupeds the fore-feet are intended not merely to support the weight of the body, but to serve as hands. But in elephants, though they must be reckoned polydactylous, as their foot has neither cloven nor solid hoof, the fore-feet, owing to the great size and weight of the body, are reduced to the condition of mere supports; and indeed their slow motion and unfitness for bending make them useless for any other purpose. A nostril, then, is given to the elephant for respiration, as to every other animal that has a lung, and is lengthened out and endowed with its power of coiling because the animal has to remain for considerable periods of time in the water, and is unable to pass thence to dry ground with any rapidity. But as the feet are shorn of their full office, this same part is also, as already said, made by nature to supply their place, and give such help as otherwise would be rendered by them.

As to other sanguineous animals, the birds, the serpents, and the oviparous 659b1 quadrupeds, in all of them there are the nostril-holes, placed in front of the mouth; but in none are there any distinctly formed nostrils, nothing in fact which can be called nostrils except from a functional point of view. A bird at any rate has nothing which can properly be called a nose. For its so-called beak is a substitute for jaws. The reason for this is to be found in the natural conformation of birds. For they are winged bipeds; and this makes it necessary that their head and neck shall be of light weight; just as it makes it necessary that their breast shall be narrow. The beak therefore is formed of a bone-like substance, in order that it may serve as a weapon as well as for nutritive purposes, but is made of narrow dimensions to suit the small size of the head. In this beak are placed the olfactory passages. But there are no nostrils; for such could not possibly be placed there.

As for those animals that have no respiration, it has already been explained why it is that they are without nostrils, and perceive odours either through gills, or through a blow-hole, or, if they are insects, by the hypozoma; and how the power of smelling depends, like their motion, upon the innate breath of their bodies, which in all of them is implanted by nature and not introduced from without.

Under the nostrils are the lips, in such sanguineous animals, that is, as have teeth. For in birds, as already has been said, the purposes of nutrition and defence are fulfilled by a bone-like beak, which forms a compound substitute for teeth and lips. For supposing that one were to cut off a man's lips, unite his upper teeth together, and similarly his under ones, and then were to lengthen out the two separate pieces thus formed, narrowing them on either side—then we should at once have a bird-like beak.

The use of the lips in all animals except man is to preserve and guard the teeth; and thus it is that the distinctness with which the lips are formed is in direct proportion to the degree of nicety and perfection with which the teeth are fashioned. In man the lips are soft and flesh-like and capable of separating from each other. Their purpose, as in other animals, is to guard the teeth, but they are more especially intended to serve a higher office, contributing in common with other parts to man's faculty of speech. For just as nature has made man's tongue unlike that of other animals, and, in accordance with what I have said is her not uncommon practice, has used it for two distinct operations, namely for the perception of savours and for speech, so also has she acted with regard to the lips, and made them serve both for speech and for the protection of the teeth. For vocal speech consists of combinations of the letters, and most of these it would be impossible to pronounce, were the lips not moist, nor the tongue such as it is. For some letters are formed by closures of the lips and others by applications of the tongue. But what are the differences presented by these and what the nature and extent of such differences, are questions to which answers must be sought from those who are versed in metrical science. It was necessary that the two parts which we are discussing should from the start be severally adapted to fulfil the office mentioned above, and be of appropriate character. Therefore are they made of flesh, and flesh is softer in man than in any other animal, the reason for this being that of all animals man has the most delicate sense of touch.

17 · The tongue is placed under the vaulted roof of the mouth. In land animals it presents but little diversity. But in other animals it is variable, and this whether we compare them as a class with such as live on land, or compare their several species with each other. It is in man that the tongue attains its greatest degree of freedom, of softness, and of breadth; the object of this being to render it suitable for its double function—both for the perception of savours (for man is the most sensitive of animals, and a soft tongue is most adapted to sensation, being most impressionable by touch, of which sense taste is but a variety), and its softness again, together with its breadth, adapts it for the articulation of letters and for speech. For these qualities, combined with its freedom from attachment, are those

which suit it best for advancing and retiring in every direction. That this is so is plain, if we consider the case of those who are tongue-tied in however slight a degree. For their speech is indistinct and lisping; that is to say there are certain letters which they cannot pronounce. In being broad is comprised the possibility of becoming narrow; for in the great the small is included, but not the great in the small.

What has been said explains why, even among birds, those that are most capable of pronouncing letters are such as have the broadest tongues; and why the viviparous and sanguineous quadrupeds, where the tongue is hard and thick and not free in its motions, have a very limited vocal articulation. Some birds have a considerable variety of notes. These are the smaller kinds. But it is the birds with talons that have the broader tongues. All birds use their tongues to communicate with each other. But some do this in a greater degree than the rest; so that in some cases it even seems as though actual instruction were imparted from one to another. These, however, are matters which have already been discussed in the *History of Animals*.

As to those oviparous and sanguineous animals that live on land, their tongue in most cases is tied down and hard, and is therefore useless for vocal purposes; in the serpents, however, and in the lizards it is long and forked, so as to be suited for the perception of savours. So long indeed is this part in serpents, that though small while in the mouth it can be protruded to a great distance. In these same animals it is forked and has a fine and hair-like extremity, because of their great liking for food. For by this arrangement they derive a twofold pleasure from savours, their gustatory sensation being as it were doubled.

Even some bloodless animals have an organ that serves for the perception of savours; and in sanguineous animals such an organ is invariably present. For even in such of these as seem to most people to have nothing of the kind, some of the fishes for example, there is a kind of shabby representative of a tongue, much like what exists in river crocodiles. In most of these cases the apparent absence of the part can be rationally explained on some ground or other. For in the first place the interior of the mouth in animals of this character is invariably spinous. Secondly, in water animals there is but short space of time for the perception of savours, and as the use of this sense is thus of short duration, shortened also is the separate part which subserves it. The reason for their food being so rapidly transmitted to the stomach is that they cannot possibly spend any time in sucking out the juices; for were they to attempt to do so, the water would make its way in during the process. Unless therefore one pulls their mouth very widely open, the projection of this part is quite invisible. The region exposed by thus opening the mouth is spinous; for it is formed by the close apposition of the gills, which are of a spinous character.

In crocodiles the immobility of the lower jaw also contributes in some measure to stunt the development of the tongue. For the crocodile's tongue is adherent to the lower jaw. For its upper and lower jaws are, as it were, inverted, it being the upper jaw which in other animals is the immovable one. The tongue, however, of this animal is not attached to the upper jaw, because that would interfere with the ingestion of food, but adheres to the lower jaw, because this is, as it were, the upper one which has changed its place. Moreover, it is the crocodile's lot, though a land animal, to live the life of a fish, and this again necessarily involves an indistinct formation of the part in question.

The roof of the mouth resembles flesh, even in many of the fishes; and in some of the river species, as for instance in the fishes known as Cyprini, is so very
661a1 flesh-like and soft as to be taken by careless observers for a tongue. The tongue of fishes, however, though it exists as a separate part, is never formed with such distinctness as this, as has been already explained. Again, the gustatory sensibility is not diffused equally over the whole surface of the tongue-like organ, but is placed chiefly in the tip; and for this reason it is the tip which is the only part of the tongue separated in fishes from the rest of the mouth. As all animals are sensible to the pleasure derivable from food, they all feel a desire for it. For the object of desire is the pleasant. The part, however, by which food produces the sensation is not alike in all of them, but while in some it is free from attachments, in others, where it is not required for vocal purposes, it is adherent. In some again it is hard, in others soft or flesh-like. Thus even the Crustacea, the crayfish for instance and the like, and the Cephalopods, such as the cuttlefish and the octopus, have some such part inside the mouth. As for the Insects, some of them have the part which serves as tongue inside the mouth, as is the case with ants, and as is also the case with many Testacea, while in others it is placed externally. In this latter case it resembles a sting, and is hollow and spongy, so as to serve at one and the same time for the tasting and for the sucking up of nutriment. This is plainly to be seen in flies and bees and all such animals, and likewise in some of the Testacea. In the purple murex, for instance, so strong is this part that it enables them to bore holes through the hard covering of shell-fish, of the spiral snails, for example, that are used as bait to catch them. So also the gad-flies and cattle-flies can pierce through the skin of man, and some of them even through the skins of other animals. Such, then, in these animals is the nature of the tongue, which is thus as it were the counterpart of the elephant's nostril. For as in the elephant the nostril is used as a defence, so in these animals the tongue serves as a sting.

In all other animals the tongue agrees with the description already given.

BOOK III

1 · We have next to consider the teeth, and with these the mouth which they
661b1 enclose and form. The teeth have one invariable office, namely the reduction of food; but besides this general function they have other special ones, and these differ in different groups. Thus in some animals the teeth serve as weapons; but this with a distinction. For there are offensive weapons and there are defensive weapons; and while in some animals, as the wild Carnivora, the teeth answer both purposes, in

many others, both wild and domesticated, they serve only for defence. In man the teeth are admirably constructed for their general office, the front ones being sharp, so as to cut the food into bits, and the molars broad and flat, so as to grind it to a pulp; while between these and separating them are the canines which, in accordance with the rule that the mean partakes of both extremes, share in the characters of those on either side, being broad in one part but sharp in another. Similar distinctions of shape are presented by the teeth of other animals, with the exception of those whose teeth are one and all of the sharp kind. In man, however, the number and the character even of these sharp teeth have been mainly determined by the requirements of speech. For the front teeth of man contribute in many ways to the formation of letter-sounds.

In some animals, however, the teeth, as already said, serve merely for the reduction of food. When, besides this, they serve as offensive and defensive weapons, they may either be formed into tusks, as for instance is the case in swine, or may be sharp-pointed and interlock with those of the opposite jaw, in which case the animal is said to be saw-toothed. For the strength of such an animal is in its teeth, and these depend for their efficiency on their sharpness. In order, then, to prevent their getting blunted by mutual friction, such of them as serve for weapons fit into each other's interspaces. No animal that has saw-teeth is at the same time furnished with tusks. For nature never makes anything superfluous or in vain. She gives, therefore, tusks to such animals as strike in fighting, and serrated teeth to such as bite. Sows, for instance, have no tusks, and accordingly sows bite.

A general principle must here be noted, which will be found applicable not only in this instance but in many others that will occur later on. Nature allots each weapon, offensive and defensive alike, to those animals alone that can use it; or, if not to them alone, to them in a more marked degree; and she allots it in its most perfect state to those than can use it best; and this whether it be a sting, or a spur, or horns, or tusks, or what it may of a like kind.

Thus as males are stronger and more choleric than females, it is in males that such parts as those just mentioned are found, either exclusively, as in some species, or more fully developed, as in others. For though females are of course provided with such parts as are necessary to them, the parts, for instance, which subserve nutrition, they have even these in an inferior degree, and the parts which answer no such necessary purpose they do not possess at all. This explains why stags have horns, while does have none; why the horns of cows are different from those of bulls, and, similarly, the horns of ewes from those of rams. It explains also why the females are often without spurs in species where the males are provided with them, and accounts for similar facts relating to all other such parts.

All fishes have teeth of the saw-toothed form, with the single exception of the fish known as the Scarus. In many of them there are teeth even on the tongue and on the roof of the mouth. The reason for this is that, living as they do in the water, they cannot but allow this fluid to pass into the mouth with the food. The fluid thus admitted they must necessarily discharge again without delay. For they cannot spend time grinding their food, since the water would run into their digestive cavities. Their teeth therefore are all sharp, being adapted only for cutting, and are numerous and set in many parts, that their abundance may serve in lieu of any grinding faculty, to mince the food into small bits. They are also curved, because they are almost the only weapons which fishes possess.

In all these offices of the teeth the mouth also takes its part; but besides these functions it is subservient to respiration, in all such animals as breathe and are cooled by external agency. For nature, as already said, uses the parts which are common to all animals for many special purposes, and this of her own accord. Thus the mouth has one universal function in all animals alike, namely its alimentary office; but in some, besides this, the special duty of serving as a weapon is attached to it; in others that of ministering to speech; and again in many, though not in all, the office of respiration. All these functions are thrown by nature upon one single organ, the construction of which she varies so as to suit the variations of office. Therefore it is that in some animals the mouth is contracted, while in others it is of wide dimensions. The contracted form belongs to such animals as use the mouth merely for nutritive, respiratory, and vocal purposes; whereas in such as use it as a means of defence it has a wide gape. This is its invariable form in such animals as are saw-toothed. For seeing that their mode of warfare consists in biting, it is advantageous to them that their mouth shall have a wide opening; for the wider it opens, the greater will be the extent of the bite, and the more numerous will be the teeth called into play.

Biting and carnivorous fish have a mouth of that sort, whereas in the rest it is a tapering snout. For this form is suited for their purposes, while the other would be useless.

In birds the mouth consists of what is called the beak, which in them is a substitute for lips and teeth. This beak presents variations in harmony with the functions and protective purposes which it serves. Thus in those birds that are called Crooked-clawed it is invariably hooked, inasmuch as these birds are carnivorous, and eat no kind of vegetable food. For this form renders it serviceable to them in obtaining the mastery over their prey, and is better suited for deeds of violence than any other. Moreover, as their weapons of offence consist of this beak and of their claws, these latter also are more crooked in them than in the generality of birds. Similarly in each other kind of bird the beak is suited to the mode of life. Thus, in woodpeckers it is hard and strong, as also in crows and birds of crow-like habit, while in the smaller birds it is delicate, so as to be of use in collecting seeds and picking up minute animals. In such birds, again, as eat herbage, and such as live about marshes—those, for example, that swim and have webbed feet—the bill is broad, or adapted in some other way to the mode of life. For a broad bill enables a bird to dig into the ground with ease, just as, among quadrupeds, does the broad snout of the pig, an animal which, like the birds in question, lives on roots. Moreover, in these root-eating birds and in some others of like habits of life, the tips of the bill end in hard points, which gives them additional facility in dealing with herbaceous food.

The several parts which are set on the head have now, pretty nearly all, been considered. In man, however, the part which lies between the head and the neck is called the face, this name being, it would seem, derived from the function of the part. For as man is the only animal that stands erect, he is also the only one that looks directly in front; and the only one whose voice is emitted in that direction.[10]

2 · We have now to treat of horns; for these also, when present, are appendages of the head. They exist in none but viviparous animals; though in some ovipara certain parts are metaphorically spoken of as horns, in virtue of a certain resemblance. To none of such parts, however, does the proper office of a horn belong; for the vivipara have their horns for the sake of defence and attack, but this is not the case with any of the other creatures said to have horns; for they do not use their horns in defence or for mastery, which are tasks requiring strength. So also no polydactylous animal is furnished with horns. For horns are defensive weapons, and these polydactylous animals possess other means of security. For to some of them nature has given claws, to others teeth suited for combat, and to the rest some other adequate defensive appliance. There are horns, however, in most of the cloven-hoofed animals, and in some of those that have a solid hoof, serving them as an offensive weapon. Horns also serve for defence in all animals that have not been provided by nature with some other means of security; such means, for instance, as speed, which has been given to horses; or great size, as in camels; for excessive bulk, such as has been given to these animals, and in a still greater measure to elephants, is sufficient in itself to protect an animal from being destroyed by others. Other animals again are protected by the possession of tusks; and among these are the swine, though they have a cloven hoof.

All animals again, whose horns are but useless appendages, have been provided by nature with some additional means of security. Thus deer are endowed with speed; for the large size and great branching of their horns makes these a source of detriment rather than of profit to their possessors. Similarly endowed are the antelope and gazelle; for though these animals will stand up against some enemies and defend themselves with their horns, yet they run away from such as are fierce and pugnacious. The bison again, whose horns curve inwards towards each other, is provided with a means of protection in the discharge of its excrement; and of this it avails itself when frightened. There are some other animals that have a similar mode of defence. In no case, however, does nature ever give more than one adequate means of protection to one and the same animal.

Most of the animals that have horns are cloven-hoofed; but the Indian ass, as they call it, is also reported to be horned, though its hoof is solid.

Again as the body, so far as regards its organs of motion, consists of two distinct parts, the right and the left, so also and for the same reasons the horns of animals are, in the great majority of cases, two in number. Still there are some that have but a single horn; the oryx, for instance, and the so-called Indian ass; in the former of which the hoof is cloven, while in the latter it is solid. In such animals the

[10] 'πρόσωπον' ('face') is connected with 'πρόσωθεν ὄπωπε' ('he looks directly in front').

horn is set in the centre of the head; for as the middle belongs equally to both extremes, this arrangement is the one that comes nearest to each side having its own horn.

Again, it would appear consistent with reason that the single horn should go with the solid rather than with the cloven hoof. For hoof, whether solid or cloven, is of the same nature as horn; so that the two naturally undergo division simultaneously and in the same animals. Again, since the division of the cloven hoof depends on deficiency of material, it is but rationally consistent, that nature, when she gave an animal an excess of material for the hoofs, which thus became solid, should have taken away something from the upper parts and so made the animal to have but one horn.

Rightly too did she act when she chose the head whereon to set the horns; and Æsop's Momus is beside the mark, when he finds fault with the bull for not having its horns upon its shoulders. For from this position, says he, they would have delivered their blow with the greatest force, whereas on the head they occupy the weakest part of the whole body. Momus was but dull-sighted in making this hostile criticism. For had the horns been set on any other part than they are, the encumbrance of their weight would have been increased, not only without any compensating gain whatsoever, but with the disadvantage of impeding many bodily operations—and similarly if they had been set on the shoulders. For the point whence the blows could be delivered with the greatest force was not the only matter to be considered, but the point also whence they could be delivered with the widest range. But as the bull has no hands and cannot possibly have its horns on its feet or on its knees, where they would prevent flexion, there remains no other site for them but the head; and this therefore they necessarily occupy. In this position, moreover, they are much less in the way of the movements of the body than they would be elsewhere.

Deer are the only animals in which the horns are solid throughout, and are also the only animals that cast them. This casting is for the advantage of the deer from the increased lightness which it produces, but, seeing how heavy the horns are, it is also a matter of necessity.

In all other animals the horns are hollow for a certain distance, and the end alone is solid, this being the part of use in a blow. At the same time, to prevent even the hollow part which grows out of the skin from being weak, the solid part fitted into it comes up from the bones. For this arrangement is not only that which makes the horns of the greatest service in fighting, but that which causes them to be as little of an impediment as possible in the other actions of life.

Such then are the reasons for which horns exist; and such the reasons why they are present in some animals, absent from others.

Let us now consider the character of the material nature whose necessary results have been employed by rational nature for a final cause.

In the first place, then, the larger the bulk of animals, the greater is the proportion of corporeal and earthy matter which they contain. Thus no very small animal is known to have horns, the smallest horned animal that we are acquainted with being the gazelle. But in all our speculations concerning nature, what we have to consider is the general rule; for that is natural which applies either universally or for the most part. Now all the bone in animals' bodies is earthy; and that is why we can say, if we consider what holds for the most part, that there is most earthy matter in the largest animals. At any rate, in the larger animals there is an excess of it, and this excess is turned by nature to useful account, being converted into weapons of defence. Part of it necessarily flows to the upper portion of the body, and this is allotted in some cases to the formation of tusks and teeth, in others to the formation of horns. Thus it is that no animal that has horns has also front teeth in both jaws, those in the upper jaw being deficient. For nature by subtracting from the teeth adds to the horns; the nutriment which in most animals goes to the former being here spent on the augmentation of the latter. Does, it is true, have no horns and yet are equally deficient with the males as regards the teeth. The reason, however, for this is that they, as much as the males, are naturally horn-bearing animals; but they have been stripped of their horns, because these would be useless—indeed they are useless to the males too, but the males' strength makes them less harmful. In other animals, where this material is not secreted from the body in the shape of horns, it is used to increase the size of the teeth; in some cases of all the teeth, in others merely of the tusks, which thus become so long as to resemble horns projecting from the jaws.

So much, then, of the parts which appertain to the head.

3 · Below the head lies the neck, in such animals as have one. This is the case with those only that have the parts to which a neck is subservient. These parts are the larynx and what is called the oesophagus. Of these the larynx exists for the sake of respiration, being the instrument by which animals inhale and discharge the air. Therefore it is that, when there is no lung, there is also no neck. Of this condition the fishes are an example. The oesophagus is the channel through which food is conveyed to the stomach; so that all animals that are without a neck are also without a distinct oesophagus. Such a part is in fact not required of necessity for nutritive purposes; for it has no action whatsoever on the food. Indeed there is nothing to prevent the stomach from being placed directly after the mouth. This, however, is impossible in the case of the lung. For there must be some sort of tube common to the two divisions of the lung, by which—it being bipartite—the breath may be apportioned to their respective bronchi, and thence pass into the air-pipes; and such an arrangement will be the best for producing inspiration and expiration. The organ then concerned in respiration must of necessity be of some length; and this, again, necessitates there being an oesophagus to unite mouth and stomach. This oesophagus is of a flesh-like character, and yet admits of extension like a sinew. This latter property is given to it, that it may stretch when food is introduced; while the flesh-like character is intended to make it soft and yielding, and to prevent it from being rasped by particles as they pass downwards, and so suffering damage. On the other hand, the windpipe and the so-called larynx are constructed out of a cartilaginous substance. For they have to serve not only for respiration, but also for

vocal purposes; and an instrument that is to produce sounds must necessarily be not only smooth but firm. The windpipe lies in front of the oesophagus, although this position causes it to be some hindrance to the latter when admitting food. For if a morsel of food, fluid or solid, slips into it by accident, choking and much distress and violent fits of coughing ensue. This must be a matter of astonishment to any of those who assert that it is by the windpipe that an animal imbibes fluid. For the consequences just mentioned occur invariably, whenever a particle of food slips in, and are quite obvious. Indeed on many grounds it is ridiculous to say that this is the channel through which animals imbibe fluid. For there is no passage leading from the lung to the stomach, such as the oesophagus which we see leading thither from the mouth. Moreover, when any cause produces sickness and vomiting, it is plain enough whence the fluid is discharged. It is manifest also that fluid does not pass directly into the bladder and collect there, but goes first into the stomach. For, when red wine is taken, the excreta from the stomach are seen to be coloured by its dregs; and such discoloration has been even seen on many occasions where there have been wounds opening into the stomach. However, it is perhaps silly to be minutely particular in dealing with silly statements such as this.

The windpipe then, owing to its position in front of the oesophagus, is exposed, as we have said, to annoyance from the food. To obviate this, however, nature has contrived the epiglottis. This part is not found in all viviparous animals, but only in such of them as have a lung and a skin covered with hairs, and not either with scaly plates or with feathers. In the latter animals, instead of an epiglottis the larynx closes and opens, just as in the other case the epiglottis falls down and rises up; rising up during the ingress or egress of breath, and falling down during the ingestion of food, so as to prevent any particle from slipping into the windpipe. Should there be the slightest want of accuracy in this movement, or should an inspiration be made during the ingestion of food, choking and coughing ensue, as already has been noticed. So admirably contrived, however, is the movement both of the epiglottis and of the tongue, that, while the food is being ground in the mouth and passing over the epiglottis, the tongue very rarely gets caught between the teeth and seldom does a particle slip into the windpipe.

The animals which have been mentioned as having no epiglottis owe this deficiency to the dryness of their flesh and to the hardness of their skin. For an epiglottis made of such materials would not admit of easy motion. It would, indeed, take a longer time to shut down an epiglottis made of the peculiar flesh of these animals, and shaped like that of those with hairy skins, than to bring the edges of the windpipe itself into contact with each other.

Thus much then as to the reason why some animals have an epiglottis while others have none. It is a contrivance of nature to remedy the unsatisfactory position of the windpipe in front of the oesophagus. That position is the result of necessity. For it is in the front and centre of the body that the heart is situated, in which we say is the principle of life and the source of all motion and sensation. (For sensation and motion are exercised in the direction which we term forwards, and it is on this very relation that the distinction of before and behind is founded.) But where the heart is, there and surrounding it is the lung. Now inspiration, which occurs because of the lung and the principle which has its seat in the heart, is effected through the windpipe. Since then the heart must of necessity lie in the very front place of all, it follows that the larynx also and the windpipe must of necessity lie in front of the oesophagus. For they lead to the lung and heart, whereas the oesophagus leads to the stomach. And in general, as regards above and below, front and back, right and left, the nobler and more honourable part invariably is placed uppermost, in front, and on the right, unless some more important object stands in the way.

4 · We have now dealt with the neck, the oesophagus, and the windpipe, and have next to treat of the viscera. These are peculiar to sanguineous animals, some of which have all of them, others only a part, while no bloodless animals have any at all. Democritus then seems to have been mistaken in the notion he formed of the viscera, if, that is to say, he fancied that the reason why none were discoverable in bloodless animals was that these animals were too small to allow them to be seen. For, in sanguineous animals, both heart and liver are visible enough when the body is only just formed, and while it is still extremely small. For these parts are to be seen in the egg sometimes as early as the third day, being then no bigger than a point; and are visible also in aborted embryos, while still excessively minute. Moreover, as the external organs are not precisely alike in all animals, but each creature is provided with such as are suited to its special mode of life and motion, so is it with the internal parts, these also differing in different animals. Viscera, then, are peculiar to sanguineous animals; and therefore are all formed from sanguineous material, as is plainly to be seen in the new-born young of these animals. For in such the viscera are more sanguineous, and of greater bulk in proportion to the body, it being in the earliest stage of formation that the nature of the material and its abundance are most conspicuous. There is a heart, then, in all sanguineous animals, and the reason for this has already been given. For that sanguineous animals must necessarily have blood is self-evident. And, as the blood is fluid, it is also a matter of necessity that there shall be a receptacle for it; and it is apparently to meet this requirement that nature has devised the blood-vessels. These, again, must necessarily have one primary source. For it is preferable that there shall be one such, when possible, rather than several. This primary source of the vessels is the heart. For the vessels manifestly issue from it and do not go through it. Moreover, being as it is homogeneous, it has the character of a blood-vessel. Again its position is that of a primary part. For nature, when no other more important purpose stands in her way, places the more honourable part in the more honourable position; and the heart lies about the centre of the body, but rather in its upper than its lower half, and also more in front than behind. This is most evident in the case of man, but even in other animals there is a tendency in the heart to assume a similar position, in the centre of the necessary part of the body, that is to say of the part which terminates in the vent for excrement. For the limbs vary in position in different animals, and are not to be counted with the parts which are necessary for life. That is why life can be maintained even when they are removed; while it is self-evident that the addition of them to an animal is not destructive of it.

There are some who say that the vessels commence in the head. In this they are mistaken. For in the first place, according to their representation, there would be many sources for the vessels, and these scattered; and secondly, these sources would be in a region that is manifestly cold, as is shown by its intolerance of chill, whereas the region of the heart is hot. Again, as already said, the vessels continue their course through the other viscera, but no vessel passes through the heart. From this it is quite evident that the heart is a part of the vessels and their origin; and for this it is well suited by its structure. For its central part consists of a dense and hollow substance, and is moreover full of blood, as though the vessels took thence their origin. It is hollow to serve for the reception of the blood, while its wall is dense, that it may serve to protect the source of heat. For here, and here alone in all the viscera and indeed in all the body, there is blood without blood-vessels, the blood elsewhere being always contained within vessels. Nor is this but consistent with reason. For the blood is conveyed into the vessels from the heart, but none passes into the heart from without. For this constitutes the origin and fountain, or primary receptacle, of the blood. It is, however, from dissections and from observations on the process of development that the truth of these statements receives its clearest demonstration. For the heart is the first of all the parts to be formed; and no sooner is it formed than it contains blood. Moreover, the motions of pain and pleasure, and generally of all sensation, plainly have their source in the heart, and find in it their termination. This, indeed, reason would lead us to expect. For the source must, whenever possible, be one; and, of all places, the best suited for a source is the centre. For the centre is one, and is equally or almost equally within reach of every part. Again, as neither the blood itself, nor yet any part which is bloodless, is endowed with sensation, it is plain that that part which first has blood, and which holds it as it were in a receptacle, must be the primary source. And that this part is the heart is not only a rational inference, but is also evident to the senses. For no sooner is the embryo formed, than its heart is seen in motion as though it were a living creature, and this before any of the other parts, it being, as thus shown, the starting-point of their nature in all animals that have blood. A further evidence of the truth of what has been stated is the fact that no sanguineous animal is without a heart. For the primary source of blood must of necessity be present in them all. It is true that sanguineous animals also invariably have a liver. But no one could ever deem the liver to be the primary organ either of the whole body or of the blood. For the position in which it is placed is far from being that of a primary part; and, moreover, in the most perfectly finished animals there is another part, the spleen, which as it were counterbalances it. Still further, the liver contains no receptacle for blood, as does the heart; but its blood is in a vessel as in all the other viscera. A vessel, moreover, extends through it, and no vessel extends through the heart; for it is from the heart that all the vessels take their rise. Since then one or other of these two parts must be the central source, and since it is not the liver which is such, it follows of necessity that it is the heart which is the source of the blood. For the definitive characteristic of an animal is the possession of sensation; and the first sensory part is that which first has blood; that is to say is the heart, which is the source of blood and the first of the parts to contain it.

The apex of the heart is pointed and more solid than the rest of the organ. It lies against the breast, and entirely in the anterior part of the body, in order to prevent that region from getting chilled. For in all animals there is comparatively little flesh over the breast, whereas there is a more abundant covering of that substance on the posterior surface, so that the heat has in the back a sufficient amount of protection. In all animals but man the heart is placed in the centre of the pectoral region; but in man it inclines a little towards the left, so that it may counterbalance the chilliness of that side. For the left side is colder in man than in any other animal. It has been stated earlier that even in fishes the heart holds the same position as in other animals; and the reason has been given why it appears not to do so. The apex of the heart, it is true, is in them turned towards the head, but this in fishes is the front aspect, for it is the direction in which their motion occurs.

The heart again is abundantly supplied with sinews, as might reasonably be expected. For the motions of the body commence from the heart, and are brought about by traction and relaxation. The heart therefore, which, as already said, is as it were a living creature inside its possessor, requires some such subservient and strengthening parts.

In no animals does the heart contain a bone, certainly in none of those that we have ourselves inspected, with the exception of the horse and a certain kind of ox. In these the heart, owing to its large bulk, is provided with a bone as a support; just as the bones serve as supports for the body generally.

In animals of great size the heart has three cavities; in smaller animals it has two; and in all has at least one, for, as already stated, there must be some place in the heart to serve as a receptacle for the first blood; which, as has been mentioned more than once, is formed in this organ. But inasmuch as the main blood-vessels are two in number, namely the so-called great vessel and the aorta, each of which is the origin of other vessels; inasmuch, moreover, as these two vessels present differences, hereafter to be discussed, when compared with each other, it is of advantage that they also shall themselves have distinct origins. This advantage will be obtained if each side have its own blood, and the blood of one side be kept separate from that of the other. For this reason the heart, whenever it is possible, has two receptacles. And this possibility exists in the case of large animals, for in them the heart too is of large size. Again it is still better that there shall be three cavities, so that the middle and odd one may serve as a source common to both sides. But this requires the heart to be of greater magnitude, so that it is only in the largest hearts that there are three cavities.

Of these three cavities it is the right that has the most abundant and the hottest 667a1
blood, and this explains why the limbs also on the right side of the body are warmer than those on the left. The left cavity has the least blood of all, and the coldest; while in the middle cavity the blood, as regards quantity and heat, is intermediate to the other two, being however of purer quality than either. For it behoves the principal part to be as tranquil as possible, and this tranquillity can be ensured by the blood being pure, and of moderate amount and warmth.

In the heart of animals there is also a kind of joint-like division, something like the sutures of the skull. This is not, however, attributable to the heart being formed by the union of several parts into a compound whole, but is rather, as already said, the result of a joint-like division. These jointings are most distinct in animals of keen sensibility, and less so in those that are of duller feeling, in swine for instance. Different hearts differ also from each other in their sizes, and in their degrees of firmness; and these differences somehow extend their influence to the temperaments of the animals. For in animals of low sensibility the heart is hard and dense in texture, while it is softer in such as are endowed with keener feeling. So also when the heart is of large size the animal is timorous, while it is more courageous if the organ be smaller and of moderate bulk. For in the former the bodily affection which results from terror already pre-exists; for the bulk of the heart is out of all proportion to the animal's heat, which being small is reduced to insignificance in the large space, and thus the blood is made colder than it would otherwise be.

The heart is of large size in the hare, the deer, the mouse, the hyena, the ass, the leopard, the weasel, and in pretty nearly all other animals that either are manifestly timorous, or betray their cowardice by their spitefulness.

What has been said of the heart as a whole is no less true of its cavities and of the blood-vessels; these also if of large size being cold. For just as a fire of equal size gives less heat in a large room than in a small one, so also does the heat in the present case; for the vessels and the cavities are receptacles. Moreover, all hot bodies are cooled by motions external to themselves, and the more spacious the cavities and vessels are, the greater the amount of breath they contain, and the more potent its action. Thus it is that no animal that has large cavities in its heart, or large blood-vessels, is ever fat, the vessels being indistinct and the cavities small in all or most fat animals.

The heart again is the only one of the viscera, and indeed the only part of the body, that is unable to tolerate any serious affection. This is but what might reasonably be expected. For, if the primary part be diseased, there is nothing from which the other parts which depend upon it can derive succour. A proof that the heart is thus unable to tolerate any affection is furnished by the fact that in no sacrificial victim has it ever been seen to be affected with those diseases that are observable in the other viscera. For the kidneys are frequently found to be full of stones, and growths, and small abscesses, as also are the liver, the lung, and more than all the spleen. There are also many other conditions which are seen to occur in these parts, those which are least liable to such being the portion of the lung which is close to the windpipe, and the portion of the liver which lies about the junction with the great blood-vessel. This again admits of a rational explanation. For it is in these parts that they are most closely in communion with the heart. On the other hand, when animals die not by sacrifice but from disease, and from affections such as are mentioned above, they are found on dissection to have morbid affections of the heart.

Thus much of the heart, its nature, and the end and cause of its existence in such animals as have it.

5 · In due sequence we have next to discuss the blood-vessels, that is to say the great vessel and the aorta. For it is into these two that the blood first passes

when it quits the heart; and all the other vessels are but offshoots from them. Now that these vessels exist on account of the blood has already been stated. For every fluid requires a receptacle, and in the case of the blood the vessels are that receptacle. Let us now explain why these vessels are two, and why they spring from one single source, and extend throughout the whole body.

The reason, then, why these two vessels coalesce into one centre, and spring from one source, is that the sensory soul is in all animals actually one, so that the part in which it primarily abides must also be one. In sanguineous animals this oneness is not only actual but potential, whereas in some bloodless animals it is only actual. Hence in the self-same place must necessarily be the source of heat; and this is the cause of the warmth and fluidity of the blood. Thus, then, the oneness of the part in which is lodged the prime source of sensation and of heat explains the oneness of the source in which the blood originates; and this, again, explains why the blood-vessels have one common starting-point.

The vessels are two because the body of every sanguineous animal that is capable of locomotion is bilateral; for in all such animals there is a distinguishable before and behind, a right and left, an above and below. Now as the front is more honourable and of higher supremacy than the hinder aspect, so also and in like degree is the great vessel superior to the aorta. For the great vessel is placed in front, 668a1
while the aorta is behind; the former again is plainly visible in all sanguineous animals, while the latter is in some indistinct and in some not discernible at all.

Lastly, the reason for the vessels being distributed throughout the entire body is that in them, or in parts analogous to them, is contained the blood, or the fluid which in bloodless animals takes the place of blood, and that this is the material from which the whole body is made. Now as to the manner in which animals are nourished, and as to the source from which they obtain nutriment and as to the way in which they absorb this from the stomach, these are matters which may be more suitably considered and explained in the treatise on Generation. [But inasmuch as the parts are, as already said, formed out of the blood, it is but rational that the flow of the blood should extend, as it does, throughout the whole of the body. For since each part is formed of blood, each must have blood all about it.][11]

To give an illustration of this. The water-courses in gardens are so constructed as to distribute water from one single source or fount into numerous channels, which convey it to all parts; and, again, in house-building stones are thrown down along the whole ground-plan of the foundation walls; because the garden-plants in the one case take their growth from water, and the foundation walls in the other are built out of the stones. Now just after the same fashion has nature laid down channels for the conveyance of the blood throughout the whole body, because this blood is the material out of which the whole fabric is made. This becomes very evident in bodies that have undergone great emaciation. For in such there is nothing to be seen but the blood-vessels; just as when fig-leaves or vine-leaves or the like have dried up, there is nothing left of them but their vessels. The explanation of this is that the blood, or fluid which takes its place, is potentially body and flesh, or substance

[11]Excised by Peck.

analogous to flesh. Now just as in irrigation the largest dykes are permanent, while the smallest are soon filled up with mud and disappear, again to become visible when the deposit of mud ceases; so also do the largest blood-vessels remain permanently open, while the smallest are converted actually into flesh, though potentially they are no whit less vessels than before. This too explains why, so long as the flesh of an animal is in its integrity, blood will flow from any part of it whatsoever that is cut. Now there can be no blood, unless there be a blood-vessel, and yet no vessel is visible—just as the dykes for irrigation are invisible until they
668b1 have been cleared of mud.

As the blood-vessels advance, they become gradually smaller and smaller, until at last their tubes are too fine to admit the blood. This fluid can therefore no longer find its way through them, though they still give passage to the residue of the moist humour which we call sweat; and especially so when the body is heated, and the mouths of the small vessels are dilated. Instances, indeed, are not unknown of persons who in consequence of a bad general condition have secreted sweat that resembled blood, their body having become loose and flabby, and their blood watery, owing to the heat in the small vessels having been too scanty for its concoction. For, as was before said, every compound of earth and water—and both nutriment and blood are such—becomes thicker from concoction. The inability of the heat to effect concoction may be due either to its being absolutely small in amount, or to the quantity of food, when this has been taken in excess and relative to which it is small. This excess again may be of two kinds, either quantitative or qualitative; for all substances are not equally amenable to concoction.

The widest passages in the body are of all parts the most liable to haemorrhage; so that bleeding occurs not infrequently from the nostrils, the gums, and the fundament, occasionally also from the mouth. Such haemorrhages are of a painless kind, and not violent as are those from the windpipe.

The great vessel and the aorta, which above lie somewhat apart, lower down exchange positions, and by so doing give compactness to the body. For when they reach the point where the legs diverge, they each split into two, and the great vessel passes from the front to the rear, and the aorta from the rear to the front. By this they contribute to the unity of the whole fabric. For as in plaited work the parts hold more firmly together, so also by the interchange of position between the blood-vessels are the anterior and posterior parts of the body more closely knit together. A similar exchange of position occurs also in the upper part of the body, between the vessels that have issued from the heart. The details however of the mutual relations of the different vessels must be looked for in the *Dissections* and the *History of* Animals.

So much, then, as concerns the heart and the blood-vessels. We must now pass on to the other viscera and apply the same method of inquiry to them.

6 · The lung, then, is an organ found in all the animals of a certain class, because they live on land. For there must of necessity be some means or other of tempering the heat of the body; and in sanguineous animals, as they are of an

especially hot nature, the cooling agency must be external, whereas in the bloodless 669a1 kinds the innate spirit is sufficient of itself for the purpose. The external cooling agent must be either air or water. In fishes the agent is water. Fishes therefore never have a lung, but have gills in its place, as was stated in the treatise on Respiration. But animals that breathe are cooled by air. These therefore are all provided with a lung.

All land animals breathe, and even some water animals, such as the whale, the dolphin, and all the spouting Cetacea. For many animals are ambivalent: some that are terrestrial and that inspire air being nevertheless of such a bodily constitution that they abide for the most time in the water; and some that are aquatic partaking so largely of the land character, that respiration constitutes for them the limiting condition of life.

The organ of respiration is the lung. This derives its motion from the heart; but it is its own large size and spongy texture that affords amplitude of space for the entrance of the breath. For when the lung rises up the breath streams in, and is again expelled when the lung collapses. It has been said that the lung exists as a provision to meet the jumping of the heart. But this is out of the question. For man is practically the only animal whose heart presents this phenomenon of jumping, inasmuch as he alone is influenced by hope and anticipation of the future. Moreover, in most animals it is separated from the lung by a considerable interval and lies above it, so that the lung can contribute nothing to mitigate any jumping of the heart.

The lung differs much in different animals. For in some it is of large size and contains blood; while in others it is smaller and of spongy texture. In the vivipara it is large and rich in blood, because of their natural heat; while in the ovipara it is small and dry but capable of expanding to a vast extent when inflated. Among terrestrial animals, the oviparous quadrupeds, such as lizards, tortoises, and the like, have this kind of lung; and, among inhabitants of the air, the animals known as birds. For in all these the lung is spongy, and like foam. For foam contracts from a large mass to a small when it runs together, and the lung of these animals is small and membraneous. In this too lies the explanation of the fact that these animals are little liable to thirst and drink but sparingly, and that they are able to remain for a considerable time under water. For, inasmuch as they have but little heat, the very motion of the lung, airlike and void, suffices by itself to cool them for a considerable 669b1 period.

These animals, speaking generally, are also distinguished from others by their smaller bulk. For heat promotes growth, and abundance of blood is an indication of heat. Heat, again, tends to make the body erect; and thus it is that man is the most erect of animals, and the vivipara more erect than other quadrupeds. For no viviparous animal, be it footless or be it possessed of feet, is so given to creep into holes.

The lung, then, exists in general for respiration; but in one order of animals it is bloodless and has the structure described above, to suit the special requirements. There is, however, no one term to denote all animals that have a lung; no designation, that is, like the term bird, applicable to the whole of a certain class. Yet the possession of a lung is a part of their substance, just as much as the presence of certain characters constitutes the essence of a bird.

7 · Of the viscera some appear to be single, as the heart and lung; others to be double, as the kidneys; while of a third kind it is doubtful in which class they should be reckoned. For the liver and the spleen would seem to be ambivalent. For they may be regarded either as constituting each a single organ, or as a pair of organs resembling each other in character.

In reality, however, all the organs are double. The reason for this is that the body itself is double, consisting of two halves, which are however combined together under a single origin. For there is an upper and a lower half, a front and a rear, a right side and a left.

This explains why it is that even the brain and the several organs of sense tend in all animals to consist of two parts; and the same explanation applies to the heart with its cavities. The lung again in Ovipara is divided to such an extent that these animals look as though they had actually two lungs. As to the kidneys, no one can overlook their double character. But when we come to the liver and the spleen, any one might fairly be in doubt. The reason for this is, that, in animals that necessarily have a spleen, this organ is such that it might be taken for a kind of bastard liver; while in those in which a spleen is not an actual necessity but is merely present, as it were, by way of token, in an extremely minute form, the liver plainly consists of two parts; of which the larger tends to lie on the right side and the smaller on the left. Not but what there are some even of the Ovipara in which this condition is comparatively indistinctly marked; while, on the other hand, there are some Vivipara in which the liver is manifestly divided into two parts. Examples of such division are furnished by the hares of certain regions, which have the appearance of having two livers, and by the selachia and some other fishes.

It is the position of the liver on the right side of the body that is the main cause for the formation of the spleen; the existence of which thus becomes to a certain extent a matter of necessity in all animals, though not of very stringent necessity.

The reason, then, why the viscera are bilateral is, as we have said, that there are two sides to the body, a right and a left. For each of these sides aims at similarity with the other, and so likewise do their several viscera; and as the sides, though dual, are knit together into unity, so also is it with each of the viscera.

Those viscera which lie below the diaphragm exist one and all on account of the blood-vessels; serving as a bond, by which these vessels, while floating freely, are yet held in connexion with the body. For the vessels give off branches which run to the body through the outstretched structures, like so many anchor-lines. The great vessel sends such branches to the liver and the spleen; and these viscera—the liver and spleen on either side with the kidneys behind—attach the great vessel to the body with the firmness of nails. The aorta sends similar branches to each kidney.

These viscera, then, contribute in this manner to the animal body. The liver and spleen assist, moreover, in the concoction of the food; for both are of a hot character, owing to the blood which they contain. The kidneys, on the other hand, take part in the separation of the excretion which flows into the bladder.

The heart then and the liver are essential constituents of every animal; the liver that it may effect concoction, the heart that it may lodge the central source of heat. For some part or other there must be which, like a hearth, shall hold the kindling fire; and this part must be well protected, seeing that it is, as it were, the citadel of the body.

All sanguineous animals, then, need these two parts; and this explains why these two viscera are found in them all. In such of them, however, as breathe, there is also a third, namely the lung. The spleen, in those animals that have it, is only present of necessity in the same sense as the excretions of the belly and of the bladder are necessary, in the sense, that is, of being a concomitant. Therefore it is that in some animals the spleen is but scantily developed as regards size. This, for instance, is the case in such feathered animals as have a hot stomach. Such are the pigeon, the hawk, and the kite. It is the case also in oviparous quadrupeds, where the spleen is excessively minute, and in many of the scaly fishes. These same animals are also without a bladder, because the loose texture of their flesh allows the residual fluid to pass through and to be applied to the formation of feathers and scales. For the spleen attracts the residual humours from the stomach, and owing to its bloodlike character is enabled to assist in their concoction. Should, however, this residual fluid be too abundant, or the heat of the spleen be too scanty, the body becomes sickly from over-repletion with nutriment. Often, too, when the spleen is affected by disease, the belly becomes hard owing to the reflux into it of the fluid; just as happens to those who form too much urine, for they also are liable to a similar diversion of the fluids into the belly. But in those animals that have but little to excrete, such as birds and fishes, the spleen is never large, and in some exists no more than by way of token. So also in the oviparous quadrupeds it is small, compact, and like a kidney. For their lung is spongy, and they drink but little, and such residue as they have is applied to the growth of the body and the formation of scaly plates, just as in birds it is applied to the formation of feathers.

On the other hand, in such animals as have a bladder, and whose lung contains blood, the spleen is watery, both for the reason already mentioned, and also because the left side of the body is more watery and colder than the right. For each of two contraries has been so placed as to go together with that which is akin to it in another pair of contraries. Thus right and left, hot and cold, are pairs of contraries; and they are in the same column as one another, after the manner described.

The kidneys when they are present exist not of actual necessity, but as matters of greater finish and perfection. For by their special character they are suited to serve in the excretion of the fluid which collects in the bladder. In animals therefore where this fluid is very abundantly formed, their presence enables the bladder to perform better its proper office.

Since then both kidneys and bladder exist in animals for one and the same function, we must next treat of the bladder, though in so doing we disregard the due order of succession in which the parts should be enumerated. For not a word has yet been said of the midriff, which is one of the parts that environ the viscera.

8 · It is not every animal that has a bladder; those only being apparently
671a1 intended by nature to have one, whose lung contains blood. To such it was but reasonable that she should give this part. For the superabundance in their lung of its natural constituents causes them to be the thirstiest of animals, and makes them require a more than ordinary quantity not merely of solid but also of liquid nutriment. This increased consumption necessarily entails the production of an increased amount of residue; which thus becomes too abundant to be concocted by the stomach and excreted with its own residual matter. The residual fluid must therefore of necessity have a receptacle of its own; and thus all animals whose lung contains blood are provided with a bladder. Those animals, on the other hand, that are without a lung of this character, and that either drink but sparingly owing to their lung being of a spongy texture, or never imbibe fluid at all for drinking's sake but only as nutriment, insects for instance and fishes, and that are moreover clad with feathers or scales or scaly plates—all these animals, owing to the small amount of fluid which they imbibe, and owing also to such residue as there may be being converted into feathers and the like, are invariably without a bladder. The tortoises, which are comprised among animals with scaly plates, form the only exception; and this is merely due to the imperfect development of their natural conformation; the explanation of the matter being that in the sea-tortoises the lung is flesh-like and contains blood, resembling the lung of the ox, and that in the land-tortoises it is of disproportionately large size. Moreover, inasmuch as the covering which invests them is dense and shell-like, so that the moisture cannot exhale through the porous flesh, as it does in birds and in snakes and other animals with scaly plates, such an amount of secretion is formed that some special part is required to receive and hold it. This then is the reason why these animals, alone of their kind, have a bladder, the sea-tortoise a large one, the land-tortoises an extremely small one.

9 · What has been said of the bladder is equally true of the kidneys. For these also are wanting in all animals that are clad with feathers or with scales or with scale-like plates; the sea and land tortoises forming the only exception. In some of the birds, however, there are flattened kidney-like bodies, as though the flesh allotted to the formation of the kidneys, unable to find one single place of sufficient size, had been scattered over several.

The fresh-water tortoise has neither bladder nor kidneys. For the softness of its shell allows of the ready transpiration of fluid; and for this reason neither of the organs mentioned exists in this animal. All other animals, however, whose lung
671b1 contains blood are, as before said, provided with kidneys. For nature uses these organs for two separate purposes, namely for the excretion of the residual fluid, and to subserve the blood-vessels, a channel leading to them from the great vessel.

In the centre of the kidney is a cavity of variable size. This is the case in all animals, excepting the seal. The kidneys of this animal are more solid than those of any other, and resemble the kidneys of the ox. The human kidneys are also like those of the ox; being as it were made up of numerous small kidneys, and not presenting one unbroken surface like the kidneys of sheep and other quadrupeds.

For this reason, should the kidneys of a man be once attacked by disease, the malady is not easily expelled. For it is as though many kidneys were diseased and not merely one; which naturally enhances the difficulties of a cure.

The duct which runs to the kidney from the great vessel does not terminate in the central cavity, but is expended on the substance of the organ, so that there is no blood in the cavity, nor does any congeal there after death. A pair of stout ducts, void of blood, run, one from the cavity of each kidney, to the bladder; and other ducts, strong and continuous, lead into the kidneys from the aorta. The purpose of this arrangement is to allow the superfluous fluid to pass from the blood-vessel into the kidney, and the resulting renal excretion to collect, by the percolation of the fluid through the solid substance of the organ, in its centre, where as a general rule there is a cavity. (This by the way explains why the kidney is the most malodorous of all the viscera.) From the central cavity the fluid is discharged into the bladder by the ducts that have been mentioned, having already assumed in great degree the character of excremental residue. The bladder is as it were moored to the kidneys; for, as already has been stated, it is attached to them by strong ducts. These then are the causes for which the kidneys exist, and such the functions of these organs.

In all animals that have kidneys, that on the right is placed higher than that on the left. For, inasmuch as motion commences from the right, and the organs on this side are in consequence stronger than those on the left, they must all push upwards because of this motion in advance of their opposite fellows; indeed, men even raise the right eyebrow more than the left, and the former is more arched than the latter. The right kidney being thus drawn upwards is in all animals brought into contact with the liver; for the liver lies on the right side. 672a1

Of all the viscera the kidneys are those that have the most fat. This is in the first place the result of necessity, because the kidneys are the parts through which the residual matters percolate. For the blood which is left behind after this excretion, being of pure quality, is of easy concoction, and the final result of thorough blood-concoction is lard and suet. For just as a certain amount of fire is left in the ashes of solid substances after combustion, so also does a remnant of the heat that has been developed remain in fluids after concoction; and this is the reason why oily matter is light, and floats on the surface of other fluids. The fat is not formed in the kidneys themselves, the density of their substance forbidding this, but is deposited about their external surface. It consists of lard or of suet, according as the animal's fat is of the former or latter character. The difference between these two kinds of fat has already been set forth in other passages. The formation, then, of fat in the kidneys is the result of necessity; being, as explained, a consequence of the necessary conditions which accompany the possession of such organs. But at the same time the fat is there to ensure the safety of the kidneys, and to maintain their natural heat. For placed, as these organs are, close to the surface, they require a greater supply of heat than other parts. For while the back is thickly covered with flesh, so as to form a shield for the heart and neighbouring viscera, the loins, in accordance with a rule that applies to all bendings, are destitute of flesh; and fat is therefore formed as a substitute for it, so that the kidneys may not be without protection. The kidneys, moreover, by being fat are the better enabled to secrete and concoct their fluid; for fat is hot, and it is heat that effects concoction.

Such, then, are the reasons why the kidneys are fat. But in all animals the right kidney is less fat than its fellow. The reason for this is, that the parts on the right side are naturally more dry and more suited for motion than those on the left. But motion is antagonistic to fat, for it tends to melt it.

Animals then, as a general rule, derive advantage from their kidneys being fat; and the fat is often very abundant and extends over the whole of these organs. But, should the like occur in the sheep, death ensues. Be its kidneys, however, as fat as they may, they are never so fat but that some part, if not in both at any rate in the right one, is left free. The reason why sheep are the only animals that suffer in this manner, or suffer more than others, is that in animals whose fat is composed of lard this is of fluid consistency, so that there is not the same chance in their case of breath getting shut in and causing mischief. But it is to this that rot is due. And thus even in men who suffer from kidney trouble, though it is beneficial to them to have fat kidneys, yet should these organs become over-fat, deadly pains ensue. As to those animals whose fat consists of suet, in none is the suet so dense as in the sheep, neither is it nearly so abundant; for of all animals there is none in which the kidneys become so soon gorged with fat as in the sheep. Rot, then, is produced by the moisture and the breath getting shut up in the kidneys, and is a malady that carries off sheep with great rapidity. For the disease forthwith reaches the heart, passing thither by the aorta and great vessel, the ducts which connect these with the kidneys being of unbroken continuity.

10 · We have now dealt with the heart and the lung, as also with the liver, spleen, and kidneys. The latter are separated from the former by the midriff or, as some call it, the diaphragm. This divides off the heart and lung, and, as already said, is called the diaphragm in sanguineous animals, all of which have a midriff, just as they all have a heart and a liver. The reason is that the midriff serves to divide the region of the heart from the region of the stomach, so that the centre wherein abides the sensory soul may be undisturbed, and not be overwhelmed, directly food is taken, by its up-steaming vapour and by the abundance of heat then superinduced. For it was to guard against this that nature made a division, constructing the midriff as a kind of partition-wall and fence, and so separated the nobler from the less noble parts, in all cases where a separation of upper from lower is possible. For the upper part is the better and that for the sake of which the rest exists; while the lower part exists for the sake of the upper and constitutes the necessary element in the body, inasmuch as it is the recipient of the food.

That portion of the midriff which is near the ribs is fleshier and stronger than the rest, but the central part has more of a membranous character; for this structure conduces best to its strength and its extensibility. Now that there are as it were outgrowths to prevent heat mounting up from below, is shown by what happens when, owing to their proximity to the stomach, they attract thence the hot and residual fluid. For when this occurs there ensues forthwith a marked disturbance of intellect and sensation. It is indeed because of this that the midriff is called the diaphragm, as though it had some share in the process of thinking.[12] In reality, however, it has no part whatsoever itself in the matter, but, lying in close proximity to organs that have, it makes the changes of intelligence evident. This too explains why its central part is thin—not only by necessity, inasmuch as those portions of the fleshy whole which lie nearest to the ribs must necessarily be fleshier than the rest, but also in order to give it as small a proportion of humour as possible; for, had it been made of flesh throughout, it would have been more likely to attract and hold a large amount of this. That heating of it affects sensation rapidly and in a notable manner is shown by the phenomena of laughing. For when men are tickled they are quickly set a-laughing, because the motion quickly reaches this part, and being heated but slightly it nevertheless manifestly so disturbs the mental action as to occasion movements that are contrary to the man's intention. That man alone is affected by tickling is due firstly to the delicacy of his skin, and secondly to his being the only animal that laughs. For to be tickled is to be set in laughter, the laughter being produced by such a motion as mentioned of the region of the armpit.

It is said also that when men in battle are wounded anywhere near the midriff, they are seen to laugh, owing to the heat produced by the wound. This is asserted by more credible persons than those who tell the story of how a human head speaks after it is cut off. For so some assert, and even call in Homer to support them, representing him as alluding to this when he wrote, 'His head still speaking rolled into the dust', instead of 'The head of the speaker'.[13] So fully was the possibility of such an occurrence accepted in Arcadia, that one of that country was actually brought to trial under the following circumstances. The priest of Zeus Hoplosmios had been murdered; but as yet it had not been ascertained who was the assassin; when certain persons asserted that they had heard the murdered man's head, which had been severed from the body, repeat several times the words, 'Cercidas slew man on man'. Search was thereupon made and a man of those parts who bore the name of Cercidas hunted out and put upon his trial. But it is impossible that any one should utter a word when the windpipe is severed and no motion any longer derived from the lung. Moreover, among the barbarians, where heads are chopped off with great rapidity, nothing of the kind has ever yet occurred. Why, again, does not the like occur in the case of other animals than man? [For the story about laughing when the midriff is wounded, is but what one would expect; for no animal but man ever laughs. So, too, there is nothing irrational in supposing that the trunk may run forwards to a certain distance after the head has been cut off; seeing that bloodless animals at any rate can live, and that for a considerable time, after decapitation, as has been set forth and explained in other passages.][14]

[12] 'φρένες' ('diaphragm') and 'φρονεῖν' ('think').
[13] See *Iliad* X 457; *Odyssey* XXII 329.
[14] Excised by Peck.

The purposes, then, for which the viscera severally exist have now been stated. It is of necessity upon the inner terminations of the vessels that they are developed;
673b1 for humour, and that of a bloody character, cannot but exude at these points, and it is of this, solidified and coagulated, that the substance of the viscera is formed. Thus they are of a bloody character, and in substance resemble each other while they differ from other parts.

11 · The viscera are enclosed each in a membrane. For they require some covering to protect them from injury, and require, moreover, that this covering shall be light. To such requirements membrane is well adapted; for it is close in texture so as to form a good protection, destitute of flesh so as neither to attract humour nor retain it, and thin so as to be light and not add to the weight of the body. Of the membranes those are the stoutest and strongest which invest the heart and the brain; as is but consistent with reason. For these are the parts which require most protection, seeing that they are the main governing powers of life, and that it is to governing powers that guard is due.

12 · Some animals have all the viscera that have been enumerated; others have only some of them. In what kind of animals this latter is the case, and what is the explanation, has already been stated. Moreover, the self-same viscera present differences in different possessors. For the heart is not precisely alike in all animals that have one; nor, in fact, is any of the others. Thus the liver is in some animals split into several parts, while in others it is comparatively undivided. Such differences present themselves even among those sanguineous animals that are viviparous, but are marked in fishes and in the oviparous quadrupeds, and this whether we compare them with each other or with the Vivipara. As for birds, their liver very nearly resembles that of the Vivipara; for in them, as in these, it is of a pure and blood-like colour. The reason for this is that the body in both these classes of animals admits of the freest exhalation and the amount of foul residual matter within is but small. Hence it is that some of the Vivipara are without any gall-bladder at all. For the liver takes a large share in maintaining the purity of composition and the healthiness of the body. For these are conditions that depend finally upon the blood, and there is more blood in the liver than in any of the other viscera, the heart only excepted. On the other hand, the liver of oviparous quadrupeds and fishes inclines, as a rule, to a yellow hue, and there are even some of them in which it is entirely of this bad colour, in accordance with the bad composition of their bodies generally. Such, for instance, is the case in the toad, the tortoise, and other similar animals.

The spleen in animals that have horns and cloven hoofs, such as the goat, the sheep, and the like, is of a rounded form; excepting when increased size has caused
674a1 some part of it to extend its growth longitudinally, as has happened in the case of the ox. On the other hand, it is elongated in all polydactylous animals. Such, for instance, is the case in the pig, in man, and in the dog. While in animals with solid hoofs it is of a form intermediate to these two and mixed, being broad in one part, narrow in another. Such, for example, is its shape in the horse, the mule, and the ass.

13 · The viscera differ from the flesh not only in the bulkiness of their substance, but also in position; for they lie within the body, whereas the flesh is placed on the outside. The explanation of this is that these parts partake of the character of blood-vessels, and that while the former exist for the sake of the vessels, the latter cannot exist without them.

14 · Below the midriff lies the stomach, placed at the end of the oesophagus when there is one, and in immediate contiguity with the mouth when the oesophagus is wanting. Continuous with this stomach is what is called the gut. These parts are present in animals, for reasons that are self-evident. For it is a matter of necessity that an animal shall receive the incoming food and discharge it when its moisture has been extracted. This residual matter, again, must not occupy the same place as the yet unconcocted nutriment, and there must be a place in which they change. For there must be one receptacle for the ingoing food and another for the useless residue, and as there are separate times for these operations, so there must be distinct places. These, however, are matters which will be more suitably set forth when we come to deal with Generation and Nutrition. What we have at present to consider are the variations presented by the stomach and its subsidiary parts. For neither in size nor in shape are these parts uniformly alike in all animals. Thus the stomach is single in all sanguineous and viviparous animals which are ambidentate. It is single therefore in all the polydactylous kinds, such as man, dog, lion, and the rest; in all the solid-hoofed animals also, such as horse, mule, ass; and in all those which, like the pig, though their hoof is cloven, yet are ambidentate. When, however, an animal is of large size, and feeds on substances of so thorny and ligneous a character as to be difficult of concoction, it may in consequence have several stomachs, as for instance is the case with the camel. A similar multiplicity of stomachs exists also in the horned animals; the reason being that horn-bearing animals are not ambidentate. The camel also, though it has no horns, is not ambidentate. The explanation of this is that it is more essential for the camel to have a multiple stomach than to have front teeth. Its stomach, then, is constructed like that of non-ambidentates, and its teeth match its stomach—for the 674b1 teeth in question would be of no service. Its food, moreover, being of a thorny character, and its tongue necessarily made of a fleshy substance, nature uses the earthy matter which is saved from the teeth to give hardness to the palate. The camel ruminates like the horned animals, because its multiple stomach resembles theirs. For all animals that have horns, the sheep for instance, the ox, the goat, the deer, and the like, have several stomachs. For since the mouth, owing to its lack of teeth, only imperfectly performs its office as regards the food, the stomachs receive the food one from the other in succession, the first taking the unreduced substances, the second the same when somewhat reduced, the third when reduction is complete, and the fourth when the whole has become a smooth pulp. Such is the reason why there is this multiplicity of parts and cavities in animals with such dentition. The names given to the several cavities are the paunch, the honey-comb bag, the manyplies, and the reed. How these parts are related to each other, in position and in shape, must be looked for in the *History of Animals* and the *Anatomies*.

Birds also present variations in the part which acts as a recipient of the food for the same reason. For here again it is because the mouth fails to perform its office—for birds have no teeth at all, nor any instrument whatsoever with which to bite up or grind down their food—it is because of this, that in some of them what is called the crop precedes the stomach and does the work of the mouth; while in others the oesophagus is either broad or a part of it bulges just before it enters the stomach, so as to form a preparatory store-house for the unreduced food; or the stomach itself has a protuberance in some part, or is strong and fleshy, so as to be able to store up the food for a considerable period and to concoct it, in spite of its not having been ground into a pulp. For nature retrieves the inefficiency of the mouth by increasing the efficiency and heat of the stomach. Other birds there are, such, namely, as have long legs and live in marshes, that have none of these provisions, but merely an elongated oesophagus.[15] The explanation of this is to be found in the moist character of their food. For all these birds feed on substances easy of reduction, and because of this, [their food being moist and not requiring much concoction][16] their stomachs are moist.

Fishes are provided with teeth, which in almost all of them are of the saw-toothed kind. For there is but one small group in which it is otherwise. Of these the fish called Scarus is an example. And this is probably the reason why this fish apparently ruminates, though no other fishes do so. For those horned animals that are not ambidentate also ruminate.

In fishes the teeth are all sharp; so that these animals can divide their food, though imperfectly. For it is impossible for a fish to linger or spend time in the act of mastication, and therefore they have no teeth that are flat or suitable for grinding; for such teeth would be to no purpose. The oesophagus again in some fishes is entirely wanting, and in the rest is short. In order, however to facilitate the concoction of the food, some of them, as the mullet, have a fleshy stomach resembling that of a bird; while most of them have numerous appendages close against the stomach, to serve as a sort of antechamber in which the food may be stored up and undergo putrefaction and concoction. There is a contrast between fishes and birds in the position of these appendages. For in fishes they are placed high up, close to the stomach; while in birds, if present at all, they are lower down, near the end of the gut. Some of the Vivipara also have appendages connected with the lower part of the gut which serve the same purpose as that stated above.

The whole tribe of fishes is of gluttonous appetite, owing to the arrangements for the reduction of their food being very imperfect, and much of it consequently passing through them without undergoing concoction; and, of all, those are the most gluttonous that have a straight intestine. For as the passage of food in such cases is rapid, and the enjoyment derived from it in consequence but brief, it follows of necessity that the return of appetite is also speedy.

It has already been mentioned that in ambidentates the stomach is of small size. It may be classed pretty nearly always under one or other of two headings,

[15] Reading *στόμαχον*. [16] Excised by Peck.

namely as resembling the stomach of the dog, or as resembling the stomach of the pig. In the pig the stomach is larger than in the dog, and presents certain folds of moderate size, the purpose of which is to lengthen out the period of concoction; while the stomach of the dog is of small size, not much larger in calibre than the gut, and smooth on the internal surface.

For in all animals after the stomach comes the gut. This, like the stomach, presents numerous modifications. For in some animals it is uniform, when uncoiled, and alike throughout, while in others it differs in different portions. Thus in some cases it is wider in the neighbourhood of the stomach, and narrower towards the other end; and this explains by the way why dogs have to strain so much in discharging their excrement. But in most animals it is the upper portion that is the narrower and the lower that is of greater width.

Of greater length than in other animals, and much convoluted, are the intestines of those that have horns. These intestines, moreover, as also the stomach, are of ampler volume, in accordance with the larger size of the body. For animals with horns are, as a rule, large, because of the thorough elaboration which their food undergoes. The gut, except in those animals where it is straight, invariably widens out as it gets farther from the stomach; then they have what is called the colon, and the blind and swollen part of the gut. After this it again becomes narrower and convoluted. Then succeeds a straight portion which runs right on to the vent. This vent is known as the anus, and is in some animals surrounded by fat, in others not so. All these parts have been so contrived by nature as to harmonize with the various operations that relate to the food and its residue. For, as the residual food gets farther on and lower down, the space to contain it enlarges, allowing it to remain stationary and undergo conversion. Thus is it in those animals which, owing either to their large size, or to the heat of the parts concerned, require more nutriment, and consume more fodder than the rest.

After this, just as a narrower gut succeeds to the upper stomach, so also does the residual food, when its juice is thoroughly exhausted, pass from the colon and the ample space of the lower stomach into a narrower channel and into the spiral coil, in order that nature can regulate her expenditure and prevent the excremental residue from being discharged all at once.

In all such animals, however, as have to be comparatively moderate in their alimentation, the lower stomach presents no wide and roomy spaces, though their gut is not straight, but has a number of convolutions. For amplitude of space causes desire for ample food, and straightness of the intestine causes quick return of appetite. And thus it is that all animals whose food receptacles are either simple or spacious are of gluttonous habits, the latter eating enormously at a meal, the former making meals at short intervals.

Again, since the food in the upper stomach, having just been swallowed, must of necessity be quite fresh, while that which has reached the lower stomach must have had its juices exhausted and resemble dung, it follows of necessity that there must also be some intermediate part, in which the change may be effected, and where the food will be neither perfectly fresh nor yet dung. And thus it is that, in all such animals as we are now considering, there is found what is called the jejunum; which is a part of the small gut which comes next to the stomach. For this jejunum lies between the upper cavity which contains the yet unconcocted food and the lower cavity which holds the useless residual matter. There is a jejunum in all these animals, but it is plainly discernible in those of large size when they have abstained from food for a certain time. For then there is a sort of no-man's land between the two regions, but when they have eaten the time occupied in the transition of food is but brief. In females this jejunum may occupy any part whatsoever of the upper intestine, but in males it comes just before the caecum and the lower stomach.

15 · What is known as rennet is found in all animals that have a multiple stomach, and in the hare among animals whose stomach is single. In the former the rennet neither occupies the large paunch, nor the honeycomb bag, nor the terminal reed, but is found in the cavity which separates this terminal one from the first, namely in the so-called manyplies. It is the thick character of their milk which causes all these animals to have rennet; whereas in animals with a single stomach the milk is thin, and consequently no rennet is formed. That is why the milk of horned animals coagulates, while that of animals without horns does not. Rennet forms in the hare because it feeds on herbage that has juice like that of the fig; for juice of this kind coagulates the milk in the stomach of the sucklings. Why it is in the manyplies that rennet is formed in animals with multiple stomachs has been stated in the *Problems*.

BOOK IV

1 · The account which has now been given of the viscera, the stomach, and the other several parts holds equally good not only for the oviparous quadrupeds, but also for such footless animals as the Serpents. These two classes of animals are indeed nearly akin, a serpent resembling a lizard which has been lengthened out and deprived of its feet. Fishes, again, resemble these two groups in all their parts, excepting that, while these, being land animals, have a lung, fishes have no lung, but gills in its place. None of these animals, excepting the tortoise, as also no fish, has a bladder. For owing to the bloodlessness of their lung, they drink but sparingly; and such fluid as they have is diverted to the scaly plates, as in birds it is diverted to the feathers, and thus they come to have the same white matter on the surface of their excrement as we see on that of birds. For in animals that have a bladder, its excretion when voided leaves a deposit of earthy brine in the containing vessel. For the sweet and fresh elements, being light, are expended on the flesh.

Among the Serpents, the same peculiarity attaches to vipers, as among fishes attaches to Selachia. For both these and vipers are externally viviparous, but previously produce ova internally.

The stomach in all these animals is single, just as it is single in all other ambidentates; and their viscera are excessively small, as always happens when there is no bladder. In serpents these viscera are, moreover, differently shaped from those of other animals. For, a serpent's body being long and narrow, its contents are as it were moulded into a similar form, and thus come to be themselves elongated.

All animals that have blood possess an omentum, a mesentery, intestines, and, moreover, a diaphragm and a heart; and all, excepting fishes, a lung and a windpipe. The relative positions, moreover, of the windpipe and the oesophagus are precisely similar in them all; and the reason is the same as has already been given.

2 · Almost all sanguineous animals have a gall-bladder. In some this is attached to the liver, in others separated from that organ and attached to the intestines, being apparently in the latter case no less than in the former an appendage of the lower stomach. It is in fishes that this is most clearly seen. For all fishes have a gall-bladder; and in most of them it is attached to the intestine, being in some, as in the bonito, united with this, like a border, along its whole length. It is similarly placed in most serpents. There are therefore no good grounds for the view entertained by some writers, that the gall exists for the sake of some sensory action. For they say that its use is to affect that part of the soul which is lodged in the neighbourhood of the liver, vexing this part so as to congeal it, and restoring it to cheerfulness when it again flows free. But in some animals there is absolutely no gallbladder at all—in the horse, for instance, the mule, the ass, the deer, and the roe; and in others, as the camel, there is no distinct bladder, but merely small vessels of a biliary character. Again, there is no such organ in the seal, nor, among sea-animals, in the dolphin. Even within the limits of the same genus, some animals appear to have and others to be without it. Such, for instance, is the case with mice; such also with man. For in some individuals there is a distinct gall-bladder attached to the liver, while in others there is no gall-bladder at all. This explains why there is a dispute about the group as a whole. For each observer, according as he has found it present or absent in the individual cases he has examined, has supposed it to be present or absent in the whole genus. The same has occurred in the case of sheep and of goats. For these animals usually have a gall-bladder; but, while in some 677a1
localities it is so enormously big as to appear a monstrosity, as is the case in Naxos, in others it is altogether wanting, as is the case in a certain district belonging to the inhabitants of Chalcis in Euboea. Moreover, the gall-bladder in fishes is separated, as already mentioned, by a considerable interval from the liver. No less mistaken seems to be the opinion of Anaxagoras and his followers, that the gall-bladder is the cause of acute diseases, inasmuch as it becomes over-full, and spurts out its excess on to the lung, the blood-vessels, and the ribs. For, almost invariably, those who suffer from these forms of disease are persons who have no gall-bladder at all, as would be quite evident were they to be dissected. Moreover, there is no kind of correspondence between the amount of bile which is present in these diseases and the amount which is exuded. The most probable opinion is that, as the bile when it is present in any other part of the body is a mere residuum or a collipuescence, so also

when it is present in the region of the liver it is a residue and not for the sake of anything; just as is the case with the excretions of the stomach and intestines. For though even the residua are occasionally used by nature for some useful purpose, yet we must not in all cases expect to find such a final cause; for granted the existence of this or that constituent, with such and such properties, many results must ensue as necessary consequences of these properties. All animals, then, whose liver is healthy in composition and supplied with none but sweet blood, are either entirely without a gall-bladder on this organ, or have merely small bile-containing vessels; or are some with and some without such parts. Thus it is that the liver in animals that have no gall-bladder is, as a rule, of good colour and sweet; and that, when there is a gall-bladder, that part of the liver is sweetest which lies immediately underneath it. But, when animals are formed of blood less pure in composition, the bile is the residue left by this. For the very meaning of excrement is that it is the opposite of nutriment, and of bitter that it is the opposite of sweet; and healthy blood is sweet. So that it is evident that the bile is not for the sake of anything, but is a purifying excretion. It was therefore no bad saying of old writers that the absence of a gall-bladder gave long life. In so saying they had in mind deer and animals with solid hoofs. For such have no gall-bladder and live long. But besides these there are other animals that have no gall-bladder, though those old writers had not noticed the fact, such as the camel and the dolphin; and these also are in fact long-lived. Seeing, indeed, that the liver is a necessary and vital part in all animals that have blood, it is but reasonable that on its character should depend the length or the shortness of life. Nor less reasonable is it that this organ and none other should have such an excretion as the bile. For the heart, unable as it is to stand any violent affection, would be utterly intolerant of the proximity of such a fluid; and, as to the rest of the viscera, none excepting the liver are necessary parts of an animal. It would be absurd to think that phlegm and the sediment from the stomach are not residues wherever they are found; and clearly the same applies to bile too, and its locality makes no difference.

3 · So much then of the gall-bladder, and of the reasons why some animals have one, while others have not. We have still to speak of the mesentery and the omentum; for these are associated with the parts already described and contained in the same cavity. The omentum, then, is a membrane containing fat; the fat being suet or lard, according as the fat of the animal generally is of the former or latter description. What kinds of animals are so distinguished has been already set forth in an earlier part of this treatise. This membrane, alike in animals that have a single and in those that have a multiple stomach, grows from the middle of that organ, along a line which is marked on it like a seam. And it covers the rest of the stomach and the greater part of the bowels, and this alike in all sanguineous animals whether they live on land or in water. Now the development of this part into such a form as has been described is the result of necessity. For, whenever dry and moist are mixed together and heated, the surface invariably becomes membranous and skin-like. But the region in which the omentum lies is full of nutriment of such a mixed

character. Moreover, in consequence of the close texture of the membrane, that portion of the sanguineous nutriment will alone filter into it which is of a greasy character; for this portion is composed of the finest particles; and it will be concocted by the heat of the part, and will be converted into suet or lard, and will not acquire a flesh-like or sanguineous constitution. The development, then, of the omentum occurs in this way. But it is used by nature to facilitate and to hasten the concoction of food. For all that is hot aids concoction; and fat is hot, and the omentum is fat. This too explains why it hangs from the middle of the stomach; for the upper part of the stomach is assisted in concoction by the adjacent liver. Thus much as concerns the omentum.

4 · The so-called mesentery is a membrane; and extends continuously from the long stretch of intestine to the great vessel and the aorta. In it are numerous and 678a1
close-packed vessels, which run from the intestines to the great vessel and to the aorta. The formation of this membrane we shall find to be the result of necessity, as is that of the other parts. What, however, is the cause of its existence in sanguineous animals is manifest on reflection. For it is necessary that animals shall get nutriment from without; and, again, that this shall be converted into the ultimate nutriment, which is then distributed to the various parts; this ultimate nutriment being, in sanguineous animals, what we call blood, and having, in bloodless animals, no definite name. This being so, there must be channels through which the nutriment shall pass, as it were through roots, from the stomach into the blood-vessels. Now the roots of plants are in the ground; for thence their nutriment is derived. But in animals the stomach and intestines represent the ground from which the nutriment is to be taken. The mesentery, then, is an organ to contain the roots; and these roots are the vessels that traverse it. This then is the final cause of its existence. But how it absorbs nutriment, and how that portion of the food which enters into the vessels is distributed by them to the various parts of the body, are questions which will be considered when we come to deal with the generation and nutrition of animals.

The constitution of sanguineous animals, so far as the parts as yet mentioned are concerned, and the reasons for such constitution, have now been set forth. In natural sequence we should next go on to the organs of generation, as yet undescribed, on which depend the distinctions of male and female. But, inasmuch as we shall have to deal specially with generation hereafter, it will be more convenient to defer the consideration of these parts to that occasion.

5 · Very different from the animals we have as yet considered are the Cephalopoda and the Crustacea. For these have absolutely no viscera whatsoever; as is indeed the case with all bloodless animals, in which are included two other genera, namely the Testacea and the Insects. For in none of them does the material out of which viscera are formed exist. None of them, that is, have blood. The cause of this lies in their substance. For the presence of blood in some animals, its absence from others, must be included in the formula which determines their respective

substances. Moreover, in the animals we are now considering, none of those final causes will be found to exist which in sanguineous animals determine the presence
678b1 of viscera. For they have no blood-vessels nor bladder, nor do they breathe; the only part that it is necessary for them to have being that which is analogous to a heart. For in all animals there must be some central and commanding part of the body, to lodge the sensory portion of the soul and the source of life. The organs of nutrition are also of necessity present in them all. They differ, however, in character because of differences of the habitats in which they get their subsistence.

In the Cephalopoda there are two teeth, enclosing what is called the mouth; and inside this mouth is a flesh-like substance which represents a tongue and serves for the discrimination of pleasant and unpleasant food. The Crustacea have front teeth in the same way, and also have the fleshy representative of a tongue. This latter part is found, moreover, in all Testacea for the same reason as in sanguineous animals, viz. to perceive their food. Similarly provided also are the Insects. For some of these, such as the bees and the flies, have, as already described, their proboscis protruding from the mouth; while those others that have no such instrument in front have a similar part inside the mouth. Such, for instance, is the case in the ants and the like. As for teeth, some insects have them, the bees and the flies for instance, though in a somewhat modified form, while others that live on fluid nutriment are without them. For in many insects the teeth are not meant to deal with the food, but to serve as weapons.

In some Testacea, as was said in the first treatise, the organ which is called the tongue is of considerable strength; and in sea-snails there are also two teeth, just as in the Crustacea. The mouth in the Cephalopoda is succeeded by a long gullet. This leads to a crop, like that of a bird, and directly continuous with this is the stomach, from which a gut runs without windings to the vent. The cuttlefish and the octopus resemble each other completely, so far as regards the shape and consistency of these parts. In the calamaries, as in the other groups, there are the two stomach-like receptacles; but the first of these cavities has less resemblance to a crop, and in neither is the form the same as in the other kinds, the whole body indeed being made of a softer kind of flesh.

The object of this arrangement of the parts in question is the same as in Birds; for these also are all unable to masticate their food; and therefore it is that a crop precedes their stomach.

For purposes of defence, and to enable them to escape from their foes, the
679a1 Cephalopoda have what is called their ink. This is contained in a membranous pouch, which is attached to the body and provided with a terminal outlet just at the point where what is termed the funnel gives issue to the residua of the stomach. This funnel is placed on the under surface of the animal. All Cephalopoda alike have this characteristic ink, but chief of all the cuttlefish, where it is more abundant than in the rest. When the animal is disturbed and frightened it uses this ink to make the surrounding water black and turbid, and so, as it were, puts a shield in front of its body.

In the Calamaries and the octopus the ink-bag is placed in the upper part of the body, in close proximity to the *mytis,* whereas in the cuttlefish it is lower down, against the stomach. For the cuttlefish has a more plentiful supply of ink than the rest, inasmuch as it makes more use of it. The reasons for this are that it lives near the shore, and that it has no other means of protection; whereas the octopus has its tentacles to use in its defence, and is, moreover, endowed with the power of changing colour. This changing of colour, like the discharge of ink, occurs as the result of fright. As to the calamary, it lives far out at sea, being the only one of the Cephalopoda that does so. Thus the ink is more abundant in the cuttlefish, and this greater abundance explains the lower position; for it allows the ink to be ejected with ease even from a distance. The ink itself is of an earthy character, in this resembling the white deposit on the surface of a bird's excrement, and the explanation in both cases is the same, namely, the absence of a bladder. For it is the ink that serves for the excretion of the earthiest matter. And this is more especially the case in the cuttlefish, because there is a greater proportion of earth in its composition. The earthy character of its bone is a clear indication of this. For in the octopus there is no bone at all, and in the calamary it is thin and cartilaginous. (Why this bone should be present in some Cephalopoda, and wanting in others, and how its character varies in those that have it, has been explained.)

These animals, having no blood, are in consequence cold and of a timid character. Now, in some animals, fear causes a disturbance of the bowels, and, in others, a flow of urine from the bladder. Similarly in these it produces a discharge of ink, and, though the ejection is the result of necessity, like the discharge of urine, yet at the same time nature makes use of this residue for the protection and safety of the animal.

The Crustacea also, both the crayfish and the crabs, are provided with two anterior teeth and between these the tongue-like piece of flesh, as has indeed been already mentioned. Directly after their mouth comes a gullet, which is small in proportion to the body; and then a stomach, which in the crayfish and some of the crabs is furnished with a second set of teeth, the anterior teeth being insufficient for adequate mastication. From the stomach a uniform gut runs in a direct line to the 679b1
excremental vent.

The parts described are to be found also in all the various Testacea. The degree of distinctness, however, with which they are formed varies in the different kinds, and the larger the size of the animal the more easily distinguishable are all these parts severally. In the sea-snails, for example, we find teeth, hard and sharp, as before mentioned, and between them the flesh-like substance, just as in the Crustacea and Cephalopoda, and again the proboscis, which, as has been stated, is something between a sting and a tongue. Directly after the mouth comes a kind of bird-like crop, then a gullet, succeeded by a stomach, in which is the 'poppy', as it is styled; and continuous with this is an intestine, starting directly from it. It is this residual substance which appears in all the Testacea to form the most palatable morsel. The purple murex, the trumpet-shell, and the other spiral-shells resemble the sea-snail. The genera and species of Testacea are very numerous. For there are those with spiral shells, of which some have just been mentioned; and, besides these, there are bivalves and univalves. Those with spiral shells may, indeed, after a certain fashion be said to resemble bivalves. For they all from their very birth have an operculum over that part of their body which is exposed to view. This is the case with the purple murex, the trumpet-shell, the nerites, and the like. Were it not for this, the part which is undefended by the shell would be very liable to injury by collision with external objects. The univalves also are not without protection. For on their upper surface they have a shell, and they attach themselves to the rocks, and so after a manner become bivalved by virtue of this borrowed protection. Of these the animals known as limpets are an example. The bivalves, scallops and mussels, for instance, are protected by the power they have of closing their valves; and the spiral-shells by the operculum just mentioned, which transforms them, as it were, from univalves into bivalves. But of all there is none so perfectly protected as the sea-urchin. For here there is a shell which encloses the body completely, and which is, moreover, set with sharp spines. This peculiarity distinguishes the sea-urchin from all other Testacea, as has already been mentioned.

The structure of the Testacea and of the Crustacea is exactly the reverse of that of the Cephalopoda. For in the latter the fleshy substance is on the outside and the earthy substance within, whereas in the former the soft parts are inside and the hard part without. In the sea-urchin, however, there is no fleshy part whatsoever.

All the other Testacea also possess, as has been said, a mouth with the tongue-like body, a stomach, and a vent for excrement, but they differ from each other in the positions and proportions of these parts. The details, however, of these differences must be looked for in the *History of Animals* and the *Anatomies*. For while there are some points which can be made clear by verbal description, there are others which are more suited for ocular demonstration.

Peculiar among the Testacea are the sea-urchins and the animals known as ascidians. The sea-urchins have five teeth, and in the centre of these the fleshy body which is common to all the animals we have been discussing. Immediately after this comes a gullet, and then the stomach, divided into a number of separate compartments, which look like so many distinct stomachs; for the cavities are separate and all contain abundant residual matter. They are all, however, connected with one and the same oesophagus, and they all end in one and the same excremental vent. There is nothing besides the stomach of a fleshy character, as has already been stated. All that can be seen are the so-called eggs, of which there are several, contained each in a separate membrane, and certain black bodies which have no name, and which, beginning at the animal's mouth, are scattered round its body here and there. These sea-urchins are not all of one species, but there are several different kinds, and in all of them the parts mentioned are to be found. It is not, however, in every kind that the so-called eggs are edible. Neither do these attain to any size in any other species than that with which we are all familiar. A similar distinction may be made generally in the case of all Testacea. For there is a great difference in the edible qualities of the flesh of different kinds; and in some, moreover, the residual substance known as the poppy is good for food, while in others it is uneatable. This in the spiral kinds is lodged in the spiral part of the shell, while in univalves, such as limpets, it occupies the fundus, and in bivalves is placed near the hinge, the so-called egg lying on the right; while on the opposite side is the vent. The former is incorrectly termed egg, for it merely corresponds to what in well-fed sanguineous animals is fat; and thus it is that it makes its appearance at those seasons of the year when they are in good condition, namely, spring and autumn. For no Testacea can abide extremes of temperature, and they are in evil plight in seasons of great cold or heat. This is clearly shown by what occurs in the case of the sea-urchins. For though the eggs are to be found in these animals even directly they are born, yet they acquire a greater size than usual at the time of full moon; not, as some think, because sea-urchins eat more at that season, but because the nights are then warmer, owing to the moonlight. For these creatures are bloodless, and so are unable to stand cold and require warmth. That is why they are found in better condition in summer everywhere except in the Pyrrhean tidal strait. There the sea-urchins flourish as well in winter as in summer. But the reason for this is that they have a greater abundance of food in the winter, because the fish desert the strait at that season.

The number of the eggs is the same in all sea-urchins, and is an odd one. For there are five ova, just as there are also five teeth and five stomachs; and the explanation of this is to be found in the fact that the eggs are not really eggs, but merely, as was said before, the result of the animal's well-fed condition. Oysters also have a so-called egg, corresponding in character to that of the sea-urchins, but existing only on one side of their body. Now inasmuch as the sea-urchin is of a spherical form, and not merely a single disk like the oyster, and in virtue of its spherical shape is the same from whatever side it be examined, its egg must necessarily be of a corresponding symmetry. For the spherical shape has not the asymmetry of the disk-shaped body of the oysters. For in all these animals the head is central, but in the sea-urchin it is at the top. But even so the egg cannot be continuous—for it is not so in the others—but is on one side of the disk only. Thus since this is a common property of them all and the sea-urchin is peculiar in being spherical, this animal cannot possibly have an even number of eggs. For were they an even number, they would have to be arranged exactly opposite to each other, so as to keep the necessary symmetry; and in that case there would be eggs on both sides of the disk. But this is not the case in any of the other shell-fish. For both in the oysters and in the scallops we find the egg only on one side of the circumference. The number then must be uneven, three for instance, or five. But if there were only three they would be much too far apart; while, if there were more than five, they would come to form a continuous mass. The former arrangement would not be for the animal's good, the latter would not be possible. There can therefore be neither more nor less than five. For the same reason the stomach is divided into five parts, and there is a corresponding number of teeth. For seeing that the eggs represent each of them a kind of body for the animal, their disposition must conform to that of the stomach, seeing that it is from this that they derive the material for their growth. Now if there were only one stomach, either the eggs would be too far off from it, or it would be so big as to fill up the whole cavity, and the sea-urchin would have great difficulty in moving about and finding due nourishment for its repletion. As then there are five intervals so are there of necessity five divisions of the stomach, one for each interval. So also, and on like grounds, there are five teeth. For nature is thus enabled to allot one alike to each of the aforementioned parts. These, then, are the reasons why the number of eggs in the sea-urchin is an odd one, and why that odd number is five. In some sea-urchins the eggs are excessively small, in others of considerable size, the explanation being that the latter are of a warmer constitution, and so are able to concoct their food more thoroughly; and that is why the inedible ones tend to be full of residue. Those of a warmer constitution are, moreover, in virtue of their warmth more given to motion, so that they make expeditions in search of food, instead of remaining stationary like the rest. As evidence of this, it will be found that they always have something or other sticking to their spines, as though they moved much about; for they use their spines as feet.

The ascidians differ but slightly from plants, and yet have more of an animal nature than the sponges, which are plants and nothing more. For nature passes from lifeless objects to animals in such unbroken sequence, interposing between them beings which live and yet are not animals, that scarcely any difference seems to exist between two neighbouring groups owing to their close proximity.

A sponge, then, as already said, in these respects completely resembles a plant, that throughout its life it is attached to a rock, and that when separated from this it dies. Slightly different from the sponges are the so-called Holothurias and the sea-lungs, as also sundry other sea-animals that resemble them. For these are free and unattached. Yet they have no sensation, and their life is simply that of a plant separated from the ground. For even among landplants there are some that spring up and grow, either upon other plants, or even entirely free. Such, for example, is the plant which is found on Parnassus, and which some call the rockplant. This you may hang up on a peg and it will yet live for a considerable time. Sometimes ascidians and the like so far resemble plants as that they never live free and unattached, but, on the other hand, inasmuch as they have a certain flesh-like substance, they must be supposed to possess some degree of sensibility—and it is unclear whether they are to be classed as plants or as animals.

An ascidian has a body divided by a single septum and with two orifices, one where it takes in the fluid matter that ministers to its nutrition, the other where it discharges the surplus juice, for it has no visible residual substance, such as have the other Testacea. This is itself a very strong justification for considering an ascidian, and anything else there may be among animals that resembles it, to be a plant; for plants also never have any residuum. Across the middle of the body of these there runs a thin transverse partition, and here it is that we may reasonably suppose the part on which life depends to be situated.

The sea-anemones or sea-nettles, as they are variously called, are not Testacea at all, but lie outside the recognized groups. Their constitution approximates them on one side to plants, on the other to animals. For seeing that some of them can detach themselves and can fasten upon their food, and that they are sensible of objects which come in contact with them, they must be considered to have an animal nature. The like conclusion follows from their using the asperity of their bodies as a protection against their enemies. But, on the other hand, they are closely allied to plants, firstly by the imperfection of their structure, secondly by their being able to attach themselves to the rocks, which they do with great rapidity, and lastly by their having no visible residuum notwithstanding that they possess a mouth.

Very similar again are the Starfishes. For these also fasten on their prey, and suck out its juices, and thus destroy a vast number of oysters. At the same time they present a certain resemblance to such of the animals we have described as the Cephalopoda and Crustacea, inasmuch as they are free and unattached. The same may also be said of the Testacea.

Such, then, is the structure of the parts that minister to nutrition and which every animal must necessarily possess. But besides these organs it is quite plain that in every animal there must be some part or other which shall be analogous to what in sanguineous animals is the presiding seat of sensation. In the Cephalopoda this part consists of a fluid substance contained in a membrane, through which runs the gullet on its way to the stomach. It is attached to the body rather towards its upper surface, and by some is called the *mytis*. Just such another organ is found also in the Crustacea and there too is known by the same name. This part is at once fluid and corporeal and, as before said, is traversed by the gullet. For had the gullet been placed between the *mytis* and the upper surface of the animal, the hardness of the back would have interfered with its due dilatation as the food enters. On the outer surface of the *mytis* runs the intestine; and in contact with this latter is placed the ink-bag, so that it may be removed as far as possible from the mouth and its obnoxious fluid be kept at a distance from the nobler and sovereign part. The position of the *mytis* shows that it corresponds to the heart of sanguineous animals; for it occupies the self-same place. The same is shown by the sweetness of its fluid, which has the character of concocted matter and resembles blood.

In the Testacea the presiding seat of sensation is in a corresponding position, but is less easily made out. It should, however, always be looked for in some midway position; namely, in such Testacea as are stationary, midway between the part by which food is taken in and the channel through which either the excrement or the spermatic fluid is voided, and, in those species which are capable of locomotion, invariably midway between the right and left sides.

In Insects the organ which is the seat of sensation, lies, as was stated in the first treatise, between the head and the cavity which contains the stomach. In most of them it consists of a single part; but in others, for instance in such as have long bodies and resemble the centipede, it is made up of several parts, so that such insects continue to live after they have been cut in pieces. For the aim of nature is to give to each animal only one such dominant part; and when she can, she makes it a unity; when she cannot, a plurality. This is much more clearly marked in some insects than in others.

The parts concerned in nutrition are not alike in all insects, but show considerable diversity. Thus some have what is called a sting in the mouth, which is a kind of compound instrument that combines in itself the character of a tongue and of lips. In others that have no such instrument in front there is a part behind the teeth that answers the same sensory purposes. Immediately after the mouth comes the intestine, which is never wanting in any insect. This runs in a straight line and without further complication to the vent; occasionally, however, it has a spiral coil. There are, moreover, some insects in which a stomach succeeds to the mouth, and is itself succeeded by a convoluted intestine, so that the larger and more voracious insects may be enabled to take in a more abundant supply of food. More peculiar than any are the Cicadae. For here the mouth and the tongue are united so as to form a single part, through which, as through a root, the insect sucks up the fluids on which it lives. Insects are always small eaters, not so much because of their diminutive size as because of their cold temperament. For it is heat which requires sustenance; just as it is heat which speedily concocts it. But cold requires no sustenance. In no insects is this so conspicuous as in these Cicadae. For they find enough to live on in the moisture which is deposited from the air. So also do the Ephemera that are found about the Black Sea. But while these latter only live for a single day, the Cicadae subsist on such food for several days, though still not many.

We have now done with the internal parts of animals, and must therefore return to the consideration of the external parts which have not yet been described. It will be better to begin with the animals we have just been describing, rather than from the point at which we left off, so that proceeding from these, which require less discussion, our account may have more time to spend on the perfect kinds of animals, those namely that have blood.

6 · Insects, though they present no great multiplicity of parts, are not without diversities when compared with each other. They are all many-footed; the object of this being to compensate their natural slowness and frigidity, and give greater activity to their motions. Accordingly we find that those which, as the centipedes, have long bodies, and are therefore the most liable to refrigeration, have also the greatest number of feet. Again, the body in these animals is insected—the reason for this being that they have not got one vital centre but many—and the number of their feet corresponds to that of the insections.[17]

Should the feet fall short of this, their deficiency is compensated by the power of flight. Of such flying insects some live a wandering life, and are forced to make long expeditions in search of food. These have a body of light weight, and four wings, two on either side, to support it. Such are bees and the insects akin to them; for they have two wings on each side. When, however, such insects are of very small bulk, their wings are reduced to two, as is the case with flies. Insects with heavy bodies and of stationary habits, though not polypterous in the same way as bees, yet have sheaths to their wings to maintain their efficiency. Such are the Melolonthae and the like. For their stationary habits expose their wings to much greater risks than are run by those of insects that are more constantly in flight, and on this

[17] Reading *κατὰ ταύτας*.

account they are provided with this protecting shield. The wing of an insect has neither divisions nor shaft. For it is no wing at all, but merely a skin-like membrane that, owing to its dryness, necessarily becomes detached from the surface of the body, as the fleshy substance grows cold.

These animals then have their bodies insected, not only for the reasons already assigned, but also to enable them to curl round in such a manner as may protect them from injury; for such insects as have long bodies can roll themselves up, which would be impossible were it not for the insections; and those that cannot do this can yet draw their segments up and so increase the hardness of their bodies. This can be felt quite plainly by putting the finger on one of the insects, for instance, known as dung-beetles. The touch frightens the insect, and it remains motionless, while its body becomes hard. The division of the body into segments is necessary; for that they have several controlling sources is a constituent of their substances, and is a character which approximates them to plants. For as plants, though cut into pieces, can still live, so also can insects. There is, however, this difference between the two cases, that the portions of the divided insect live only for a limited time, whereas the portions of the plant actually attain the perfect form of the whole, so that from one single plant you may obtain two or more.

Some insects are also provided with another means of protection against their enemies, namely a sting. In some this is in front, connected with the tongue, in others behind at the posterior end. For just as the organ of smell in elephants answers several uses, serving alike as a weapon and for purposes of nutrition, so does also the sting, when placed in connexion with the tongue, as in some insects, answer more than one end. For it is the instrument through which they derive their sensations of food, as well as that with which they suck it up and bring it to the mouth. Such of these insects as have no anterior sting are provided with teeth, which serve in some of them for biting the food, and in others for its prehension and conveyance to the mouth. Such are their uses, for instance, in ants and all the various kinds of bees. As for the insects that have a sting behind, this weapon is given them because they are of a fierce disposition. In some of them the sting is lodged inside the body, in bees, for example, and wasps. For these insects are made for flight, and were their sting external and of delicate make it would soon get spoiled; and if, on the other hand, it were of thicker build, as in scorpions, its weight would be an incumbrance. As for scorpions that live on the ground and have a tail, their sting must be set upon this, as otherwise it would be of no use as a weapon. Dipterous insects never have a posterior sting. For the very reason of their being dipterous is that they are small and weak, and therefore require no more than two feathers to support their light weight; and for the same reason their sting is in front; for their strength is not sufficient to allow them to strike efficiently with the hinder part of their body. Polypterous insects, on the other hand, are of greater bulk and hence have more wings and are stronger in their hinder parts. Now it is better, when possible, that one and the same instrument shall not be made to serve several dissimilar uses; but that there shall be one organ to serve as a weapon, which can then be very sharp, and a distinct one to serve as a tongue, which can then be of

spongy texture and fit to absorb nutriment. Whenever, therefore, nature is able to provide two separate instruments for two separate uses, without the one hampering the other, she does so, instead of acting like a coppersmith who for cheapness makes a spit and lampholder in one. It is only when this is impossible that she uses one organ for several functions. The anterior legs are in some cases longer than the others, that they may serve to wipe away any foreign matter that may lodge on the insect's eyes; for their sight is not very distinct owing to the eyes being made of a hard substance. Flies and bees and the like may be constantly seen thus dressing themselves with crossed forelegs. Of the other legs, the hinder are bigger than the middle pair, both to aid in walking and also that the insect, when it takes flight, may spring more easily from the ground. This difference is still more marked in such insects as leap, in locusts for instance, and in the various kinds of fleas. For these first bend and then extend the legs, and, by doing so, are necessarily shot up from
683b1 the ground. It is only the hind legs of locusts, and not the front ones, that resemble the steering oars of a ship. For this requires that the joint shall be deflected inwards, and such is never the case with the anterior limbs. The whole number of legs, including those used in leaping, is six in all these insects.

7 · In the Testacea the body consists of but few parts, the reason being that these animals live a stationary life. For such animals as move much about must of necessity have more numerous parts than such as remain quiet; for their activities are many, and the more the movements the greater the number of organs required to effect them. Some species of Testacea are absolutely motionless, and others not quite but nearly so. Nature, however, has provided them with a protection in the hardness of the shell with which she has invested their body. This shell, as already has been said, may have one valve, or two valves, or be spiral. In the latter case it may be either helical, as in trumpet-shells, or spherical, as in sea-urchins. When it has two valves, these may be gaping, as in scallops and mussels, where the valves are united together on one side only, so as to open and shut on the other; or they may be united together on both sides, as in the razor-fish. In all cases alike the Testacea have, like plants, the head downwards. The reason for this is, that they take in their nourishment from below, just as do plants with their roots. Thus the under parts come in them to be above, and the upper parts to be below. The body is enclosed in a membrane, and through this the animal filters fresh water and absorbs its nutriment. In all there is a head; but none of the parts, excepting this recipient of food, has any distinctive name.

8 · All the Crustacea can crawl as well as swim, and accordingly they are provided with numerous feet. There are four main genera, viz. the crayfish, the lobsters, the prawns, and the crabs. In each of these genera, again, there are numerous species, which differ from each other not only as regards shape, but also very considerably as regards size. For, while in some species the individuals are large, in others they are excessively minute. The crabs and crayfish resemble each other in possessing claws. These claws are not for locomotion, but to serve in place of

hands for seizing and holding objects; and they are therefore bent in the opposite direction to the feet, being so twisted as to turn their convexity towards the body, while their feet turn towards it their concavity. For in this position the claws are best suited for laying hold of the food and carrying it to the mouth. The distinction between the crayfish and the crabs consists in the former having a tail while the latter have none. For the crayfish swim about and a tail is therefore of use to them, serving for their propulsion like the blade of an oar. But it would be of no use to the crabs; for these animals live habitually close to the shore, and creep into holes and corners. In such of them as live out at sea, the feet are much less adapted for locomotion than in the rest, because they are little given to moving about but depend for protection on their shell-like covering. The Maiae and the crabs known as Heracleotic are examples of this; the legs in the former being very thin, in the latter very short.

The very minute crabs that are found among the small fry have their hindermost feet flattened out into the semblance of fins or oar-blades, so as to help the animal in swimming.

The prawns are distinguished from the crabs by the presence of a tail; and from the crayfish by the absence of claws. This is explained by their large number of feet, on which has been expended the material for the growth of claws. Their feet again are numerous to suit their mode of progression, which is mainly by swimming.

Of the parts on the under surface, those near the head are in some of these animals formed like gills, for the admission and discharge of water; while the parts lower down in the female crayfish are more laminar than in the males, and in the female crabs the flap is furnished with hairier appendages. For the females retain their eggs in these parts instead of letting them go free, as do fishes and all other oviparous animals; for the appendages are broader and provide more room for the eggs. In the crayfish and in the crabs the right claw is invariably the larger and the stronger. For it is natural to every animal in active operations to use the parts on its right side in preference to those on its left; and nature invariably assigns each organ, either exclusively or in a more perfect condition, to such animals as can use it. So it is with tusks, and teeth, and horns, and spurs, and all such defensive and offensive weapons.

In the lobsters alone it is a matter of chance which claw is the larger, and this in either sex. Claws they must have, because they belong to a genus in which this is a constant character; but they have them in this indeterminate way, owing to imperfect formation and to their not using them for their natural purpose, but for locomotion.

For a detailed account of the several parts of these animals, of their position and their differences, those parts being also included which distinguish the sexes, reference must be made to the *Anatomies* and to the *History of Animals*.

9 · We come now to the Cephalopoda. Their internal organs have already been described with those of other animals. Externally there is the trunk of the body, not distinctly defined, and in front of this the head surrounded by feet, which

form a circle about the mouth and teeth, and are set between these and the eyes. Now in all other animals the feet, if there are any, are disposed in one of two ways; either before and behind or along the sides, the latter being the plan in such of them, for instance, as are bloodless and have numerous feet. But in the Cephalopoda there is a peculiar arrangement, different from either of these. For their feet are all placed at what may be called the fore end. The reason for this is that the hind part of their body has been drawn up close to the fore part, as is also the case in the spiral Testacea. For the Testacea, while in some points they resemble the Crustacea, in others resemble the Cephalopoda. Their earthy matter is on the outside, and their fleshy substance within. So far they are like the Crustacea. But the general plan of their body is that of the Cephalopoda; and, though this is true in a certain degree of all the Testacea, it is more especially true of those turbinated species that have a spiral shell. For[18] both classes have this nature; and that is why they walk evenly, unlike quadrupeds and men. Now men have their mouth in their head, i.e. in the upper part of their body; next comes the gullet, then the stomach, then the gut which extends to the vent for the residue. That is the arrangement in the sanguinea, i.e. the head is followed by what is called the thorax and the parts about it; the remaining parts, such as the anterior and posterior limbs, having been superadded by nature, to minister to these and for locomotion.

In the Crustacea also and in Insects there is a tendency to a similar arrangement of the internal parts in a straight line; the distinction between these groups and the sanguineous animals depending on differences of the external organs which minister to locomotion. But the Cephalopoda and the spiral Testacea have in common an arrangement which stands in contrast with this. For here the two extremities are brought together by a curve, as if one were to bend the straight line until *D* came close to *A*. Such, then, is the disposition of the internal parts; and round these, in the Cephalopoda, is placed the sac (in the octopus alone called a head), and, in the Testacea, the spiral shell which corresponds to the sac. There is, in fact, only this difference between them, that the investing substance of the Cephalopoda is soft while the shell of the Testacea is hard, nature having surrounded their fleshy part with this hard coating as a protection because of their limited power of locomotion. For this reason, in both classes the excrement is voided near the mouth; at a point below this orifice in the Cephalopoda, and in the spiral-shells on one side of it.

Such, then, is the explanation of the position of the feet in the Cephalopoda, and of the contrast they present to other animals in this matter. The arrangement, however, in the cuttlefish and the calamaries is not precisely the same as in the octopus, owing to the former having no other mode of progression than by swimming, while the latter not only swim but crawl. For in the former six of the feet are above the teeth and small, the outer one on either side being the biggest; while the remaining two of the eight are below the mouth and are the biggest of all, just as the hind limbs in quadrupeds are stronger than the fore limbs. For it is these that have to support the weight, and to take the main part in locomotion. And the outer

[18]The Greek text of the next two sentences is corrupt: Peck's text, which is translated here, draws heavily on the Arabic version.

two are bigger than the pair which intervene between them because they have to assist the lowermost pair in their office. In the octopus, on the other hand, the four central feet are the biggest. Again, though the number of feet is the same in all the Cephalopoda, namely eight, their length varies in different kinds, being short in the cuttlefish and the calamaries, but greater in the octopus. For in these latter the trunk of the body is of small bulk, while in the former it is of considerable size; and so in the one case nature has used the materials subtracted from the body to give length to the feet, while in the other she has given to the growth of the body what she has first taken from the feet. The octopus then, owing to the length of their feet, can not only swim but crawl, whereas in the other genera the feet are useless for the latter mode of progression, being small while the bulk of the body is considerable. These short feet would not enable their possessors to cling to the rocks and keep themselves from being torn off by the waves when these run high in times of storm; neither would they serve to lay hold of objects at all remote and bring them in; but, to supply these defects, the animal is furnished with two long proboscises, by which it can moor itself and ride at anchor like a ship in rough weather, and by which it can catch prey at a distance and to bring it to the mouth. They are so used by both the cuttlefish and the calamaries. In the octopus the feet are themselves able to perform these offices, and there are consequently no proboscises. Some animals have suckers and tentacles as well as feet; and these have the same capacity and structure as those plaited instruments which were used by physicians of old to reduce dislocations of the fingers. Like these they are made by the interlacing of their fibres, and they act by pulling upon pieces of flesh and yielding substances. For they encircle an object in a slackened condition, and when they are put on the stretch they grasp and cling tightly to whatever it may be that is in contact with their inner surface. Since, then, the Cephalopoda have no other instruments with which to convey anything to themselves from without, than either feet, as in some species or proboscises as in others, they are provided with these to serve as hands for offence and defence and other uses.

The suckers are set in double line in all the Cephalopoda excepting in one kind of octopus where there is but a single row. The length and the slimness which is part of the nature of this kind of octopus explain the exception. For a narrow space cannot possibly admit of more than a single row. This exceptional character, then, belongs to them, not because it is the most advantageous arrangement, but because it is the necessary consequence of the special nature of their substance.

In all these animals there is a fin, encircling the sac. In the octopus and the cuttlefish this fin is unbroken and continuous, as is also the case in the larger calamaries. But in the smaller kind, called Teuthides, the fin is not only broader than in the cuttlefish and the octopus where it is narrow, but, moreover, does not encircle the entire sac, but only begins in the middle of the side. The use of this fin is to enable the animal to swim, and also to direct its course. It acts, that is, like the rump-feathers in birds, or the tail-fin in fishes. In none is it so small or so indistinct as in the octopus. For in these the body is of small bulk and can be steered by the feet sufficiently well.

The Insects, the Crustacea, the Testacea, and the Cephalopoda, have now been dealt with in turn; and their parts have been described, whether internal or external.

10 · We must now go back to the vivipara that have blood, and consider such of their parts, already enumerated, as were before passed over. When we have done with these, we will pass on to the oviparous sanguinea, and treat of them in like manner.

The parts that border on the head, and on what is known as the neck and throat, have already been taken into consideration. All animals that have blood have a head; whereas in some bloodless animals, such as crabs, the part which represents a head is not clearly defined. As to the neck, it is present in all the Vivipara, but only in some of the Ovipara; for while those that have a lung also have a neck those that do not inhale the outer air have none.

The head exists mainly for the sake of the brain. For every animal that has blood must of necessity have a brain; and must, moreover, for reasons already given, have it placed in an opposite region to the heart. But the head has also been chosen by nature as the part in which to set some of the senses; because its blood is mixed in such suitable proportions as to ensure their tranquillity and precision, while at the same time it can supply the brain with such warmth as it requires. There is yet a third constituent superadded to the head, namely the part which ministers to the ingestion of food. This has been placed here by nature, because such a situation accords best with the general configuration of the body. For the stomach could not possibly be placed above the heart, seeing that this is the sovereign organ; and if placed below, as in fact it is, then the mouth could not possibly be placed there also. For this would have necessitated a great increase in the length of the body; and the stomach, moreover, would have been removed too far from the source of motion and of concoction.

The head, then, exists for the sake of these three parts; while the neck, again, exists for the sake of the windpipe. For it acts as a defence to this and to the oesophagus, encircling them and keeping them from injury. In all other animals this neck is flexible and contains several vertebrae; but in wolves and lions it contains only a single bone. For the object of nature was to give these animals an organ which should be serviceable in the way of strength, rather than for other purposes.

Continuous with the head and neck is the trunk with the anterior limbs. In man the forelegs and forefeet are replaced by arms and by what we call hands. For of all animals man alone stands erect, in accordance with his god-like nature and substance. For it is the function of the god-like to think and to be wise; and no easy task were this under the burden of a heavy body, pressing down from above and obstructing by its weight the motions of the intellect and of the general sense. When, moreover, the weight and corporeal substance become excessive, the body must of necessity incline towards the ground. In such cases therefore nature, in order to give support to the body, has replaced the arms and hands by forefeet, and has thus converted the animal into a quadruped. For, as every animal that walks must of necessity have the two hinder feet, such an animal becomes a quadruped, its body inclining downwards in front from the weight which its soul cannot sustain. For all animals, man alone excepted, are dwarf-like in form. For the dwarf-like is that in which the upper part is large, while that which bears the weight and is used in progression is small. This upper part is what we call the trunk, which reaches from the mouth to the vent. In man it is duly proportionate to the part below, and diminishes much in its comparative size as the man attains to full growth. But in his infancy the contrary obtains, and the upper parts are large, while the lower part is small, so that the infant can only crawl, and is unable to walk; and at first cannot even crawl, but remains without motion. For all children are dwarfs in shape, but cease to be so as they become men, from the growth of their lower part; whereas in quadrupeds the reverse occurs, their lower parts being largest in youth, and advance of years bringing increased growth above, that is in the trunk, which extends from the rump to the head. Thus it is that foals are scarcely, if at all, below horses in height; and that while still young they can touch their heads with the hind legs, though this is no longer possible when they are older. Such, then, is the form of animals that have either a solid or a cloven hoof. But such as are polydactylous and without horns, though they too are of dwarf-like shape, are so in a less degree; and therefore the greater growth of the lower parts as compared with the upper is also small, being proportionate to this smaller deficiency.

Dwarf-like again is the race of birds and fishes; and so in fact, as already has been said, is every animal that has blood. This is the reason why no other animal is so intelligent as man. For even among men themselves if we compare children with adults, or such adults as are of dwarf-like shape with such as are not, we find that, whatever other superiority the former may possess, they are at any rate deficient as compared with the latter in intelligence. The explanation, as already stated, is that in many their psychical principle is corporeal and impeded in its motions. Let now a further decrease occur in the elevating heat, and a further increase in the earthly matter, and the animals become smaller in bulk, and their feet more numerous, until at a later stage they become footless and extended full length on the ground. Then, by further small successions of change, they come to have their principal organ below; and at last the part which answers to a head becomes motionless and destitute of sensation. Thus the animal becomes a plant, that has its upper parts downwards and its lower parts above. For in plants the roots are the equivalents of mouth and head, while the seed has an opposite significance, for it is produced above at the extremities of the twigs.

The reasons have now been stated why some animals have many feet, some only two, and others none; why, also, some living things are plants and others animals; and, lastly, why man alone of all animals stands erect. Standing thus erect, man has no need of legs in front, and in their stead has been endowed by nature with arms and hands. Now it is the opinion of Anaxagoras that the possession of these hands is the cause of man being of all animals the most intelligent. But it is more rational to suppose that man has hands because of his superior intelligence. For the hands are instruments, and the invariable plan of nature in distributing the organs is to give each to such animal as can make use of it; nature acting in this matter as any prudent man would do. For it is a better plan to take a person who is already a flute-player and give him a flute, than to take one who possesses a flute and teach him the art of flute-playing. For nature adds that which is less to that which is greater and more important, and not that which is more valuable and greater to that which is less. Seeing then that such is the better course, and seeing also that of what is possible nature invariably brings about the best, we must conclude that man does not owe his superior intelligence to his hands, but his hands to his superior intelligence. For the most intelligent of animals is the one who would put the most organs to good use; and the hand is not to be looked on as one organ but as many; for it is, as it were, an instrument for further instruments. This instrument, therefore,—the hand—of all instruments the most variously serviceable, has been given by nature to man, the animal of all animals the most capable of acquiring the most varied arts.

Much in error, then, are they who say that the construction of man is not only faulty, but inferior to that of all other animals; seeing that he is, as they point out, barefooted, naked, and without weapon of which to avail himself. For other animals have each but one mode of defence, and this they can never change; so that they must perform all the offices of life and even, so to speak, sleep with sandals on, never laying aside whatever serves as a protection to their bodies, nor changing such single weapon as they may chance to possess. But to man numerous modes of defence are open, and these, moreover, he may change at will; as also he may adopt such weapon as he pleases, and at such places as suit him. For the hand is talon, hoof, and horn, at will. So too it is spear, and sword, and whatsoever other weapon or instrument you please; for all these can it be from its power of grasping and holding them all. In harmony with this varied office is the form which nature has contrived for it. For it is split into several divisions, and whereas being compounded is contained in being divided, the reverse is not the case. The divisions also may be used singly or two together and in various combinations. The joints, moreover, of the fingers are well constructed for prehension and for pressure. One of these also, short and thick but not long, is placed laterally. For were it not so placed all prehension would be as impossible, as were there no hand at all. For the pressure of this digit is applied from below upwards, while the rest act from above downwards; an arrangement which is essential, if the grasp is to be firm and hold like a tight clamp. As for the shortness of this digit, the object is to increase its strength, so that it may be able, though but one, to counterbalance the other four.[19] Moreover, were it long it would be of no use. (The finger which stands at the end is small, while the central one of all is long, like a centre oar in a ship. This is rightly so; for it is mainly by the central part of the encircling grasp that a tool must be held when put to use.) And for this reason it is called the great finger, though it is small, because the others are pretty well useless without it.

No less skilfully contrived are the nails. For, while in man these serve simply as coverings to protect the tips of the fingers, in other animals they are also used for active purposes.

The arms in man and the fore limbs in quadrupeds bend in contrary directions,

[19]Transposing ἵνα . . . πολλοῖς to follow τὴν ἰσχύν.

this difference having reference to the conveying of food and to the other offices which belong to these parts. For quadrupeds must of necessity bend their anterior limbs inwards that they may serve in locomotion; for they use them as feet. Not but what even among quadrupeds there is at any rate a tendency for such as are polydactylous to use their forefeet not only for locomotion but as hands. And they are in fact so used, as any one may see. For these animals seize hold of objects, and also repel assailants with their anterior limbs; whereas quadrupeds with solid hoofs use their hind legs for this latter purpose. For their fore limbs are not analogous to the elbows and hands of man.

It is this which explains why in some of the polydactylous quadrupeds, such as wolves, lions, dogs, and leopards, there are actually five digits on each forefoot, though there are only four on each hind one. For the fifth digit of the foot corresponds to the fifth digit of the hand, and like it is called the big one. It is true that in the smaller polydactylous quadrupeds the hind feet also have each five toes. But this is because these animals are creepers; and the increased number of nails serves to give them a tighter grip, and so enables them to creep up steep places with greater facility, or even to run head downwards.

In man between the arms, and in other animals between the forelegs, lies what is called the chest. This in man is broad, as one might expect; for as the arms are set laterally on the body, they offer no impediment to such expansion in this part. But in quadrupeds the chest is narrow, owing to the legs having to be extended in a forward direction in progression and locomotion.

For this reason the breasts of quadrupeds are never placed on the chest. But in the human body there is ample space in this part; moreover, the heart and neighbouring organs require protection, and for these reasons this part is fleshy and the breasts are placed upon it separately, being themselves of a fleshy substance in the male for the reason just stated; while in the female, nature, in accordance with what we say is her frequent practice, makes them minister to an additional function, employing them as a store-place of nutriment for the offspring. The human breasts are two in number, in accordance with the division of the body into two halves, a right and a left. They are somewhat firmer and divided, because the ribs in this region are joined together and because their presence is not burdensome. In other animals it is impossible for the breasts to be placed on the chest between the forelegs, for they would interfere with locomotion; they are therefore disposed of in a variety of ways. Thus in such animals as produce but few at a birth, whether horned quadrupeds or those with solid hoofs, the breasts are placed in the region of the thighs, and are two in number, while in such as produce litters, or such as are polydactylous, they are either numerous and placed laterally on the belly, as in pigs and dogs, or are only two in number, being set, however, in the centre of the abdomen, as in the case in the lion. The explanation of this is not that the lion produces few at a birth, for sometimes it has more than two cubs at a time, but is to be found in the fact that this animal has no plentiful supply of milk. For, being a flesh-eater, it gets food at but rare intervals, and such nourishment as it obtains is all expended on the growth of its body.

In the elephant also there are but two breasts which are placed under the pits of the forelimbs. The breasts are not more than two, because this animal has only a single young one at a birth; and they are not placed in the region of the thighs, because they never occupy that position in any polydactylous animal such as this. Lastly, they are placed above, close to the armpits, because this is the position of the foremost breasts in all animals whose breasts are numerous, and they give the most milk. Evidence of this is furnished by the sow. For she always presents these foremost teats to the first-born of her litter. A single young one is of course a first-born, and so such animals as only produce a single young one must have these first breasts, and the first breasts are those under the armpits. This, then, is the reason why the elephant has but two breasts, and why they are so placed. But, in such animals as have litters of young, the teats are disposed about the belly; the reason being that more teats are required by those that will have more young to nourish. Now it is impossible that these should be set transversely in rows of more than two, one, that is, for each side of the body, the right and the left; they must therefore be placed lengthways, and the only place where there is sufficient length for this is the region between the front and hind legs. As to the animals that are not polydactylous but produce few at a birth, or have horns, their breasts are placed in the region of the thighs. The horse, the ass, the camel are examples; all of which bear but a single young one at a time, and of which the two former have solid hoofs, while in the last the hoof is cloven. As still further examples may be mentioned the deer, the ox, the goat, and all other similar animals.

The explanation is that in these animals growth takes place in an upward direction; so that there must be an abundant collection of residual matter and of blood in the lower region, that is to say in the neighbourhood of the orifices for efflux, and here therefore nature has placed the breasts. For the place in which the nutriment is set in motion must also be the place whence nutriment can be derived by them. In man there are breasts in the male as well as in the female; but some of the males of other animals are without them. Such, for instance, is the case with horses, some stallions being destitute of these parts, while others that resemble their dams have them. Thus much then concerning the breasts.

Next after the chest comes the region of the belly, which is left unenclosed by
689a1 the ribs for a reason which has already been given; namely that there may be no impediment to the swelling which necessarily occurs in the food as it gets heated, not to the expansion of the womb in pregnancy.

At the extreme end of what is called the trunk are the parts concerned in the evacuation of the solid and of the fluid residue. In all sanguineous animals with some few exceptions, and in all Vivipara without any exception at all, the same part which serves for the evacuation of the fluid residue is also made by nature to serve in sexual congress, and this alike in male and female. For the semen is a kind of fluid and residual matter. (The proof of this will be given hereafter, but for the present let it be taken for granted.) The like holds good of the menstrual fluid in women, and of the part where they emit semen. This also, however, is a matter of which a more accurate account will be given hereafter. For the present let it be simply stated as a fact, that the menstrual fluids of the female are also residual matter. Both of them, moreover, being fluid, it is only natural that things which are alike should be discharged into the same parts. Of the internal structure of these parts, and of the differences which exist between the parts concerned with semen and the parts concerned with conception, a clear account is given in the *History of Animals* and in the *Anatomies*. Moreover, I shall have to speak of them later in the work *On Generation*. As regards, however, the external shape of these parts, it is plain enough that they are adapted to their operations, as indeed of necessity they must be. There are, however, differences in the male organ corresponding to differences in the body generally. For all animals are not of an equally sinewy nature. This organ, again, is the only one that, independently of any morbid change, admits of augmentation and of diminution of bulk. The former condition is of service in copulation, while the other is required for the advantage of the body at large. For, were the organ constantly in the former condition, it would be an incumbrance. The organ therefore has been formed of such constituents as will admit of either state. For it is partly sinewy, partly cartilaginous, and thus is enabled either to contract or to become extended, and is capable of admitting air.

All female quadrupeds are retromingent, because the position of the parts which this implies is useful to them in the act of copulation. This is the case with only some few males, such as the lynx, the lion, the camel, and the hare. No quadruped with a solid hoof is retromingent.

The posterior portion of the body and the parts about the legs are peculiar in man as compared with quadrupeds. Nearly all these latter have a tail, and this whether they are viviparous or oviparous. For, even if the tail be of no great size, yet they have a kind of stump as at any rate a small representative of it. But man is tail-less. He has, however, buttocks, which exist in none of the quadrupeds. His legs also are fleshy (as too are his thighs and calves); while the legs in all other animals that have any, whether viviparous or not, are fleshless, being made of sinew and bone and spinous substance. For all these differences there is, so to say, one common explanation, and this is that of all animals man alone stands erect. It was to facilitate the maintenance of this position that nature made his upper parts light, taking away some of their corporeal substance, and using it to increase the weight of the parts below, so that the buttocks, the thighs, and the calves of the legs were all made fleshy. The character which she thus gave to the buttocks renders them at the same time useful in resting the body. For standing causes no fatigue to quadrupeds, and even the long continuance of this posture produces in them no weariness; for they are supported the whole time by four props, which is much as though they were lying down. But to man it is no easy task to remain for any length of time on his feet, his body demanding rest in a sitting position. This, then, is the reason why man has buttocks and fleshy legs; and the presence of these fleshy parts explains why he has no tail. For the nutriment which would otherwise go to the tail is used up in the production of these parts, while at the same time the existence of buttocks does away with the necessity of a tail. But in quadrupeds and other animals the reverse obtains. For they are of dwarf-like form, so that all the pressure of their weight and corporeal substance is on their upper part, and is withdrawn from the parts below.

On this account they are without buttocks and have hard legs. In order, however, to cover and protect that part which serves for the evacuation of excrement, nature has given them a tail of some kind or other, subtracting for the purpose some of the nutriment which would otherwise go to the legs. Intermediate in shape between man and quadrupeds is the ape, belonging therefore to neither or to both, and having on this account neither tail nor buttocks; no tail in its character of biped, no buttocks in its character of quadruped. There is a great diversity of so-called tails; and this organ like others is sometimes used by nature for by-purposes, being made to serve not only as a covering and protection to the fundament, but also for other uses and advantages of its possessor.

There are differences in the feet of quadrupeds. For in some of these animals there is a solid hoof, and in others a hoof cloven into two, and again in others a foot divided into many parts.

The hoof is solid when the body is large and the earthy matter present in great abundance; in which case the earth, instead of forming teeth and horns, is separated in the character of a nail, and being very abundant forms one continuous nail, that is a hoof, in place of several. This explains why these animals, as a rule, have no huckle-bones; a second reason being that the presence of such a bone in the joint of the hind leg somewhat impedes its free motion. For extension and flexion can be made more rapidly in parts that have but one angle than in parts that have several. But the presence of a huckle-bone, as a connecting bolt is the introduction as it were of a new limb between the two. Such an addition adds to the weight of the foot, but renders the act of progression more secure. Thus it is that in such animals as have a huckle-bone, it is only in the posterior and not in the anterior limbs that this bone is found. For the anterior limbs, moving as they do in advance of the others, require to be light and capable of ready flexion, whereas firmness and extensibility are what are wanted in the hind limbs. Moreover, a huckle-bone adds weight to the blow of a limb, and so renders it a suitable weapon of defence; and these animals all use their hind legs to protect themselves, kicking out against anything which annoys them. In the cloven-hoofed quadrupeds the lighter character of the hind legs admits of there being a huckle-bone; and the presence of the huckle-bone prevents them from having a solid hoof, the bony substance remaining in the joint, and therefore being deficient in the foot. As to the polydactylous quadrupeds, none of them have huckle-bones. For if they had they would not be polydactylous, but the divisions of the foot would only extend to that amount of its breadth which was covered by the huckle-bone. Thus it is that most of the animals that have huckle-bones are cloven-hoofed.

Of all animals man has the largest foot in proportion to the size of the body. This is only what might be expected. For seeing that he is the only animal that stands erect, the two feet which are going to bear all the weight of the body must be both long and broad. Equally intelligible is it that the proportion between the size of the fingers and that of the whole hand should be inverted in the case of the toes and feet. For the function of the hands is to take hold of objects and retain them by pressure; so that the fingers require to be long. For it is by its flexed portion that the hand grasps an object. But the function of the feet is to enable us to stand securely, and for this the undivided part of the foot requires to be of larger size than the toes. And it is better for the extremity to be divided than to be undivided. For in an undivided foot disease of any one part would extend to the whole organ; whereas, if the foot be divided into separate digits, there is not an equal liability to such an occurrence. The digits, again, by being short would be less liable to injury. For these reasons the feet in man are many-toed, while the separate digits are of no great length. The toes, finally, are furnished with nails for the same reason as are the fingers, namely because the tips are weak and therefore require special protection.

11 · We have now done with practically all the sanguineous animals that live on land and bring forth their young alive. Of the oviparous Sanguinea, some have four feet, while others have none. The latter form a single genus, namely the serpents; and why these are footless has been already explained in the remarks *On the Progression of Animals*. But in other respects serpents resemble the oviparous quadrupeds in their conformation.

In all these animals there is a head with its component parts; its presence being determined by the same causes as obtain in the case of other sanguineous animals; and in all, with the single exception of the river crocodile, there is a tongue inside the mouth. In this one exception there would seem to be no actual tongue, but merely a space left vacant for it. The reason is that a crocodile is in a way a land-animal and a water-animal combined. In its character of land-animal it has a space for a tongue; but in its character of water-animal it is without the tongue itself. For in some fishes, as has already been mentioned, there is no appearance whatsoever of a tongue, unless the mouth be stretched open very widely indeed; while in others it is indistinctly separated from the rest of the mouth. The reason for this is that a tongue would be of but little service to such animals, seeing that they are unable to chew their food or to taste it beforehand, the pleasurable sensations they derive from it occurring during swallowing. For it is in their passage down the gullet that solid edibles cause enjoyment, while it is by the tongue that the savour of fluids is perceived. Thus it is during swallowing that the oiliness, the heat, and other such qualities of food are recognized. Now the Vivipara too have this power of perception (and in fact the satisfaction from most solid edibles and dainties is derived almost entirely from the dilatation of the oesophagus during swallowing—that is why the same animals are not intemperate both with regard to tasty drinks and with regard to dainty foods); but while other animals have in addition the sensation of taste, tongueless animals lack it and have the other sensation only.

In some oviparous quadrupeds, namely in lizards, the tongue is bifid, as also it is in serpents, and its terminal divisions are of hair-like fineness, as has already been described. (Seals also have a forked tongue.) This is why all these animals are fond of dainty food. The teeth in the four-footed Ovipara are of the saw-like kind, like the teeth of fishes. The organs of all the senses are present and resemble those of other animals. Thus there are nostrils for smell, eyes for vision, and ears for hearing. The latter organs, however, do not project from the sides of the head, but consist simply of the duct, as also is the case in birds. This is due in both cases to the hardness of the integument; birds having their bodies covered with feathers, and these oviparous quadrupeds with horny plates. These plates are equivalent to scales, but of a harder character. This is manifest in tortoises and river crocodiles, and also in the large serpents. For here the plates become stronger than the bones, being of the same substance as these.

These animals have no upper eyelid, but close the eye with the lower lid. In this they resemble birds, and the reason is the same as was assigned in their case. Among birds there are some that also blink by means of a membrane which comes from the corner of the eye. But none of the oviparous quadrupeds blink; for their eyes are harder than those of birds. The reason for this is that keen vision is of very considerable service to birds, flying as they do in the air, whereas it would be of comparatively small use to the oviparous quadrupeds, seeing that they all live in holes.

Of the two separate portions which constitute the head, namely the upper part and the lower jaw, the latter in man and in the viviparous quadrupeds moves not only upwards and downwards, but also from side to side; while in fishes and birds and oviparous quadrupeds, the only movement is up and down. The reason is that this latter movement is the one required in biting and dividing food, while the lateral movement serves to reduce substances to a pulp. To such animals, therefore, as have molars this lateral motion is of service; but to those animals that have none it would be quite useless, and they are therefore invariably without it. For nature never makes anything that is superfluous. While in all other animals it is the lower jaw that is movable, in the river crocodile it is exceptionally the upper. This is because the feet in this creature are so excessively small as to be useless for seizing and holding prey; on which account nature has given it a mouth that can serve for these purposes in their stead. For that direction of motion which will give the greater force to a blow will be the more serviceable one in holding or in seizing prey; and a blow from above is always more forcible than one from below. Seeing, then, that both the prehension and the mastication of food are offices of the mouth, and that the former of these two is the more essential in an animal that has neither hands nor suitably formed feet, these crocodiles will derive greater benefit from a motion of the upper jaw than from a motion of the lower jaw. The same considerations explain why crabs also move the upper division of each claw and not the lower. For their claws are substitutes for hands, and so require to be suitable for the prehension of food, and not for its division; for such division and biting is the office of teeth. In crabs, then, and in such other animals as are able to seize their food in a leisurely manner, inasmuch as their mouth is not called on to perform its office while they are still in the water, the two functions are assigned to different parts, prehension to the hands or feet, biting and division of food to the mouth. But in crocodiles the mouth has been so framed by nature as to serve both purposes, the jaws being made to move in the manner just described.

Another part present in all these animals is a neck, this being the consequence of their having a lung. For the windpipe by which the air is admitted to the lung is of some length. Since the portion between the head and the shoulders is called the neck, a serpent can scarcely be said with the same right as the rest of these animals to have a neck, but only to have something analogous to that part of the body—if, indeed, the neck must be determined by the limits just stated. It is a peculiarity of serpents, as compared with other animals allied to them, that they are able to turn their head backwards without stirring the rest of the body. The reason of this is that a serpent, like an insect, has a body that admits of being curled up, its vertebrae being cartilaginous and easily bent. The faculty in question belongs then to serpents as a necessary consequence of this cause; but it is for the sake of their good too—for it enables them to guard against attacks from behind. For their body, owing to its length and the absence of feet, is ill-suited for turning round and protecting the hinder parts; and merely to lift the head, without the power of turning it round, would be of no use whatsoever.

The animals with which we are dealing have, moreover, a part which corresponds to the chest; but neither here nor elsewhere in their body have they any breasts, as neither has any bird or fish. This is a consequence of their having no milk; for a breast is a receptacle for milk and, as it were, a vessel to contain it. This absence of milk is not peculiar to these animals, but is common to all such as are not internally viviparous. For all such produce eggs, and the nutriment which in Vivipara has the character of milk is in them engendered in the egg. Of all this, however, a clearer account will be given in the treatise *On Generation.* As to the mode in which the legs bend, a general account, in which all animals are considered, has already been given in the work on *Progression.* These animals also have a tail, larger in some of them, smaller in others, and the reason for this has been stated in general terms in an earlier passage.

Of all oviparous animals that live on land there is none so lean as the chamaeleon. For there is none that has so little blood. The explanation of this is to be found in the psychical temperament of the creature. For it is of a timid nature—hence its many changes of appearance. But fear is a refrigeration, and results from deficiency of natural heat and scantiness of blood.

We have now done with such sanguineous animals as are quadrupeds and also such as are footless, and have stated with sufficient completeness what external parts they possess, and for what reasons they have them.

12 · The differences of birds compared one with another are differences of magnitude, and of the greater or smaller development of parts. Thus some have long legs, others short legs; some have a broad tongue, others a narrow tongue; and so on with the other parts. There are few of their parts that differ, taking birds by themselves. But when birds are compared with other animals the parts present differences of form also.

Birds, then, are feathered, and this is a character common to them all and peculiar to them. For the parts of animals are covered in some cases with hair, in others with scales, in others with scaly plates; but birds have feathers. Their feathers, too, are split and distinct in kind from the undivided feathers of insects; for the bird's feather is divided, these are not; the bird's feather has a shaft, these have none.

A second strange peculiarity which distinguishes birds from all other animals is their beak. For as in elephants the nostril serves in place of hands, and as in some insects the tongue serves in place of mouth, so in birds there is a beak, which, being bony, serves in place of teeth and lips. Their organs of sense have already been considered.

All birds have a neck naturally extending from the body; and the purpose of this neck is the same as in such other animals as have one. This neck in some birds is long, in others short; its length, as a general rule, being pretty nearly determined by that of the legs. For long-legged birds have a long neck, short-legged birds a short one, to which rule, however, the web-footed birds form an exception. For to a bird perched up on long legs a short neck would be of no use whatsoever in collecting food from the ground; and equally useless would be a long neck, if the legs were short. Such birds, again, as are carnivorous would find length in this part interfered greatly with their habits of life. For a long neck is weak, and it is on their superior strength that carnivorous birds depend for their subsistence. No bird, therefore, that has talons ever has an elongated neck. In web-footed birds, however, and in those other birds belonging to the same class, whose toes though actually separate are shaped like a snub nose, the neck is elongated, so as to be suitable for collecting food from the water; while the legs are short, so as to serve in swimming.

The beaks of birds also vary with their modes of life. For in some the beak is straight, in others crooked; straight, in those who use it merely for eating; crooked, in those that live on raw flesh. For a crooked beak is an advantage in fighting; and these birds must, of course, get their food from the bodies of other animals, and in most cases by violence. In such birds, again, as live in marshes and are herbivorous the beak is broad and flat, this form being best suited for digging and cropping, and for pulling up plants. In some of these marsh birds, however, the beak is elongated, as too is the neck, the reason for this being that the bird gets its food from some depth below the surface. For most birds of this kind, and most of those whose feet are webbed, either in their entirety or each part separately, live by preying on some of the smaller animals that are to be found in water, and their neck serves as a fishing-rod, the beak representing the line and hook.

The upper and under sides of the body, that is of what in quadrupeds is called the trunk, present in birds one unbroken surface, and they have no arms or forelegs attached to it, but in their stead wings, which are a distinctive peculiarity of these animals; and that is why the ends of the wings lie on the back in the place of a shoulder-blade.

The legs are two in number, as in man; not however, as in man, bent outwards, but bent inwards like the legs of a quadruped. The wings are bent like the forelegs of a quadruped, having their convexity turned outwards. That the feet should be two in number is a matter of necessity. For a bird is essentially a sanguineous animal, and at the same time a winged animal; and no sanguineous animal has more than four points for motion. In birds, then, as in those other sanguineous animals that live and move upon the ground, the limbs attached to the trunk are four in number. But, while in all the rest these four limbs consist of a pair of arms and a pair of legs, or of four legs as in quadrupeds, in birds the arms or forelegs are replaced by a pair of wings, and this is their distinctive character. For it is part of the substance of a bird that it shall be able to fly; and it is by the extension of wings that this is made possible. Of all arrangements, then, the only possible, and so the necessary, one is that birds shall have two feet; for this with the wings will give them four points for motion. The breast in all birds is sharp-edged, and fleshy. The sharp edge is to minister to flight, for broad surfaces move with considerable difficulty, owing to the large quantity of air which they have to displace; while the fleshy character acts as a protection, for the breast, owing to its form, would be weak, were it not amply covered.

Below the breast lies the belly, extending, as in quadrupeds and in man, to the vent and to the place where the legs are jointed to the trunk.

Such, then, are the parts which lie between the wings and the legs. Birds like all other animals, whether produced viviparously or from eggs, have an umbilicus during their development, but, when the bird has attained to fuller growth, no signs of this remain visible. The cause of this is plainly to be seen during the process of development; for in birds the umbilical cord unites with the intestine, and is not a portion of the blood vessels as is the case in viviparous animals.

Some birds, again, are well adapted for flight, their wings being large and strong. Such, for instance, are those that have talons and live on flesh. For their mode of life renders the power of flight a necessity, and it is on this account that their feathers are so abundant and their wings so large. Besides these, however, there are also other genera of birds that can fly well; all those, namely, that depend on speed for security, or that are of migratory habits. On the other hand, some kinds of birds have heavy bodies and are not constructed for flight. These are birds that are frugivorous and live on the ground, or that are able to swim and get their living in watery places. In those that have talons the body, without the wings, is small; for the nutriment is consumed in the production of these wings, and of the weapons and defensive appliances; whereas in birds that are not made for flight the contrary obtains, and the body is bulky and so of heavy weight. In some of these heavy-bodied birds the legs are furnished with what are called spurs, which replace the wings as a means of defence. Spurs and talons never co-exist in the same bird. For nature never makes anything superfluous; and if a bird can fly, and has talons, it has no use for spurs; for these are weapons for fighting on the ground, and on this account belong to certain heavy-bodied birds. These latter, again, would find the possession of talons not only useless but actually injurious; for the claws would stick into the ground and interfere with progression. This is the reason why all birds with talons walk so badly, and why they never settle upon rocks. For the character of their claws is ill-suited for either action.

All this is the necessary consequence of the process of development. For the earthy matter in the body issuing from it is converted into parts that are useful as weapons. That which flows upwards gives hardness or size to the beak; and, should any flow downwards, it either forms spurs upon the legs or gives size and strength to the claws upon the feet. But it does not at one and the same time produce both these results, one in the legs, the other in the claws; for such a dispersion of this residual matter would destroy all its efficiency. In other birds this earthy residue furnishes 694b1 the legs with the material for their elongation; or sometimes, in place of this, fills up the interspaces between the toes. Thus it is a matter of necessity that such birds as swim shall either be actually web-footed, or shall have a kind of broad blade-like margin running along the whole length of each distinct toe. The forms, then, of these feet are the necessary results of the causes that have been mentioned. Yet at the same time they are intended for the animal's advantage. For they are in harmony with the mode of life of these birds, who, living on the water, where their wings are useless, require that their feet shall be such as to serve in swimming. For these feet are so developed as to resemble the oars of a boat, or the fins of a fish; and if the fins of the one or the webbing of the other is destroyed, they can no longer swim.

In some birds the legs are very long, the cause of this being that they inhabit marshes—and nature makes the organs for the function, and not the function for the organs. It is, then, because these birds are not meant for swimming that their feet are without webs, and it is because they live on ground that gives way under the foot that their legs and toes are elongated, and that these latter in most of them have an extra number of joints. Again, though all birds have the same material composition, they are not all made for flight; and in these, therefore, the nutriment that should go to their tail-feathers is spent on the legs and used to increase their size. This is the reason why these birds when they fly make use of their legs as a tail, stretching them out behind, and so rendering them serviceable, whereas in any other position they would be simply an impediment.

In other birds, where the legs are short, these are held close against the belly during flight. In some cases this is merely to keep the feet out of the way, but in birds that have talons the position has a further purpose, being the one best suited for rapine. Birds that have a long and a thick neck keep it stretched out during flight; but those whose neck though long is slender fly with it coiled up. For in this position it is protected, and less likely to get broken, should the bird fly against any obstacle.

695a1 In all birds there is an ischium, but in such a way that it would scarcely be taken for one, but rather for a second thigh-bone because of its length; for it extends as far as to the middle of the belly. The reason for this is that the bird is a biped, and yet is unable to stand erect. For if its ischium extended but a short way from the fundament, and then immediately came the leg, as is the case in man and in quadrupeds, the bird would be unable to stand up at all. For while man stands erect, and while quadrupeds have their heavy bodies propped up in front by the forelegs, birds can neither stand erect owing to their dwarf-like shape, nor have anterior legs to prop them up, these legs being replaced by wings. As a remedy for this nature has given them a long ischium, and brought it to the centre of the body, fixing it firmly;

and she has placed the legs under this, so that the weight on either side may be equally balanced, and standing or progression rendered possible. Such then is the reason why a bird, though it is a biped, does not stand erect. The reason why its legs are destitute of flesh is the same as in the case of quadrupeds, about which we have already spoken.

In all birds alike, whether web-footed or not, the number of toes in each foot is four. For the Libyan ostrich may be disregarded for the present, and its cloven hoof and other discrepancies of structure as compared with the tribe of birds will be considered further on. Of these four toes three are in front, while the fourth points backwards, serving as a heel, to give steadiness. In the long-legged birds this fourth toe is much shorter than the others, as is the case with the corncrake, but the number of their toes is not increased. The arrangement of the toes is such as has been described in all birds with the exception of the wryneck. Here only two of the toes are in front, the other two behind; and the reason for this is that the body of the wryneck is not inclined forward so much as that of other birds. All birds have testicles; but they are inside the body. The reason for this will be given in the treatise on the *Generation of Animals*.

13 · Thus then are fashioned the parts of birds. But in fishes a still further 695b1
stunting has occurred in the external parts. For here, for reasons already given, there are neither legs nor hands nor wings, the whole body from head to tail presenting one unbroken surface. This tail differs in different fishes, in some approximating in character to the fins,[20] while in some of the flat kinds, it is spinous and elongated, because the material which should have gone to the tail has been diverted thence and used to increase the breadth of the body. Such, for instance, is the case with the torpedos, the sting-rays, and whatever other Selachia there may be of like nature. In such fishes, then, the tail is spinous and long; while in some others it is short and fleshy, for the same reason which makes it spinous and long in the torpedo. For to be short and fleshy comes to the same thing as to be long and less amply furnished with flesh.

The opposite has occurred in the fishing-frog; for here the anterior and broad part of the body is not of a fleshy character, and so all the fleshy substance which has been thence diverted has been placed by nature in the tail and hinder portion of the body.

In fishes there are no limbs attached to the body. For in accordance with their essential substance they are swimming animals; and nature never makes anything superfluous or in vain. Now fish are sanguineous in their substance; and since they are made for swimming they have fins, and as they are not made for walking they are without feet; for feet are attached to the body that they may be of use in progression on land. Moreover, fishes cannot have feet, or any other similar limbs, as well as four fins; for they are sanguineous animals. The cordylus, though it has gills, has feet, for it has no fins but has its tail flattened out and loose in texture.

[20] Reading παραπλησίαν τοῖς πτερυγίοις.

Fishes, unless, like the ray and the sting-ray they are broad and flat, have four fins, two on the upper and two on the under side of the body; and no fish ever has more than these. For, if it had, it would be a bloodless animal.

The upper pair of fins is present in nearly all fishes, but not so the under pair; for these are wanting in some of those fishes that have long thick bodies, such as the eel, the conger, and a certain kind of mullet that is found in the lake at Siphae. When the body is still more elongated, and resembles that of a serpent as is the case in the muraena, there are absolutely no fins at all; and locomotion is effected by the flexures of the body, the water being put to the same use by these fins as is the ground by serpents. For serpents swim in water exactly in the same way as they glide on the ground. The reason for these serpent-like fishes being without fins is the same as that which causes serpents to be without feet; and what this is has been already stated in the works on the *Progression* and the *Movement of Animals.* The reason was this. If the points of motion were four, motion would be effected under difficulties; for either the two pairs of fins would be close to each other, in which case motion would scarcely be possible, or they would be at a very considerable distance apart, in which case the long interval between them would be just as great an evil. On the other hand, to have more than four such motor points would convert the fishes into bloodless animals. A similar explanation applies to the case of those fishes that have only two fins. For here again the body is of great length and like that of a serpent, and its undulations do the office of the two missing fins. It is owing to this that such fishes can even crawl on dry ground, and can live there for a considerable time; and some do not begin to gasp at once, while others, whose nature is akin to that of land-animals, are still less affected. In such fishes as have but two fins it is the upper pair that is present, excepting when the flat broad shape of the body prevents this. The fins in such cases are placed at the head, because in this region there is no elongation, which might serve in the absence of fins as a means of locomotion; whereas in the direction of the tail there is a considerable lengthening out in fishes of this conformation. As for the rays and the like, they use the marginal part of their flattened bodies in place of fins for swimming.

Fish which are not so flat, e.g. the torpedo and the fishing-frog, have fins: the upper pair are placed further back because of the flatness of the fore parts, and the under pair are placed close to the head (for the flatness does not prevent it from moving), while to compensate for this advancement they are smaller than the upper ones. In the torpedo two fins are placed on the tail, and the fish uses the broad expansion of its body to supply the place of the other two, each lateral half of its circumference serving the office of a fin.

The head, with its several parts, as also the organs of sense, have already come under consideration.

There is one peculiarity which distinguishes fishes from all other sanguineous animals, namely, the possession of gills. Why they have these organs has been set forth in the treatise on *Respiration.* These gills are in most fishes covered by opercula, but in the Selachia there are no such coverings. For an operculum requires fish-spine for its formation, and in other fishes the skeleton is made of this substance, whereas in the Selachia it is invariably formed of cartilage. Again, while the motions of spinous fishes are rapid, those of the Selachia are sluggish, inasmuch as they have neither fish-spine nor sinew; but an operculum requires rapidity of motion, seeing that the office of the gills is to minister as it were to expiration. For this reason in Selachia the branchial orifices themselves effect their own closure, and thus there is no need for an operculum to ensure its taking place with due rapidity. In some fishes the gills are numerous, in others few in number; in some again they are double, in others single. The last gill in most cases is single. For a detailed account of all this, reference must be made to the *Anatomies* and to the *History of Animals*.

It is the abundance or the deficiency of the cardiac heat which determines the abundance or deficiency of the gills. For, the greater an animal's heat, the more rapid and the more forcible does it require the branchial movement to be; and numerous and double gills act with more force and rapidity than such as are few and single. Thus, too, it is that some fishes that have but few gills, and those of comparatively small efficacy, can live out of water for a considerable time; for in them there is no great demand for refrigeration. Such, for example, are the eel and all other fishes of serpent-like form.

Fishes also present diversities as regards the mouth. For in some this is placed in front, at the very extremity of the body, while in others, as the dolphin and the Selachia, it is placed on the under surface; so that these fishes turn on the back in order to take their food. The purpose of nature in this was apparently not merely to provide a means of salvation for other animals, by allowing them opportunity of escape during the time lost in the act of turning—for all the fishes with this kind of mouth prey on living animals—but also to prevent these fishes from giving way too much to their gluttonous ravening after food. For had they been able to seize their prey more easily than they do, they would soon have perished from over-repletion. An additional reason is that their snout is round and small, and therefore cannot admit of a wide opening.

Again, even when the mouth is not placed on the under surface, there are differences in the extent to which it can open. For in some cases it can gape widely, 697a1
while in others it is set at the point of a small tapering snout; the former being the case in carnivorous fishes, such as those with saw teeth, whose strength lies in their mouth, while the latter is its form in all such as are not carnivorous.

The skin is in some fishes covered with scales (the scale of a fish is a thin and shiny film, and therefore easily becomes detached from the surface of the body). In others it is rough, as for instance in the angel-fish, the ray, and the like. Fewest of all are those whose skin is smooth. The Selachia have no scales, but a rough skin. This is explained by their cartilaginous skeleton. For the earthy material which has been thence diverted is expended by nature upon the skin.

No fish has testicles either externally or internally; as indeed have no footless animals, among which of course are included the serpents. One and the same orifice serves both for the excrement and for the generative secretions, as is the case also in all other oviparous animals, quadrupeds included, inasmuch as they have no bladder and form no fluid excretion.

Such then are the characters which distinguish fishes from all other animals.

But dolphins and whales and all such Cetacea are without gills; and, having a lung, are provided with a blow-hole; for this serves them to discharge the sea-water which has been taken into the mouth. For, feeding as they do in the water, they cannot but let this fluid enter into their mouth, and, having let it in, they must of necessity let it out again. Gills are useful here, as has been explained in the treatise on *Respiration,* to such animals as do not breathe; for no animal can possibly possess gills and at the same time be a respiratory animal. In order, therefore, that these Cetacea may discharge the water, they are provided with a blow-hole. This is placed in front of the brain; for otherwise it would have cut off the brain from the spine. The reason for these animals having a lung and breathing, is that animals of large size require more heat to enable them to move. A lung, therefore, is placed within their body, and is fully supplied with blood-heat. These creatures are after a fashion land and water animals in one. For so far as they are inhalers of air they resemble land-animals, while they resemble water-animals in having no feet and in deriving their food from the sea. So also seals and bats are ambivalent, the former between land and water animals, and the latter between animals that live on the ground and animals that fly; and so they belong to both kinds or to neither. For seals, if looked on as water-animals, are yet found to have fins. For their hind feet are exactly like the fins of fishes; and their teeth also are sharp and saw-like as in fishes. Bats again, if regarded as winged animals, have feet; and, if regarded as quadrupeds, are without them. So also they have neither the tail of a quadruped nor the tail of a bird; no quadruped's tail, because they are winged animals; no bird's tail, because they are terrestrial. This absence of tail is the result of necessity. For they are skin-winged; but no animal, unless it has barbed feathers, has the tail of a bird; for a bird's tail is composed of such feathers. As for a quadruped's tail, it would be an actual impediment, if present among the feathers.

14 · Much the same may be said also of the Libyan ostrich. For it has some of the characters of a bird, some of the characters of a quadruped. It differs from a quadruped in being feathered; and from a bird in being unable to soar aloft, and in having feathers that resemble hair and are useless for flight. Again, it agrees with quadrupeds in having upper eyelashes, and the parts about the head and the upper portion of the neck are bare—so that its eyelashes are more hairy; and it agrees with birds in being feathered in all the parts posterior to these. Further, it resembles a bird in being a biped, and a quadruped in having a cloven hoof; for it has hoofs and not toes. The explanation of these peculiarities is to be found in its bulk, which is that of a quadruped rather that of a bird. For speaking generally, a bird must necessarily be of very small size. For a body of heavy bulk can with difficulty be raised into the air.

Thus much then as regards the parts of animals. We have discussed them all, and set forth the cause why each exists; and in do doing we have severally considered each group of animals. We must now pass on, and in due sequence must next deal with the question of their generation.

MOVEMENT OF ANIMALS

A. S. L. Farquharson

1 · Elsewhere we have investigated the movement of animals after their 698a1 various kinds, the differences between them, and the causes of their particular characters (for some animals fly, some swim, some walk, others move in various other ways); there remains an investigation of the common cause of any sort of animal movement whatsoever.

Now we have already determined (when we were discussing whether eternal motion exists or not, and what it is, if it does exist) that the origin of other motions is that which moves itself, and that the origin of this is the immovable, and that the prime mover must of necessity be immovable. And we must grasp this not only generally in theory, but also by reference to individuals in the world of sense; for with these in view we seek general theories, and with these we believe that general theories ought to harmonize. Now in the world of sense too it is plainly impossible for movement to be initiated if there is nothing at rest, and before all else in our present subject—animal life. For if one of the parts of an animal be moved, another must be at rest, and this is the purpose of their joints; animals use joints like a centre, and the whole member, in which the joint is, becomes both one and two, both straight and bent, changing potentially and actually by reason of the joint. And when it is bending and being moved one of the points in the joint is moved and one is at rest, just as if on a diameter AD were at rest, and B were moved, and AC were generated. However, in the geometrical illustration, the centre is held to be altogether indivisible (for in mathematics the motion they speak of is a fiction, no mathematical entity being really moved), whereas in the case of joints the centres become potentially and actually now one, now divided. But still the origin of movement, qua origin, always remains at rest when the lower part of a limb is 698b1 moved; for example, the elbow joint, when the forearm is moved, and the shoulder, when the whole arm; the knee when the tibia is moved, and the hip when the whole leg. Accordingly it is plain that each animal as a whole must have within itself a point at rest, whence will be the origin of that which is moved, and supporting itself upon which it will be moved both as a complete whole and in its members.

2 · But the point of rest in the animal is still quite ineffectual unless there is something outside it which is absolutely at rest and immovable. Now it is worth

TEXT: M. C. Nussbaum, *Aristotle's de Motu Animalium*, Princeton University Press, Princeton, N.J., 1978

while to pause and consider what has been said; for it involves a speculation which extends beyond animals even to the motion and march of the universe. For just as there must be something immovable within the animal, if it is to be moved, so even more must there be without it something immovable, by supporting itself upon which that which is moved moves. For were that something always to give way (as it does for tortoises walking on mud or persons walking in sand) advance would be impossible, and neither would there be any walking unless the ground were to remain still, nor any flying or swimming were not the air and the sea to resist. And this which resists must needs be different from what is moved, the whole of it from the whole of that, and what is thus immovable must be no part of what is moved; otherwise there will be no movement. Evidence of this lies in the problem why it is that a man easily moves a boat from outside, if he push with a pole, putting it against the mast or some other part, but if he tried to do this when in the boat itself he would never move it, no not even Tityus himself nor Boreas blowing from inside the ship, if he really were blowing in the way painters represent him; for they paint him sending the breath out from himself. For whether one blew gently or so stoutly as to make a very great wind, and whether what were thrown or pushed were breath or something else, it is necessary in the first place to be supported upon one of one's own members which is at rest and so to push, and in the second place for this member, either itself, or that of which it is a part, to remain at rest, fixing itself against something external to itself. Now the man who is himself in the boat, if he pushes, fixing himself against the boat, does not move the boat, because what he pushes against must remain at rest. Now what he is trying to move, and what he is fixing himself against is in his case the same. If, however, he pushes or pulls from outside he does move it; for the ground is no part of the boat.

3 · Here we may ask the question whether if something moves the whole heavens this mover must be immovable, and moreover be no part of the heavens, nor in the heavens. For either it is moved itself and moves the heavens, in which case it must touch something immovable in order to cause movement, and then this is no part of that which cause movement; or if the mover is from the first immovable it will equally be no part of that which is moved. In this point at least they argue correctly who say that as the sphere is carried round in a circle no single part remains still; for then either the whole would necessarily stand still or its continuity be torn asunder; but they argue less well in supposing that the poles have a certain power, though they have no magnitude, but are merely termini or points. For besides the fact that no such things have any substantial existence it is impossible for a single movement to be initiated by what is twofold; and yet they make the poles two. From a review of these difficulties we may conclude that there is something so related to the whole of nature, as the earth is to animals and things moved by them.

And the mythologists with their fable of Atlas setting his feet upon the earth appear to have based the fable upon intelligent grounds. They make Atlas a kind of diameter twirling the heavens about the poles. Now as the earth remains still this would be reasonable enough, but their theory involves them in the position that the earth is no part of the universe. And further the force of that which initiates movement must be made equal to the force of that which remains at rest. For there is a definite quantity of force or power by dint of which that which remains at rest does so, just as there is of force by dint of which that which initiates movement does so; and as there is a necessary proportion between contrary motions, so there is between states of rest. Now equal forces are unaffected by one another, but are overcome by a superiority of force. And so Atlas, or whatever similar power initiates movement from within, must exert no more force than will exactly balance the stability of the earth—otherwise the earth will be moved out of her place in the centre of things. For as the pusher pushes so is the pushed pushed, and with equal force. But that which initiates movement is to begin with at rest, so that its force is greater, rather than equal and like to the stability. And similarly also than the stability of what is moved but does not initiate movement. Therefore the power of the earth in its immobility will have to be as great as that of the whole heavens, and of that which moves the heavens. But if that is impossible, it follows that the heavens cannot be moved by anything of this kind inside them.

4 · There is a difficulty about the motions of the parts of the heavens which, as akin to what has gone before, may be considered next. For if one could overcome by power of motion the immobility of the earth he would clearly move it away from the centre. And it is plain that the force from which this power would originate will not be infinite; for the earth is not infinite and therefore its weight is not. Now things are called impossible in several ways; for when we say it is impossible to see a sound, and when we say it is impossible to see the men in the moon, we use the word in different ways: the former is of necessity, the latter, though their nature is to be seen, will not actually be seen by us. Now we suppose that the heavens are *of necessity* impossible to destroy and to dissolve, whereas the result of the present argument would be to do away with this necessity. For it is natural and possible for a motion to exist greater than that by dint of which the earth is at rest, or than that by dint of which fire and the upper body are moved. If then there are superior motions, these will be dissolved by one another; and if there actually are not, but might possibly be (for they cannot be infinite because not even body can be infinite), there is a possibility of the heavens being dissolved. For what is to prevent this coming to pass, unless it be impossible? And it is not impossible unless the opposite is necessary. This difficulty, however, we will discuss elsewhere.[1]

Must there be something immovable and at rest outside of what is moved, and no part of it, or not? And must this necessarily be so also in the case of the universe? Perhaps it would be thought strange were the origin of movement inside. And to those who so conceive it the words of Homer[2] would appear to have been well spoken: 'Nay, ye would not pull Zeus, highest of all, from heaven to the plain, no not even if ye toiled right hard; come, all ye gods and goddesses! Set hands to the chain'.

[1]See *Physics* VIII; *On the Heavens* I.
[2]See *Iliad* VIII 20–22.

For that which is entirely immovable cannot possibly be moved by anything. And herein lies the solution of the difficulty stated just now, the possibility or impossibility of dissolving the system of the heavens, in that it depends from an origin which is immovable.

Now in the animal world there must be not only an immovable without, but also within those things which move in place, and initiate their own movement. For one part of an animal must be moved, and another be at rest, and against this the part which is moved will support itself and be moved; for example, if it moves one of its parts; for one part supports itself against another as though it were at rest.

But about things without life which are moved one might ask the question whether all contain in themselves both that which is at rest and that which initiates movement, and whether they also, for instance fire, earth, or any other inanimate thing, must support themselves against something outside which is at rest. Or is this impossible and must it not be looked for rather in those primary causes by which they are set in motion? For all things without life are moved by something other, and the origin of all things so moved are things which move themselves. And out of these we have spoken about animals (for they must all have in themselves that which is at rest, and without them that against which they are supported); but whether there is some higher and prime mover is not clear, and an origin of that kind involves a different discussion. Animals at any rate which move themselves are all moved supporting themselves on what is outside them, even when they breathe in and out; for there is no essential difference between casting a great and a small weight, and this is what men do when they spit and cough and when they breathe in and breathe out.

5 · But is it only in that which moves itself in place that there must be a point at rest, or does this hold also of that which causes its own qualitative changes, and its own growth? Now the question of original generation and decay is different; for if there is, as we hold, a primary movement, this would be the cause of generation and decay, and probably of all the secondary movements too. And as in the universe, so in the animal world this is the primary movement, when the creature attains maturity; and therefore it is the cause of growth, when the creature becomes the cause of its own growth and the cause too of alteration. Otherwise, the point at rest is not necessary. However, the earliest growth and alteration in the living creature
700b1 arise through another and by other channels, nor can anything possibly be the cause of its own generation and decay; for the mover must exist before the moved, the begetter before the begotten, and nothing is prior to itself.

6 · Now whether the soul is moved or not, and how it is moved if it be moved, has been stated before in our treatise concerning it.[3] And since all inanimate things are moved by some other thing—and the manner of the movement of the first and

[3]See *On the Soul* I 3–4.

eternally moved, and how the first mover moves it, has been determined before in our work on first philosophy,[4] it remains to inquire how the soul moves the body, and what is the origin of movement in a living creature. For, if we except the movement of the universe, things with life are the causes of the movement of all else, that is of all that are not moved by one another by mutual impact. And so all their motions have a limit, inasmuch as the movements of things with life have such. For all living things both move and are moved for the sake of something, so that this is the limit of all their movement—that for the sake of which. Now we see that the living creature is moved by intellect, imagination, purpose, wish, and appetite. And all these are reducible to thought and desire. For both imagination and sensation are on common ground with thought, since all three are faculties of discrimination though differing according to distinctions stated elsewhere. Wish, however, impulse, and appetite, are all three forms of desire, while purpose belongs both to intellect and to desire. Therefore the object of desire or of intellect first initiates movement—not every object of intellect, but only the end in the domain of conduct. Accordingly it is goods of this sort that initiate movement, not everything fine. For it initiates movement only so far as something else is for its sake, or so far as it is the end of that which is for the sake of something else. And we must suppose that a seeming good may take the room of actual good, and so may the pleasant, which is itself a seeming good. From these considerations it is clear that in one regard that which is eternally moved by the eternal mover is moved in the same way as every living creature, in another regard differently, and so while it is moved eternally, the movement of living creatures has a limit. Now the eternally fine, and the truly and primarily good (which is not at one time good, at another time not good), is too divine and precious to be relative to anything else. The prime mover then moves, itself being unmoved, whereas desire and its faculty are moved and so move. But it is not necessary for the last in the chain of things moved to move something else; wherefore it is plainly reasonable that motion in place should be the last of the movements in things that come into being; for the living creature is moved and goes forward by reason of desire or purpose, when some alteration has been set going on the occasion of sensation or imagination.

7 · But how is it that thought is sometimes followed by action, sometimes not; sometimes by movement, sometimes not? What happens seems parallel to the case of thinking and inferring about the immovable objects. There the end is the truth seen (for, when one thinks the two propositions, one thinks and puts together the conclusion), but here the two propositions result in a conclusion which is an action—for example, whenever one thinks that every man ought to walk, and that one is a man oneself, straightaway one walks; or that, in this case, no man should walk, one is a man: straightaway one remains at rest. And one so acts in the two cases provided that there is nothing to compel or to prevent. Again, I ought to create a good, a house is good: straightaway he makes a house. I need a covering, a coat is a

[4] See *Metaphysics* Λ 7.

covering: I need a coat. What I need I ought to make, I need a coat: I make a coat. And the conclusion 'I must make a coat' is an action. And the action goes back to a starting-point. If there is to be a coat, there must first be this, and if this then this—and straightaway he does this. Now that the action is the conclusion is clear. But the premisses of action are of two kinds, of the good and of the possible.

And as sometimes happens in dialectical questioning, so here the intellect does not stop and consider at all the one proposition, the obvious one; for example if walking is good for man, one does not dwell upon the proposition 'I am a man'. And so what we do without reflection, we do quickly. For when a man is actually using perception or imagination or thought in relation to that for the sake of which, what he desires he does at once. For the actualizing of desire is a substitute for inquiry or thinking. I want to drink, says appetite; this is drink, says sense or imagination or thought: straightaway I drink. In this way living creatures are impelled to move and to act, and desire is the last cause of movement, and desire arises through perception or through imagination and thought. And things that desire to act make and act sometimes from appetite or impulse and sometimes from wish.

The movements of animals may be compared with those of automatic puppets, which are set going on the occasion of a tiny movement (the strings are released, and the pegs strike against one another); or with the toy wagon (for the child mounts on it and moves it straight forward, and yet it is moved in a circle owing to its wheels being of unequal diameter—the smaller acts like a centre on the same principle as the cylinders). Animals have parts of a similar kind, their organs, the sinewy tendons to wit and the bones; the bones are like the pegs and the iron; the tendons are like the strings; for when these are slackened or released movement begins. However, in the puppets and the toy wagon there is no change of quality, since if the inner wheels became smaller and greater by turns there would be the same circular movement set up. In an animal the same part has the power of becoming now larger and now smaller, and changing its form, as the parts increase by warmth and again contract by cold and change their quality. This change of quality is caused by imaginations and sensations and by ideas. Sensations are obviously a form of change of quality, and imagination and thinking have the same power as the objects. For in a measure the form conceived be it of hot or cold[5] or pleasant or fearful is like what the actual objects would be, and so we shudder and are frightened merely by thinking. Now all these affections are actually changes of quality, and with those changes some parts of the body enlarge, others grow smaller. And it is not hard to see that a small change occurring at the centre makes great and numerous changes at the circumference, just as by shifting the rudder a hair's breadth you get a wide deviation at the prow. And further, when by reason of heat or cold or some kindred affection a change is set up in the region of the heart, even in an imperceptibly small part of the heart, it produces a vast difference in the body—blushing, let us say, or turning white, and tremblings and shivers and their opposites.

[5]Nussbaum excises θερμοῦ ἢ ψυχροῦ ἢ.

8 · But to return, the object we pursue or avoid in the field of action is, as has been explained, the origin of movement, and upon the thought and imagination of this there necessarily follows a heating or chilling. For what is painful we avoid, what is pleasing we pursue, and anything painful or pleasing is generally speaking accompanied by a chilling and heating (but we do not notice this when it happens in a small part). One may see this by considering the affections. Blind courage and panic fears, erotic motions, and the rest of the corporeal affections, pleasant and painful, are all accompanied by heating or chilling, some in a particular member, others in the body generally. So, memories and anticipations, using things of this kind as likenesses, are now more and now less causes of the same changes of temperature. And so we see the reason of nature's handiwork in the inward parts, and in the centres of movement of the organic members; they change from solid to moist, and from moist to solid, from soft to hard and vice versa. And so when these are affected in this way, and when besides the passive and active have the constitution we have many times described, as often as it comes to pass that one is active and the other passive, and neither of them falls short of the elements of its account, straightaway one acts and the other responds. And on this account thinking that one ought to go and going are virtually simultaneous, unless there be something else to hinder action. The organic parts are suitably prepared by the affections, these again by desire, and desire by imagination. Imagination in its turn depends either upon thinking or upon sense-perception. And the simultaneity and speed are due to the natural correspondence of the active and passive.

However, that which first moves the animal organism must be in a definite origin. Now we have said that a joint is the origin of one part of a limb, the end of another. And so nature employs it sometimes as one, sometimes as two. When movement arises from a joint, one of the extreme points must remain at rest, and the other be moved (for as we explained above the mover must support itself against a point at rest); accordingly, in the case of the elbow-joint, the last point of the forearm is moved but does not move anything, while, in the flexion, one point of the elbow, which lies in the whole forearm that is being moved, is moved, but there must also be a point which is unmoved, and this is our meaning when we speak of a point which is in potency one, but which becomes two in actual exercise. Now if the forearm were the living animal, somewhere in its elbow-joint would be the movement-imparting origin of the soul.

Since, however, it is possible for a lifeless thing to be so related to the hand as the forearm is to the upper (for example, when a man moves a stick in his hand), it is evident that the soul could not lie in either of the two extreme points, neither, that is, in the last point of what is moved, nor in the other origin. For the stick too has an end point and an origin by reference to the hand. Accordingly, for this reason, if the moving origin which derives from the soul is not in the stick, then it is not in the hand either; for a precisely similar relation obtains between the extremity of the hand and the wrist, and between the wrist and the elbow. In this matter it makes no difference whether the part is naturally connected to the body or not; the stick may be looked at as a detached part of the whole. It follows then of necessity that it cannot lie in any origin which is the end of another member, even though there may lie another part outside the one in question. For example, relatively to the end point of the stick the hand is the origin, but the origin of the hand's movement is in the wrist. And so if it is not even in the hand, because there is still something higher up, neither is the origin here; for once more if the elbow is at rest the whole part below it can be moved as a continuous whole.

9 · Now since the left and the right sides are symmetrical, and these opposites are moved simultaneously, it cannot be that the left is moved by the right remaining stationary, nor vice versa; the origin must always be in what lies above both. Therefore, the origin of the moving soul must be in the middle; for of both extremes the middle is the limiting point; and this is similarly related to the movements from above and below—e.g. from the head—and to those which spring from the spinal column, in creatures that have a spinal column.

And this is a reasonable arrangement. For the sensorium is in our opinion in the centre too; and so, if the region of the origin is altered through sense-perception and thus changes, the adjacent parts change with it and they too are extended or contracted, and in this way the movement of the creature necessarily follows. And the middle of the body must needs be in potency one but in actuality more than one; for the limbs are moved simultaneously from the origin, and when one is at rest the other is moved. For example, in the line ABC, B is moved, and A is the mover. There must, however, be a point at rest if one is to move, the other to be moved. A then being one in potency must be two in actuality, and so be a magnitude not a point. Again, C may be moved simultaneously with B. Both the origin then in A must move and be moved, and so there must be something other than them which moves but is not moved. For otherwise, when the movement begins, the extremes, i.e. the origin, in A would rest upon one another, like two men putting themselves back to back and so moving their legs. There must then be some one thing which moves both. This something is the soul, distinct from the magnitude just described and yet located therein.

10 · Although from the point of view of the account which gives the cause of movement desire is the middle, and desire moves being moved, still in the animated body there must be some body of this kind. Now that which is moved, but whose nature is not to initiate movement, is capable of being passive to an external power, while that which initiates movement must needs possess a kind of force and power. Now it is clear that animals do both possess connatural spirit and derive force from this. (How this connatural spirit is maintained in the body is explained in other passages of our works.) And this spirit appears to stand to the soul-origin in a relation analogous to that between the point in a joint which moves being moved and the unmoved. Now since this origin is for some animals in the heart, in the rest in a part analogous with the heart, for this reason the connatural spirit is clearly there too. (The question whether the spirit remains always the same or constantly changes must be discussed elsewhere; for the same question arises about the rest of

the parts of the body.) At all events we see that it is well disposed to excite movement and to exert force. Now the functions of movement are thrusting and pulling. Accordingly, the organ of movement must be capable of expanding and contracting; and this is precisely the characteristic of spirit. It contracts and expands without constraint, and so is able to pull and to thrust from one and the same cause, exhibiting weight compared with the fiery element, and lightness by comparison with the opposites of fire. Now that which is to initiate movement without alteration must be of the kind described; for the natural bodies prevail over one another by dint of predominance; the light is overcome and kept down by the heavier, and the heavy kept up by the lighter.

We have now explained what the part is which is moved when the soul originates movement, and what is the reason for this. And the animal organism must be conceived after the similitude of a well-governed commonwealth. When order is once established in a city there is no more need of a separate monarch to preside over each several task. The individuals each play their assigned part as it is ordered, and one thing follows another because of habit. So in animals the same thing happens because of nature, each part naturally doing its own work as nature has composed it. There is no need then of a soul in each part, but it resides in a kind of origin of the body, and the remaining parts live by being naturally connected, and play their parts because of their nature.

11 · So much then for the voluntary movements of animal bodies, and the reasons for them. These bodies, however, display in certain members involuntary movements too, but most often non-voluntary movements. By involuntary I mean motions of the heart and of the penis; for often upon an image arising and without express mandate of the intellect these parts are moved. By non-voluntary I mean sleep and waking and respiration, and other similar movements. For neither imagination nor desire is properly mistress of any of these. But since the animal body must undergo natural changes of quality, and when the parts are so altered some must increase and others decrease, so that the body must straightaway be moved and change with the changes that nature makes dependent upon one another (the causes of the movements are heatings and chillings, both those coming from outside the body, and those taking place naturally within it)—so the movements which occur in spite of reason in the aforesaid parts occur when a change of quality supervenes. For thinking and imagination, as we said above, produce that which brings about the affections, since they produce the forms which bring them about. And the parts aforesaid display this motion more conspicuously than the rest, because each is in a sense a separate animal, the reason being that each contains vital moisture.[6] In the case of the heart the cause is plain; for it contains the origins of the senses; while an indication that the generative organ too is vital is that there flows from it the seminal potency, itself a kind of living creature. Again, it is a reasonable arrangement that the movements arise in the origin upon movements in

[6] Nussbaum, following Jaeger, excises τούτου . . . ζωτικήν.

the parts, and in the parts upon movements in the origin, and so reach one another. Conceive A to be the origin. The movements then arrive at the origin from each letter in the diagram we have drawn, and back again from the origin which is moved and changes, (for it is potentially multiple) the movement of B goes to B, that of C to C, the movement of both to both; but from B to C the movements flow by dint of going from B to A as to an origin, and then from A to C as from an origin. And a movement contrary to reason sometimes does and sometimes does not arise in the parts on the occasion of the same thoughts; the reason is that sometimes the matter
704a1 which is passive is there in sufficient quantity and of the right quality and sometimes not.

And so we have finished our account of the reasons for the parts of each kind of
704b1 animal, of the soul, and further of sense-perception, of sleep, of memory, and of movement in general; it remains to speak of generation.

PROGRESSION OF ANIMALS

A. S. L. Farquharson

1 · We have now to consider the parts which are useful to animals for movement in place; first, why each part is such as it is and to what end they possess them; and second, the differences between these parts both in one and the same creature, and again by comparison of the parts of creatures of different species with one another. First then let us lay down how many questions we have to consider.

The first is what are the fewest points of motion necessary to animal progression, the second why sanguineous animals have four points and not more, but bloodless animals more than four, and generally why some animals are footless, others bipeds, others quadrupeds, others polypods, and why all have an even number of feet, if they have feet at all; why the points on which progression depends are even in number.

Next, why are man and bird bipeds, but fish footless; and why do man and bird, though both bipeds, have an opposite curvature of the legs. For man bends his legs convexly, a bird has his bent concavely; again, man bends his arms and legs in opposite directions, for he has his arms bent convexly, but his legs concavely. and a viviparous quadruped bends his limbs in opposite directions to a man's, and in opposite directions to one another; for he has his forelegs bent convexly, his hind legs concavely. Again, quadrupeds which are not viviparous but oviparous have a peculiar curvature of the limbs laterally away from the body. Again, why do quadrupeds move their legs criss cross?

We have to examine the reasons for all these facts, and others cognate to them; that the facts are such is clear from our natural history, we have now to ask reasons for the facts.

2 · At the beginning of the inquiry we must postulate the principles we are accustomed constantly to use for our scientific investigation of nature, that is we must take for granted principles of this universal character which appear in all nature's work. Of these one is that nature creates nothing without a purpose, but always the best possible in each kind of living creature by reference to its essential constitution. Accordingly if one way is better than another that is the way of nature. Next we must take for granted the different species of dimensions which inhere in

TEXT: W. W. Jaeger, Teubner, Leipzig, 1913

various things; of these there are three pairs of two each, superior and inferior, before and behind, to the right and to the left. Further we must assume that the sources of movements in place are thrusts and pulls. (These are the essential place-movements, it is only accidentally that what is carried by another is moved; it is not thought to move itself, but to be moved by something else.)

3 · After these preliminaries, we go on to the next questions in order.

Now of animals which change their position some move with the whole body at once, for example jumping animals, others with their parts, for example walking animals. In both these changes the moving creature always changes its position by pressing against what lies below it. Accordingly if what is below gives way too quickly for that which is moving upon it to lean against it, or if it affords no resistance at all to what is moving, the latter can of itself effect no movement upon it. For an animal which jumps makes its jump both by leaning against its own upper part and also against what is beneath its feet; for at the joints the parts do in a sense lean upon one another, and in general that which pushes down leans upon what is pushed down. That is why athletes jump further with weights in their hands than without, and runners run faster if they swing their arms; there is in extending the arms a kind of leaning against the hands and wrists. In all cases then that which moves makes its change of position by the use of at least two parts of the body; one part so to speak squeezes, the other is squeezed; for the part that is still is squeezed as it has to carry the weight, the part that is lifted strains against that which carries the weight. It follows then that nothing without parts can move itself in this way, for it has not in it the distinction of the part which is passive and that which is active.

4 · Again, the boundaries by which living beings are naturally determined are six in number, superior and inferior, before and behind, right and left. Of these all living beings have a superior and an inferior part; for superior and inferior is in plants too, not only in animals. And this distinction is one of function, not merely of position relatively to the earth and the sky. The superior is that from which flows in each kind the distribution of nutriment and the process of growth; the inferior is that to which the process flows and in which it ends. One is a starting-point, the other an end, and the starting-point is the superior. And yet it might be thought that in the case of plants at least the inferior is rather the appropriate starting-point, for in them the superior and inferior are in position other than in animals. Still they are similarly situated from the point of view of function, though not in their position relatively to the universe. The roots are the superior part of a plant, for from them the nutriment is distributed to the growing members, and a plant takes it with its roots as an animal does with its mouth.

Things that are not only alive but are animals have both a front and a back, because they all have sense, and front and back are distinguished by reference to sense. The front is the part in which sense is naturally located, and whence each thing gets its sensations, the opposite parts are the back.

All animals which partake not only in sense, but are able of themselves to make a change of place, have a further distinction of left and right besides those already enumerated; like the former these are distinctions of function and not of position. The right is that from which change of position naturally begins, the opposite which naturally depends upon this is the left.

This distinction (of right and left) is more articulate and detailed in some than in others. For animals which make the aforesaid change by the help of organized parts (I mean feet for example, or wings or similar organs) have the left and right distinguished in greater detail, while those which are not differentiated into such parts, but make the differentiation in the body itself and so progress, like some footless animals (for example snakes and caterpillars, and besides what men call earth-worms), all these have the distinction spoken of, although it is not made so manifest to us. That the beginning of movement is on the right is indicated by the fact that all men carry burdens on the left shoulder; in this way they set free the side which initiates movement and enable the side which bears the weight to be moved. And so men hop easier on the left leg; for the nature of the right is to initiate movement, that of the left to be moved. The burden then must rest on the side which is to be moved, not on that which is going to cause movement, and if it be set on the moving side, which is the source of movement, it will either not be moved at all or with more labour. Another indication that the right is the source of movement is the way we put our feet forward; all men lead off with the left, and after standing still prefer to put the left foot forward, unless something happens to prevent it. The reason is that their movement comes from the leg they step off, not from the one put forward. Again, men guard themselves with their right. And this is the reason why the right is the same in all; for that from which motion begins is the same for all, and has its natural position in the same place, and the origin of motion is from the right. And for this reason the spiral-shaped testaceans have their shells on the right, for they do not move in the direction of the spiral but all go forward in the direction opposite to the spiral. Examples are the murex and the trumpet-shell. As all animals then start movement from the right, and the right moves in the same direction as the whole, it is necessary for all to be alike right-handed. And man has the left limbs detached more than any other animal because he is natural in a higher degree than the other animals; now the right is naturally better than the left, being separate from it, and so in man the right is more especially the right, more dextrous that is, than in other animals. The right then being differentiated it is only reasonable that in man the left should be less movable, and most detached. In man, too, the other starting-points are found most naturally and clearly distinct, the superior part that is and the front.

5 · Animals which, like men and birds, have the superior part distinguished from the front are two-footed (biped). In them, of the four points of motion, two are wings in the one, hands and arms in the other. Animals which have the superior and the front parts identically situated are four-footed, many-footed, or footless. I use the term foot for a member connected with a point on the ground which produces movement; for the feet appear to have got their name from the ground under our feet.[1]

[1] ποῦς derived from πέδον.

Some animals, too, have the front and back parts identically situated, for 706b1 example cephalopods and spiral-shaped testaceans, and these we have discussed elsewhere in another connexion.

Now there is in place a superior, an intermediate, and an inferior; in respect to place bipeds have their superior part corresponding to the superior part of the universe; polypods, and footless animals to the intermediate part, and plants to the inferior. The reason is that these have no power of locomotion, and the superior part is determined relatively to the nutriment, and their nutriment is from the earth. Quadrupeds, polypods, and footless animals again have their superior part corresponding to the intermediate, because they are not erect. Bipeds have theirs corresponding to the superior part of the universe because they are erect, and of bipeds, man *par excellence;* for man is the most natural of bipeds. And it is reasonable for the starting-points to be in these parts; for the starting-point is honourable, and the superior is more honourable than the inferior, the front than the back, and the right than the left. Or we may reverse the argument and say quite well that these parts are more honourable than their opposites just because the starting-points are in them.

6 · The above discussion has made it clear that the source of movement is in the parts on the right. Now every continuous whole, one part of which is moved while the other remains at rest must, in order to be able to move as a whole while one part stands still, have in the place where both parts have opposed movements some common part which connects the moving parts with one another. Further in this common part the source of the motion (and similarly of the absence of motion) of each of the parts must lie.

Clearly[2] then if any of the opposite pairs of parts (right and left, that is, superior and inferior, before and behind) have a movement of their own, each of them has a common source of its movements at the juncture of the parts in question.

Now before and behind are not distinctions relatively to that which sets up its own motion, because in nature nothing has a movement backwards, nor has a moving animal any division whereby it may make a change of position towards its front or back; but right and left, superior and inferior are so distinguished. 707a1 Accordingly, all animals which progress by the use of distinct members have these members distinguished not by the differences of before and behind, but only by those of the remaining two pairs; the prior difference dividing these members into right and left—for this difference must appear as soon as you have division into two, the other difference appearing of necessity where there is division into four.

Since then the superior and inferior and the right and left are linked to one another by the same common source (by which I mean that which controls their movement), and further, everything which is going to make a movement in each such part properly must have the original cause of all the said movements arranged

[2]Reading στάσεως, δῆλον ὅτι.

in a certain definite position relatively to the distances from it of the said sources (and these sources in the individual parts are in pairs arranged co-ordinately or diagonally, and the common centre is the source from which the animal's movements of right and left, and similarly of superior and inferior, start), and since each animal must have this source at a point where it is similarly related to each of the sources in the four parts described—it is clear then how locomotion belongs to those animals only which make their changes of place by means of two or four points in their structure, or to such animals *par excellence.* Thus, since this property belongs almost peculiarly to sanguineous animals, we see that no sanguineous animal can progress at more points than four, and that if it is the nature of anything so to progress at four points it must of necessity be sanguineous.

7 · What happens in the animal world is in agreement with the above account. For no sanguineous animal if it be divided into more parts can live for any appreciable length of time, nor can it enjoy the power of locomotion which it possessed while it was a continuous and undivided whole. But some bloodless animals and polypods can live a long time, if divided, in each of the severed parts, and can move in the same way as before they were dismembered. Examples are what is termed the centipede and other insects that are long in shape; for even the hinder portion of all these goes on progressing in the same direction as the fore-part.

The explanation of their living when thus divided is that each of them is constructed like a continuous body of many separate living beings. It is plain, too, from what was said above why they are like this. Animals constructed most naturally are made to move at two or four points, and even limbless Sanguinea are no exception. They too move by dint of four points, whereby they achieve progression. They go forward by means of two flexions. For in each of their flexions there is a right and a left, both before and behind in their flat surface—in the part towards the head a right and a left front point, and in the part towards the tail the two hinder points. They look as if they moved at two points only, where they touch before and behind, but that is only because they are narrow in breadth. Even in them the right is the leading part, and there is an alternate correspondence behind, exactly as in quadrupeds. The reason of their flexions is their great length, for just as tall men walk with their backs hollowed and with their right shoulder leading in a forward direction (for their left hip is rather inclined backwards, so that their middle becomes hollowed), so we ought to conceive snakes as moving with hollowed backs upon the ground. And this is evidence that they move themselves like the quadrupeds, for they make the concave in its turn convex and the convex concave. When in its turn the left of the forward parts is leading, the concavity is in its turn reversed, for the right becomes the inner. (Let the right front point be A, the left B, the left hind C, the right D.)

Among land animals this is the character of the movement of snakes, and among water animals of eels, and conger-eels and also lampreys, in fact of all that have their form snakelike. However, some marine animals of this shape have no fin, 708a1 lampreys for example, but put the sea to the same use as snakes do both land and water (for snakes swim precisely as they move on the ground). Others have two fins only, for example conger-eels and eels and a kind of mullet which breeds in the lake of Siphae. On this account too those that are accustomed to live on land, for example all the eels, move with fewer flexions in a fluid than on land, while the kind of mullet which has two fins, by its flexion in a fluid makes up the four points.

8 · The reason why snakes are limbless is first that nature makes nothing without purpose, but always regards what is the best possible for each individual, preserving the peculiar substance of each and its essence, and secondly the principle we laid down above that no Sanguineous creature can move itself at more than four points. Granting this it is evident that sanguineous animals like snakes, whose length is out of proportion to the rest of their dimensions, cannot possibly have limbs; for they cannot have more than four (or they would be bloodless), and if they had two or four they would be practically stationary; so slow and unprofitable would their movement necessarily be.

But every footed animal has necessarily an even number of such feet. For those which only jump and so move from place to place do not need feet for this movement at least, but those which not only jump but also need to walk, finding that movement not sufficient for their purposes, evidently either are better able to progress with even feet or cannot otherwise progress at all;[3] [for every animal which has limbs must have an even number][4] for as this kind of movement is effected by part of the body at a time, and not by the whole at once as in the movement of leaping, some of the feet must in turn remain at rest, and others be moved, and the animal must act in each of these cases with opposite limbs, shifting the weight from the limbs
708b1 that are being moved to those at rest. And so nothing can walk on three limbs or on one; in the latter case it has no support at all on which to rest the body's weight, in the former only in respect of one pair of opposites, and so it must necessarily fall in endeavouring so to move. Polypods however, like the centipede, can indeed make progress on an odd number of limbs, as may be seen by the experiment of wounding one of their limbs; for then the mutilation of one row of limbs is corrected by the number of limbs which remain on either side. Such mutilated creatures, however, drag the wounded limb after them with the remainder, and do not properly speaking walk.[5] Moreover, it is plain that they, too, would make the change of place better if they had an even number, in fact if none were missing and they had the limbs which correspond to one another. In this way they could equalize their own weight, and not oscillate to one side, if they had corresponding supports instead of one section of the opposite sides being unoccupied by a limb. A walking creature advances from each of its members alternately, for in this way it recovers the same figure that it had at first.

9 · The fact that all animals have an even number of feet, and the reasons for the fact have been set forth. What follows will explain that if there were no point at

[3]Reading τοῖς δ' ἄλλως ὅλως. [4]Excised by Jaeger.
[5]Jaeger excises 'and do not . . . walk'.

rest flexion and straightening would be impossible. Flexion is a change from a straight line to an arc or an angle, straightening a change from either of these to a straight line. Now in all such changes the flexion or the straightening must be relative to one point. Moreover, without flexion there could not be walking or swimming or flying. For since limbed creatures stand and take their weight alternately on one or other of the opposite legs, if one be thrust forward the other must of necessity be bent. For the opposite limbs are naturally of equal length, and the one which is under the weight must be a kind of perpendicular at right angles to the ground.

When then one leg is advanced it becomes the hypotenuse. Its square then is equal to the square on the side at rest together with the square on the line between the legs. As the legs then are equal, the one at rest must bend either at the knee or, if there were any kneeless animal which walked, at some other articulation. The following exhibits the fact. If a man were to walk parallel to a wall . . .[6] the line described would be not straight but zigzag, becoming lower as he bends, and higher when he stands and lifts himself up.

It is, indeed, possible to move oneself even if the leg be not bent, in the way in which children crawl. This was the old though erroneous account of the movement of elephants. But these kinds of movements involve a flexion in the shoulders or in the hips. Nothing could walk upright continuously and securely without flexions at the knee, but would have to move like men in the wrestling schools who crawl forward through the sand on their knees. For the upper part of the upright creature is long so that its leg has to be correspondingly long; in consequence there must be flexion. For since a stationary position is perpendicular, if that which moves forward cannot bend it will either fall as the right angle becomes acute or will not be able to progress. For if one leg is at right angles to the ground and the other is advanced, the latter will be at once equal and greater. For it will be equal to the stationary leg and also equivalent to the hypotenuse. That which goes forward therefore must bend, and while bending one, extend the other leg simultaneously, so as to incline forward and make a stride and still remain above the perpendicular; for the legs form an isosceles triangle, and the head sinks lower when it is perpendicularly above the base on which it stands.

Of limbless animals, some progress by undulations (and this happens in two ways, either they undulate on the ground, like snakes, or up and down, like caterpillars), and undulation is a flexion; others by crawling, like what are called earthworms and leeches. These go forward, first one part leading and then drawing the whole of the rest of the body up to this, and so they change from place to place. It is plain too that if the two curves were not greater than the one line which subtends them undulating animals could not move themselves; when the flexure is extended they would not have moved forward at all if the flexure were equal; as it is, it reaches further when it is straightened out, and then this part stays still and it draws up what is left behind.

In all the changes described that which moves now extends itself in a straight

[6]The text is corrupt: Michael of Ephesus explains that the man has a brush tied to his head which traces a line along the wall as he walks.

line to progress, and now is hooped; it straightens itself in its leading part, and is hooped in what follows behind. Even jumping animals all make a flexion in the part of the body which is underneath, and after this fashion make their leaps. So too flying and swimming things progress, the one straightening and bending their wings to fly, the other their fins to swim. Of the latter some have four fins, others which are rather long, for example eels, have only two. These swim by substituting a flexion of the rest of their body for the pair of fins to complete the movement, as we have said before. Flat fish use two fins, and the flat of their body as a substitute for the absent pair of fins. Quite flat fish, like the ray, produce their swimming movement with the actual fins and with the outer peripheries of their body, bending and straightening themselves alternately.

10 · A difficulty might perhaps be raised about birds. How, it may be said, can they, either when they fly or when they walk, be said to move at four points? Now we did not say that all Sanguinea move at four points, but merely at not more than four. Moreover, they cannot as a fact fly if their legs be removed, nor walk without their wings. Even a man does not walk without moving his shoulders. Everything indeed, as we have said, makes a change of place by flexion and straightening, for all things progress upon what being beneath them as it were gives way up to a point; accordingly, even if there be no flexion in another member, there must be at least in the point whence motion begins, that is in sheath-winged insects and in birds at the base of the wing, in others at the base of the corresponding member, the fins, for instance, in fishes. In others, for example snakes, the flexion begins in the joints of the body.

In winged creatures the tail serves, like a ship's rudder, to keep the flying thing in its course. The tail then must like other limbs be able to bend at the point of attachment. And so flying insects, and birds whose tails are ill-adapted for the use in question, for example peacocks, and domestic cocks, and generally birds that hardly fly, cannot steer a straight course. Flying insects have absolutely no tail, and so drift along like a rudderless vessel, and beat against anything they happen upon; and this applies equally to sharded insects, like the scarab-beetle and the chafer, and to unsharded, like bees and wasps. Further, birds that are not made for flight have a tail that is of no use; for instance the purple coot and the heron and all water-fowl. These fly stretching out their feet as a substitute for a tail, and use their legs instead of a tail to direct their flight. The flight of insects is slow and frail because the character of their wings is not proportionate to the bulk of their body; this is heavy, their wings small and frail, and so the flight they use is like a cargo boat attempting to make its voyage with oars; now the frailty both of the actual wings and of the outgrowths upon them contributes in a measure to the flight described. Among birds, the peacock's tail is at one time useless because of its size, at another because it is shed. But birds are in general at the opposite pole to flying insects as regards their feathers, but especially the swiftest flyers among them. (These are the birds with curved talons, for swiftness of wing is useful to their mode of life.) The rest of their bodily structure is in harmony with their swift movement, the small head, the slight neck, the strong and acute breastbone (acute like the prow

of a clipper-built vessel, so as to be compact, and strong by dint of its mass of flesh), in order to be able to push away the air that beats against it, and that easily and 710b1
without exhaustion. The hind-quarters, too, are light and taper again, in order to conform to the movement of the front and not by their breadth to sweep the air.

11 · So much then for these questions. But why an animal that is to stand erect must necessarily be a biped, and must also have the superior parts of the body lighter, and those that lie under these heavier, is plain. Only if situated like this could it possibly carry itself easily. And so man, the only erect animal, has legs longer and stouter relatively to the upper parts of his body than any other animal with legs. What we observe in children also is evidence of this. Children cannot walk erect because they are always dwarf-like, the upper parts of their bodies being too long and too stout in proportion to the lower. With advancing years the lower increase disproportionately, until they get their appropriate size, and then they succeed in walking erect. Birds are light yet stand on two legs because their weight is set back, after the principle of horses fashioned in bronze with their forelegs prancing. But their being bipeds and able to stand is above all due to their having the hip-bone shaped like a thigh, and so large that it looks as if they had two thighs, one in the leg before the knee-joint, the other joining this part to the fundament. Really this is not a thigh but a hip, and if it were not so large the bird could not be a biped. As in a man or a quadruped, the thigh and the rest of the leg would be attached immediately to quite a small hip; consequently the whole body would be tilted too far forward. As it is, however, the hip is long and extends right along to the middle of the belly, so that the legs are attached at that point and carry as supports the whole frame. It is also evident from these considerations that a bird cannot possibly be erect in the way in which man is. For as it holds its body now the wings are naturally useful to it, but if it were erect they would be as useless as the wings of 711a1
Cupids we see in pictures. It is clear at the same time from what we said that the form of no human nor any similar being permits of wings; not only because it would, though sanguineous, be moved at more than four points, but also because to have wings would be useless to it when moving naturally. And nature makes nothing contrary to nature.

12 · We have stated above that without flexion in the legs or shoulders and hips no sanguineous animal with feet could progress, and that flexion is impossible except some point be at rest, and that men and birds, both bipeds, bend their legs in opposite directions, and further that quadrupeds bend theirs in opposite directions, and in the opposite way to a man's limbs. For men bend their arms backwards, their legs forwards; quadrupeds their forelegs forwards, their back legs backwards, and in like manner also birds bend theirs. The reason is that nature's workmanship is never purposeless, as we said above, but everything for the best possible in the circumstances. Inasmuch, therefore, as all creatures which naturally have the power of changing position by the use of limbs, must have one leg stationary with the weight of the body on it, and when they move forward the leg which has the

leading position must be unencumbered, and the progression continuing the weight must be shifted to it again, it is evidently necessary for the leg from being bent to become straight again, while the point of movement of the leg thrust forward and its lower part remain still. And it is possible for this to take place and at the same time for the animal to go forward, if the leading leg has its articulation forwards, impossible if it be backwards. For, if it be forwards the stretching out of the leg will occur while the body is going forwards, but, if the other way, while it is going backwards. And again, if the flexion were backwards, the placing of the foot would be made by two movements and those contrary to one another, one, that is, backwards and one forwards; for in the bending together of the limb the end of the thigh would go backwards, and the shin would move the foot forwards away from the flexion; whereas, with the flexion forwards, the progression described will be performed not with contrary motions, but with one forward motion.

Now man, being a biped and making his change of position in the natural way with his two legs, bends them forward for the reasons set forth, but his arms bend backwards reasonably enough. If they bent the opposite way they would be useless for the work of the hands, and for taking food. But quadrupeds which are viviparous[7] necessarily bend their front legs forwards. For these lead when they move, and are also in the fore-part of their body. The reason that they bend forward is the same as in the case of man, for in this respect they are like mankind. And so quadrupeds as well bend these legs forward in the manner described. Moreover, if the flexion is like this, they are enabled to lift their feet high; if they bent them in the opposite way they would only lift them a little way from the ground, because the whole thigh and the joint from which the shin-bone springs would lie under the belly as the beast moved forward. If, however, the flexion of the hind legs were forwards the lifting of these feet would be similar to that of the forefeet (for the hind legs, too, would in this case have only a little room for their lifting inasmuch as both the thigh and the knee-joint would fall under the position of the belly); but the flexion being backwards, as in fact it is, nothing comes in the way of their progression with this mode of moving the feet. Moreover, it is necessary or at least better for their legs to bend thus when they are suckling their young, with a view to such ministrations. If the flexion were inwards it would be difficult to keep their young under them and to shelter them.

13 · Now there are four modes of flexion if we take the combinations in pairs.[8] Fore and hind may bend either both backwards, as the figures marked A, or in the opposite way both forwards, as in B, or in converse ways and not in the same direction, as in C where the fore bend forwards and the hind bend backwards, or as in D, the opposite way to C, where the convexities are turned towards one another and the concavities outwards. Now no biped or quadruped bends his limbs like the figures A or B, but the quadrupeds like C, and like D only the elephant among quadrupeds and man if you consider his arms as well as his legs. For he bends his arms concavely and his legs convexly.

[7] Reading καὶ ζῳοτόκα.
[8] Reading συνδυασμούς.

In man, too, the flexions of the limbs are always alternately opposite; for example the elbow bends back, but the wrist of the hand forwards, and again the shoulder forwards. In like fashion, too, in the case of the legs, the hip backwards, the knee forwards, the ankle in the opposite way backwards. And plainly the lower limbs are opposed in this respect to the upper, because the first principles are opposed, the shoulder bending forwards, the hip backwards; and that is why the ankle bends backwards, and the wrist of the hand forwards.

14 · This is the way then the limbs bend, and for the reasons given. But the hind limbs move criss-cross with the fore limbs; after the right fore they move the left hind, then the left fore, and then the right hind. The reason is that if they moved the forelegs together and first, the animal would be wrenched or the progression would be a stumbling forwards with the hind parts as it were dragged after. Again, that would not be walking but jumping, and it is hard to make a continuous change of place, jumping all the time. Here is evidence of what I say; even as it is, all horses that move in this way soon begin to refuse, for example the horses in a religious procession. For these reasons the fore limbs and the hind limbs do not move in this 712b1 separate way. And if they moved both the right legs first the weight would be outside the supporting limbs and they would fall. If then it is necessary to move in one or other of these ways or criss-cross fashion, and neither of these two is possible, they must move criss-cross; for moving in the way we have said they cannot possibly experience either of these results. And this is why horses and such-like animals stand still with their legs put forward criss-cross, not with the right or the left put forward together at once. In the same fashion animals with more than four legs make their movements; if you take two consecutive pairs of legs the hind always move criss-cross with the forelegs; you can see this if you watch them moving slowly. Even crabs move in this way, and they are polypods. They, too, always move criss-cross in whichever direction they are making progress. For this animal has a movement all its own; it is the only animal that moves not forwards, but obliquely. Yet since forwards is a distinction relative to the line of vision, nature has made its eyes able to conform to its limbs; for its eyes can move themselves obliquely, and therefore after a fashion crabs too in this sense move forwards.

15 · Birds bend their legs in the same way as quadrupeds. For their natural construction is broadly speaking nearly the same. That is, in birds the wings are a substitute for the forelegs; and so they are bent in the same way as the forelegs of a quadruped, since when they move to progress the natural beginning of change is from the wings. Flight in fact is their appropriate movement. And so if the wings be cut off a bird can neither stand still nor go forwards.

Again, the bird though a biped is not erect, and has the forward parts of the body lighter than the hind, and so it is necessary (or at least better) for the standing posture to have the thigh so placed below the body as it actually is, I mean growing towards the back. If then it must have this situation the flexion of the leg must be backwards, as in the hind legs of quadrupeds. The reasons are the same as those 713a1 given in the case of viviparous quadrupeds.

In general, in the case of birds and winged insects, and animals which swim in a watery medium, all I mean that make their progress in water by dint of organs of movement, it is not difficult to see that it is better to have the attachment of the parts in question oblique to the frame, exactly as in fact we see it to be both in birds and insects. And this same arrangement obtains also among fishes. Among birds the wings are attached obliquely; so are the fins in water animals, and the wings of insects.[9] In this way they divide[10] the air or water most quickly and with most force and so effect their movement. For the hinder parts in this way would follow forwards as they are carried along in the yielding medium, some in the water, others in the air.

Of oviparous quadrupeds all those that live in holes, like crocodiles, lizards, spotted lizards, freshwater tortoises, and turtles, have their legs attached obliquely and stretched out over the ground, and bend them obliquely. The reason is that this is useful for ease in creeping into holes, and for sitting upon their eggs and guarding them. And as they project outwards they must of necessity tuck in their thighs and put them under them in order to achieve the lifting of the whole body. In view of this they cannot bend them otherwise than outwards.

16 · We have already stated the fact that non-sanguineous animals with limbs are polypods and none of them quadrupeds. And the reason why their legs, except the extreme pairs, are necessarily attached obliquely and have their flexions upwards, and the legs themselves are somewhat bowed backwards is plain. In all such creatures the intermediate legs both lead and follow. If then they were under
713b1 them, they would have to have their flexion both forwards and backwards; on account of leading, forwards; and on account of following, backwards. Now since they have to do both, for this reason their limbs are bowed and bent obliquely, except the extreme pairs. (These are more natural in their movement, the front leading and the back following.) Another reason for this kind of flexion is the number of their legs; arranged in this way they would interfere less with one another in progression and not knock together. But the reason that they are bandy is that all of them or most of them live in holes; for creatures living so cannot possibly be high above the ground.

But crabs are in nature the oddest of the polypods; they do not progress forwards except in the sense explained above, and they are the only animals which have more than one pair of leading limbs. The explanation of this is the hardness of their limbs, and the fact that they use them not for swimming but for walking; they always keep on the ground. However, the flexion of the limbs of all polypods is oblique, like that of the quadrupeds which live in holes—for example lizards and crocodiles and many of the oviparous quadrupeds. And the explanation is that some of them in their breeding periods, and some all their life, live in holes.

[9]Jaeger excises 'and the wings of insects'.
[10]Omitting συστέλλοντα καί.

17 · Now the rest have bandy legs because they are soft-skinned, but the crayfish is hard-skinned and its limbs are for swimming and not for walking. Crabs, too, have their limbs bent obliquely, but not bandy like oviparous quadrupeds and non-sanguineous polypods, because their limbs have a hard and shell-like skin, although they do not swim but live in holes; they live in fact on the ground. Moreover, their shape is round, and they have not a tail like the crayfish; a tail is useful to the crayfish for swimming, but the crab is not a swimming creature. Further, it alone has its side equivalent to a hinder part, because it has many leading feet. The explanation of this is that its flexions are not forward nor its legs bandy. We have given above the reason why its legs are not bandy, that is the hardness and shell-like character of its integument.

For these reasons then it must lead off with all its legs and move obliquely; obliquely, because the flexion is oblique; and with all its legs, because otherwise the limbs that were still would have got in the way of those that were moving.

Fishes of the flat kind swim as one-eyed men walk; they have their natural shape distorted. Web-footed birds swim with their feet; because they take in air and breathe they are bipeds, but because they have their home in the water they are webbed; by this arrangement their feet serve them instead of fins. They have their legs too, not like the rest of birds in the centre of their body, but rather set back. Their legs are short, and being set back are serviceable for swimming. The reason for their having short legs is that nature has added to their feet by subtracting from the length of their limbs and instead of length has given stoutness to the legs and breadth to the feet. Broad feet are more useful than long for pushing away the water when they are swimming.

18 · There is reason, too, for winged creatures having feet, but fish none. The former have their home in the dry medium, and cannot remain always in mid air; they must therefore have feet. Fish on the contrary live in the wet medium, and take in water, not air. Fins are useful for swimming, but feet not. And if they had both they would be non-sanguineous. There is a broad similarity between birds and fishes: birds have their wings on the superior part, similarly fish have two pectoral fins; again, birds have legs on their under parts and most fish have fins on the under parts and near the pectorals. Birds, too, have a tail and fish a tail-fin.

19 · A difficulty may be suggested as to the movements of molluscs, that is, as to where that movement originates; for they have no distinction of left and right. Now observation shows them moving. We must, I think, treat all this class as mutilated, and as moving in the way in which limbed creatures do when one cuts off their legs, or[11] as analogous with the seal and the bat. Both the latter are quadrupeds but misshapen. Now molluscs do move, but move in a manner contrary to nature. They are not moving things, but are moving if regarded as sedentary creatures and creatures attached by growth, sedentary if classed with progressing animals.

[11]Reading ἢ ὥσπερ.

As to right and left, crabs, too, show the distinction poorly, still they do show it. You can see it in the claw; the right claw is larger and stronger, as though the right and left sides were trying to get distinguished.

The structure of animals, both in their other parts, and especially in those which concern progression and any movement in place, is as we have now described. It remains, after determining these questions, to investigate the soul.

GENERATION OF ANIMALS

A. Platt

BOOK I

1 · We have now discussed the other parts of animals, both generally and with reference to the peculiarities of each kind, explaining how each part exists on account of such a cause, and I mean by this the cause for the sake of something. 715a1

There are four causes: first, the final cause, that for the sake of which; secondly, the definition of essence (and these two we may regard pretty much as one and the same); thirdly, the material; and fourthly, that from which the source of movement comes.

We have then already discussed the other three causes, for the definition and the final cause are the same, and the material of animals is their parts— of the whole animal the non-homogeneous parts, of these again the homogeneous, and of these last the so-called elements of bodies. It remains to speak of those parts which contribute to the generation of animals and of which nothing definite has yet been said, and to explain what is the moving cause. To inquire into this last and to inquire into the generation of each animal is in a way the same thing; and, therefore, my plan has united them together, arranging the discussion of these parts last, and the beginning of the question of generation next to them.

Now some animals come into being from the union of male and female, i.e. all those kinds of animal which possess the two sexes. This is not the case with all of them; though in the sanguinea with few exceptions the creature, when its growth is complete, is either male or female, and though some bloodless animals have sexes so that they generate offspring of the same kind, yet other bloodless animals generate indeed, but not offspring of the same kind; such are all that come into being not from a union of the sexes, but from decaying earth and excrements. To speak generally, if we take all animals which change their locality,[1] some by swimming, others by flying, others by walking, we find in these the two sexes, not only in the sanguinea but also in some of the bloodless animals; and this applies in the case of

TEXT: H. J. Drossaart Lulofs, OCT, Oxford, 1965

[1] Reading ἐστί for ὄντα.

715b1 the latter sometimes to the whole class, as the cephalopoda and crustacea, but in the class of insects only to the majority. Of these, all which are produced by union of animals of the same kind generate also after their kind, but all which are not produced by animals, but from decaying matter, generate indeed, but produce another kind, and the offspring is neither male nor female; such are some of the insects. This is what might have been expected; for if those animals which are not produced by parents had themselves united and produced others, then their offspring must have been either like or unlike themselves. If like, then their parents ought to have come into being in the same way; this is only a reasonable postulate to make, for it is plainly the case with other animals. If unlike, and yet able to copulate, then there would have come into being again from them another kind of creature and again another from these, and this would have gone on to infinity. But nature flies from the infinite; for the infinite is imperfect, and nature always seeks an end.

But all those creatures which do not move, as the testacea and animals that live by clinging to something else, inasmuch as their nature resembles that of plants, have no sex any more than plants have, but as applied to them the word is only used in virtue of a similarity and analogy. For there is a slight distinction of this sort, since even in plants we find in the same kind some trees which bear fruit and others which, while bearing none themselves, yet contribute to the ripening of the fruits of those which do, as in the case of the fig-tree and caprifig.

The same holds good also in plants, some coming into being from seed and others, as it were, by the spontaneous action of nature, arising either from decomposition of the earth or of some parts in other plants; for some are not formed
716a1 by themselves separately but are produced upon other trees, as the mistletoe. Plants, however, must be investigated separately.

2 · Of the generation of animals we must speak as various questions arise in order in the case of each, and we must connect our account with what has been said. For, as we said above, the male and female principles may be put down first and foremost as origins of generation, the former as containing the efficient cause of generation, the latter the material of it. The most convincing proof of this is drawn from considering how and whence comes the semen; for it is out of this that those creatures are formed which are produced in the ordinary course of nature; but we must observe carefully the way in which this semen actually comes into being from the male and female. For it is just because the semen is secreted from the two sexes, the secretion taking place *in* them and *from* them, that they are first principles of generation. For by a male animal we mean that which generates in another, and by a female that which generates in itself; that is why in the macrocosm also, men think of the earth as female and a mother, but address heaven and the sun and other like entities as progenitors and fathers.

Male and female differ in their definition by each having a separate faculty, and to perception by certain parts; by definition the male is that which is able to generate in another, as said above; the female is that which is able to generate in itself and out of which comes into being the offspring previously existing in the generator. And since they are differentiated by a faculty and by their function, and since instruments are needed for all functioning, and since the bodily parts are the instruments to serve the faculties, it follows that certain parts must exist for union and production of offspring. And these must differ from each other, so that consequently the male will differ from the female. (For even though we speak of the animal as a whole as male or female, yet really it is not male or female in virtue of the whole of itself, but only in virtue of a certain faculty and a certain part—just as with sight or locomotion—which part is also plain to sense-perception.)

Now as a matter of fact such parts are in the female the so-called uterus, in the male the testes and the penis, in all the sanguinea; for some of them have testes and others the corresponding passages. There are corresponding differences of male and female in all the bloodless animals also which have this division into opposite sexes. 716b1
But if in the sanguinea the parts concerned in copulation differ in their forms, we must observe that a small change in a first principle is usually attended by changes in many of the things depending on it. This is plain in the case of castrated animals; for, though only the generative part is disabled, yet pretty well the whole form of the animal changes in consequence so much that it seems to be female or not far short of it, and thus it is clear that an animal is not male or female in virtue of any random part or faculty. Clearly, then, the distinction of sex is a first principle; at any rate, when that which distinguishes male and female suffers change, many other changes accompany it, as would be the case if a first principle is changed.

3 · The sanguinea are not all alike as regards testes and uterus. Taking the former first, we find that some of them have not testes at all, as the classes of fish and of serpents, but only two spermatic ducts. Others have testes indeed, but internally by the loin in the region of the kidneys, and from each of these a duct, as in the case of those animals which have no testes at all; these ducts unite also as with those animals; this applies (among animals breathing air and having a lung) to all birds and oviparous quadrupeds. For all these have their testes internal near the loin, and two ducts from these in the same way as serpents; I mean the lizards and tortoises and all the scaly reptiles. But all the vivipara have their testes in front; some of them inside at the end of the abdomen, as the dolphin, not with ducts but with a penis projecting externally from them as in the ox-fish; others outside, either pendent as in man or towards the fundament as in swine. They have been discriminated more accurately in the *History of Animals*.[2]

The uterus is always double, just as the testes are always two in the male. It is situated either near the pudendum (as in women, and all those animals which bring forth alive not only externally but also internally, and all fish that lay eggs 717a1
externally) or up towards the hypozoma (as in all birds and in viviparous fishes). The uterus is also double in the crustacea and the cephalopoda; for the membranes which include their so-called eggs are of the nature of a uterus. It is particularly

[2] *History of Animals* III 1.

hard to distinguish in the case of the octopus, so that it seems to be single, but the reason of this is that the bulk of the body is everywhere similar.

It is double also in the larger insects; in the smaller it is indistinct owing to the small size of the body.

Such is the description of the aforesaid parts of animals.

4 · With regard to the difference of the spermatic organs in males, if we are to investigate the causes of their existence, we must first grasp the final cause of the testes. Now if nature makes everything either because it is necessary or because it is better so, this part also must be for one of these two reasons. But that it is not necessary for generation is plain; for in that case it would have been possessed by all creatures that generate, but as it is neither serpents have testes nor have fish; for they have been seen uniting and with their ducts full of milt. It remains then that it must be because it is somehow better so. Now it is true that the business of most animals is, you may say, nothing else than to produce young, as the business of a plant is to produce seed and fruit. But still as, in the case of nutriment, animals with straight intestines are more violent in their desire for food, so those which have not testes but only ducts, or which have them indeed but internally, are all quicker in accomplishing copulation. But those which are to be more temperate in the one case have not straight intestines, and in the other have their ducts twisted to prevent their desire being too violent and hasty. It is for this that the testes are contrived; for they make the movement of the spermatic secretion steadier, preserving the folding back of the passages in the vivipara, as horses and the like, and in man. (For details see the *History of Animals*.)[3] For the testes are no part of the ducts but are only attached to them, as women fasten stones to the loom when weaving; if they are 717b1 removed the ducts are drawn up internally, so that castrated animals are unable to generate; if they were not drawn up they would be able, and before now a bull mounting immediately after castration has caused conception in the cow because the ducts had not yet been drawn up. In birds and oviparous quadrupeds the testes receive the spermatic secretion, so that its expulsion is slower than in fishes. This is clear in the case of birds, for their testes are much enlarged at the time of copulation, and all those which pair at one season of the year have them so small when this time is past that they are almost indiscernible, but during the season they are very large. When the testes are internal the act of copulation is quicker, for when the testes are external the semen is not emitted before the testes are drawn up.

5 · Besides, quadrupeds have the organ of copulation, since it is possible for them to have it, but for birds and the footless animals it is not possible, because the former have their legs under the middle of the abdomen and the latter have no legs at all; now the penis depends from that region and is situated there. (That is why the legs are strained in intercourse, both the penis and the legs being sinewy.) So that,

[3] *History of Animals* 510a20ff.

since it is not possible for them to have this organ, they must necessarily either have no testes also, or at any rate not have them there, as those animals that have both penis and testes have them in the same situation.

Further, with those animals at any rate that have external testes, the semen is collected together before emission, and emission is due to the penis being heated by its movement; it is not ready for emission at immediate contact as in fishes.

All the vivipara have their testes in front, internally or externally, except the hedgehog; he alone has them near the loin. This is for the same reason as with birds, because their union must be quick, for the hedgehog does not, like the other quadrupeds, mount upon the back of the female, but they conjugate standing upright because of their spines.

So much for the reasons why those animals have testes which have them, and why they are sometimes external and sometimes internal.

6 · All those animals which have no testes are deficient in this part, as has been said, not because it is better to be so but simply because of necessity, and secondly because it is necessary that their copulation should be speedy. Such is the nature of fish and serpents. Fish copulate throwing themselves alongside of the females and separating again quickly. For as men and all such creatures must hold their breath before emitting the semen, so fish at such times must cease taking in the sea-water, and then they perish easily. Therefore they must not mature the semen during copulation, as viviparous land-animals do, but they have it all matured together at the time, so as not to be maturing it while in contact but to emit it ready matured. So they have no testes, and the ducts are straight and simple. There is a small part similar to this connected with the testes in the system of quadrupeds, for part of the folded duct is sanguineous and part is not; the fluid is already semen when it is received by and passes through this latter part, so that once it has arrived there it is soon emitted in these quadrupeds also. Now in fishes the *whole* passage resembles the last section of the folded part of the duct in man and similar animals.

7 · Serpents copulate twining round one another, and, as said above, have neither testes nor penis, the latter because they have no legs, the former because of their length, but they have ducts like fish; for on account of their extreme length the seminal fluid would take too long in its passage and be cooled if it were further delayed by testes. (This happens also if the penis is large; such men are less fertile than when it is smaller because the semen, if cold, is not generative, and that which is carried too far is cooled.) So much for the reason why some animals have testes and others not. Serpents intertwine because of their inaptitude to cast themselves alongside of one another. For they are too long to unite closely with so small a part and have no organs of attachment, so they make use of the suppleness of their bodies, intertwining. That is why they seem to be slower in copulation than fish, not only on account of the length of the ducts but also of this elaborate arrangement in uniting.

8 · It is not easy to state the facts about the uterus in female animals, for there are many points of difference. The vivipara are not all alike in this part; women and all the vivipara with feet have the uterus low down by the pudendum, 718b1 but the viviparous selachia have it higher up near the hypozoma. In the ovipara, again, it is low in fish (as in women and the viviparous quadrupeds), high in birds and all oviparous quadrupeds. Yet even these differences are on a principle. To begin with the ovipara, they differ in the manner of laying their eggs, for some produce them imperfect, as fishes whose eggs increase and are finally developed outside of them. The reason is that they produce many young, and this is their function as it is with plants. If then they perfected the egg in themselves they must needs be few in number, but as it is, they have so many that each uterus seems to be an egg, at any rate in the small fishes. For these are the most productive, just as with the other animals and plants whose nature is analogous to theirs, for the increase of size turns with them to seed.

But the eggs of birds and the quadrupedal ovipara are perfect when produced. In order that these may be preserved they must have a hard covering (for their envelope is soft so long as they are increasing in size), and the shell is made by heat squeezing out the moisture from the earthy material; consequently the place must be hot in which this is to happen. But the part about the hypozoma *is* hot, as is shown by that being the part which concocts the food. If then the eggs must be within the uterus, then the uterus must be near the hypozoma in those creatures which produce their eggs in a perfect form. Similarly it must be low down in those which produce them imperfect, for it is advantageous that it should be so. And it is more natural for the uterus to be low down than high up, when nature has no other business in hand to hinder it; for its end is low down, and where is the end, there is the function, and the uterus itself is naturally where the function is.

9 · We find differences in the vivipara also as compared with one another. Some produce their young alive, not only externally, but also internally, as men, horses, dogs, and all those which have hair, and among aquatic animals, dolphins, whales, and such cetacea.

10 · But the selachia and the vipers produce their young alive externally, but first produce eggs internally. The egg is perfect, for so only can an animal be generated from an egg, and nothing comes from an imperfect one. It is because they are of a cold nature, not hot as some assert, that they do not lay their eggs externally.

11 · At least they certainly produce their eggs in a soft envelope, the reason being that they have but little heat and so their nature does not complete the process of drying the egg-shell. Because, then, they are cold they produce soft-shelled eggs, 719a1 and because the eggs are soft they do not produce them externally; for that would have caused their destruction.

When an animal is produced from an egg, the process is for the most part the same as in birds, for the egg descends and the young is hatched from it near the vagina, where the young is produced in those animals which are viviparous from the beginning. Therefore in such animals the uterus is dissimilar to that of both the vivipara and ovipara, because they participate in both classes; for it is at once near the hypozoma and also stretching along downwards in all the selachia. But the facts about this and the other kinds of uterus must be gathered from the *Anatomies* and from the *History*.[4] Thus, because they are oviparous, laying perfect eggs, they have the uterus placed high, but, as being viviparous, low, participating in both classes.

Animals that are viviparous from the beginning all have it low, nature here having no other business to interfere with her, and their production having no double character. Besides this, it is impossible for animals to be produced alive near the hypozoma, for the foetus must needs be heavy and move, and that region in the mother is vital and would not be able to bear the weight and the movement. Thirdly, parturition would be difficult because of the length of the passage to be traversed; even as it is there is difficulty with women if they draw up the uterus in parturition by yawning or anything of the kind, and even when empty it causes a feeling of suffocation if moved upwards. For if a uterus is to hold a living animal it must be stronger than in ovipara, and therefore in all the vivipara it is fleshy, whereas when the uterus is near the hypozoma it is membranous. And this is clear also in the case of the animals which produce young by the mixed method, for their eggs are high up and sideways, but the living young are produced in the lower part of the uterus.

So much for the reason why differences are found in the uterus of various animals, and generally why it is low in some and high in others near the hypozoma.

12 · Why is the uterus always internal, but the testes sometimes internal, sometimes external? The reason for the uterus always being internal is that in this is contained the offspring which needs guarding, shelter, and concoction, while the outer surface of the body is easily injured and cold. The testes vary in position because they also need shelter and a covering to preserve them and to mature the 719b1
semen; for it would be impossible for them, if chilled and stiffened, to be drawn up and discharge it. Therefore, whenever the testes are visible, they have a cuticular covering known as the scrotum. If the nature of the skin is opposed to this, being too hard to be adapted for enclosing them or for being soft like a true skin,[5] as with the scaly integument of fish and reptiles, then the testes must be internal. Therefore they are so in dolphins and all the cetacea which have them, and in the oviparous quadrupeds among the scaly animals. The skin of birds also is hard so that it will not conform to the size of anything and enclose it neatly. (This is another reason with all these animals for their testes being internal besides those previously mentioned as arising necessarily from the details of copulation.) For the same reason they are internal in the elephant and hedgehog, for the skin of these, too, is not well suited to keep the protective part separate.

[4]*History of Animals* III 1.
[5]Drossaart Lulofs excises 'like a true skin'.

The position of the uterus differs in animals viviparous within themselves and those externally oviparous, and in the latter class again it differs in those which have the uterus low and those which have it near the hypozoma, as in fishes compared with birds and oviparous quadrupeds. And it is different again in those which produce young in both ways, being oviparous internally and viviparous externally. For those which are viviparous both internally and externally have the uterus placed on the abdomen, as men, cattle, dogs, and the like, since it is expedient for the safety and growth of the foetus that no weight should be upon the uterus.

13 · The passages also are different through which the solid and liquid excreta pass out in all the vivipara. That is why both males and females in this class all have a part whereby the urine is voided, and this serves also for the issue of the semen in males, of the offspring in females. This passage is situated above and in front of the passage of the solid excreta. Those ovipara that produce imperfect eggs; 720a1 e.g. the oviparous fish, have their uterus not under the abdomen but near the loin; for the growth of the egg does not hinder this, since the growing creature is perfected and develops externally.[6] The passage is the same as that of the solid nutriment in all those animals that have no penis, in all the ovipara, even those of them that have a bladder, as the tortoises. For it is for the sake of generation, not for the evacuation of the urine, that the passages are double; but because the semen is naturally liquid, the liquid excretion also shares the same passage. This is clear from the fact that all animals produce semen, but all do not void liquid excrement. Now the spermatic passages of the male must be fixed and must not wander, and the same applies to the uterus of the female, and this fixing must take place at either the front or the back of the body. To take the uterus first, it is in the front of the body in vivipara because of the foetus, but at the loin and the back in ovipara. All animals which are internally oviparous and externally viviparous are in an intermediate condition because they participate in both classes, being at once oviparous and viviparous. For the upper part of the uterus, where the eggs are produced, is under the hypozoma by the loin and the back, but as it advances[7] is low at the abdomen; for it is in that part that the animal is viviparous. In these also the passage for solid excrement and for copulation is the same, for none of these, as has been said already, has a separate pudendum.

The same applies to the passages in the male, whether they have testes or no, as to the uterus of the ovipara. For in all of them, the ducts adhere to the back and the region of the spine. For they must not wander but be settled, and that is the character of the region of the back, which gives continuity and stability. Now in those which have internal testes, the ducts are fixed from the first, and they are fixed in like manner if the testes are external; then they meet together towards the region of the penis.

The like applies to the ducts in the dolphins, but they have their testes hidden under the abdominal cavity.

[6]Drossaart Lulofs excises 'Those ovipara . . . develops externally'.
[7]Reading προϊοῦσα.

We have now discussed the situation of the parts contributing to generation, and the causes thereof. 720b1

14 · The bloodless animals do not agree either with the sanguinea or with each other in the fashion of the parts contributing to generation. There are four classes still left to deal with, first the crustacea, secondly the cephalopoda, thirdly the insects, and fourthly the testacea. We cannot be certain about all of them, but that most of them do not copulate is plain; in what manner they unite must be stated later.

The crustacea copulate like the retromingent quadrupeds, fitting their tails to one another, the one supine and the other prone. For the fins attached to the sides of the tail being long prevent them from uniting with the belly against the back. The males have fine spermatic ducts, the females a membranous uterus alongside the intestine, cloven on each side, in which the egg is produced.

15 · The cephalopoda entwine together at the mouth, pushing against one another and enfolding their tentacles. This attitude is necessary, because nature has bent backwards the end of the intestine and brought it round near the mouth, as has been said before in the treatise on *Parts of Animals*.[8] The female has a part corresponding to the uterus, plainly to be seen in each of these animals, for it contains an egg which is at first indistinct but afterwards splits up into many; each of these eggs is imperfect when deposited, as with the oviparous fishes. In the cephalopoda (as also in the crustacea) the same passage serves to void the excrement and leads to the part like a uterus,† for the male discharges the seminal fluid through this passage. And it is†[9] on the lower surface of the body, where the mantle is open and the sea-water enters the cavity. Hence the union of the male with the female takes place at this point, for it is necessary, if the male discharges either semen or a part of himself or any other force, that he should unite with her at the uterine passage. But the insertion, in the case of the octopus, of the tentacle of the male into the funnel of the female, by which tentacle the fishermen say the male copulates with her, is only for the sake of attachment, and it is not an organ useful for generation, for it is outside the passage and indeed outside the body.

Sometimes also cephalopoda unite by the male mounting on the back of the female, but whether for generation or some other cause has not yet been 721a1
observed.

16 · Some insects copulate and the offspring are produced from animals of the same name, just as with the sanguinea; such are the locusts, cicadae, spiders, wasps, and ants. Others unite indeed and generate; but the result is not a creature of the same kind, but only a grub, and these insects do not come into being from animals but from putrefying matter, liquid or solid; such are fleas, flies, and cantharides. Others again are neither produced from animals nor unite with each

[8] *Parts of Animals*, IV 9—Drossaart Lulofs excises the reference.
[9] The text of the obelized passage is uncertain.

other; such are gnats, mosquitoes, and many similar kinds. In most of those which unite the female is larger than the male. The males do not appear to have spermatic passages. In most cases the male does not insert any part into the female, but the female from below upwards into the male; this has been observed in many cases (as also that the male mounts the female),[10] the opposite in few cases; but observations are not yet comprehensive enough to enable us to make a distinction of classes. And generally it is the rule with most of the oviparous fish and oviparous quadrupeds that the female is larger than the male because this is expedient in view of the increase of bulk in conception by reason of the eggs. In the female the part analogous to the uterus is cleft and extends along the intestine, as with the other animals; in this are produced the results of conception. This is clear in locusts and all other large insects whose nature it is to unite—most insects are too small.

Such is the character of the generative organs in animals which were not spoken of before. It remains now to speak of the homogeneous parts concerned, the seminal fluid and milk. We will take the former first, and treat of milk afterwards.

17 · Some animals manifestly emit semen, as all the sanguinea, but whether the insects and cephalopoda do so is uncertain. Therefore this is a question to be considered, whether all males do so, or not all; and if not all, why some do and some not; and whether the female also contributes any semen or not; and, if not semen, whether she does not contribute anything else either, or whether she contributes something else which is not semen. We must also inquire what those animals which emit semen contribute by means of it to generation, and generally what is the nature of semen, and of the menstrual flow in all animals which discharge this liquid.

Now it is thought that all animals are generated out of semen, and that the semen comes from the parents. That is why it is part of the same inquiry to ask whether both male and female produce it or only one of them, and to ask whether it comes from the whole of the body or not from the whole; for if the latter is true it is reasonable to suppose that it does not come from both parents either. Accordingly, since some say that it comes from the whole of the body, we must investigate this question first.

The proofs from which it can be argued that the semen comes from each and every part of the body[11] may be reduced to four. First, the intensity of the pleasure of coition; for the same state of feeling is more pleasant if multiplied, and that which affects all the parts is multiplied as compared with that which affects only one or a few. Secondly, the argument that mutilated parents produce mutilated offspring; for they argue that since the parent is deficient in this part the semen does not come from thence, and the result is that the corresponding part is not formed in the offspring. Thirdly, the resemblances to the parents; for the young are born like them part for part as well as in the whole body; if then the coming of the semen from the whole body is cause of the resemblance of the whole, so the parts would be like because it comes from each of the parts. Fourthly, it would seem to be reasonable to

[10] Drossaart Lulofs excises the parenthetical sentence.
[11] Drossaart Lulofs excises 'that the semen . . . the body'.

say that as there is some first thing from which the whole arises, so it is also with each of the parts, and therefore if semen is cause of the whole so each of the parts would have a seed peculiar to itself. And these opinions are plausibly supported by such evidence as that children are born with a likeness to their parents, not only in congenital but also in acquired characteristics; for before now, when the parents have had scars, the children have been born with a mark in the form of the scar in the same place, and there was a case at Chalcedon where the father had a brand on his arm and the letter was marked on the child, only confused and not clearly articulated. That is pretty much the evidence on which some believe that the semen comes from all the body.

18 · On examining the question, however, the opposite appears more likely; 722a1
for it is not hard to refute the above arguments and besides the view involves impossibilities. First, then, the resemblance of children to parents is no proof that the semen comes from the whole body, because the resemblance is found also in voice, nails, hair, and way of moving, from which nothing comes. And men generate before they yet have certain characters, such as a beard or grey hair. Further, children are like their more remote ancestors from whom nothing has come; for the resemblances recur at an interval of many generations, as in the case of the woman in Elis who had intercourse with a negro; her daughter was not negroid but the son of that daughter was. The same thing applies also to plants; for it is clear that if this theory was true the seed would come from all parts of plants also; but often a plant does not possess one part, and another part may be removed, and a third grows afterwards. Besides, the seed does not come from the pericarp, and yet this also comes into being with the same form as in the parent plant.

We may also ask whether the semen comes from each of the homogeneous parts only, such as flesh and bone and sinew, or also from the heterogeneous, such as face and hands. For if from the former only, we object that the resemblance exists rather in the latter; if then it is not because of the semen coming from all parts that children resemble their parents in *these,* what is there to stop the homogeneous parts also from being like for some other reason than this? If the semen comes from the heterogeneous alone, then it does not come from all parts; but it is more fitting that it should come from the homogeneous parts, for they are prior to the heterogeneous which are composed of them; and as children are born like their parents in face and hands, so they are in flesh and nails. If the semen comes from both, what would be the manner of generation? For the heterogeneous parts are composed of the homogeneous, so that to come from the former would be to come from the latter and from their composition. Similarly, take a written name: if anything came from the whole of it, it would be from each of the syllables, and if from these, from the letters and their composition. So that if really flesh and bones are composed of fire and the like elements, the semen would come rather from the elements; for how can it come from their composition? Yet without this composition there would be no resemblance. If again something creates this composition later, it 722b1
would be *this* that would be the cause of the resemblance, not the coming of the semen from every part of the body.

Further, if the parts of the future animal are separated in the semen, how do they live? and if they are connected, they would form a small animal.

And what about the generative parts? For that which comes from the male is not similar to what comes from the female.

Again, if the semen comes from all parts of both parents alike, the result is *two* animals; for the offspring will have all the parts of both. That is why Empedocles seems to say what agrees pretty well with this view (if we are to adopt it), to a certain extent at any rate, but to be wrong if we think otherwise.[12] For he declares that there is a sort of tally in the male and female, and that the whole offspring does not come from either, 'but sundered is the fashion of limbs, some in man's . . .'[13] For why does not the female generate from herself if the semen comes from all parts alike and she has a receptacle? But, it seems, either it does not come from all the parts, or if it does it is in the way Empedocles says, not the same parts coming from each parent, which is why they need intercourse with each other.

Yet this also is impossible, just as much as it is impossible for the parts when full grown to survive and have life in them when torn apart, as Empedocles accounts for the creation of animals in the time of his Reign of Love, saying that 'many heads sprang up without necks',[14] and later on these isolated parts combined into animals. Now that *this* is impossible is plain, for neither would the separate parts be able to survive without having any soul or life in them, nor if they were living things, so to say, could several of them combine so as to become one animal again. Yet those who say that semen comes from the whole of the body really have to talk in that way, and as it happened then in the earth during the Reign of Love, so it happens according to them in the body. Now it is impossible that the parts should be united together when they come into being and should come from different parts of the parent, meeting together in one place. Then how can the upper and lower, right and left, front and back parts have been sundered? All these points are unintelligible. Further, some parts are distinguished by possessing a faculty, others by being in certain conditions; the heterogeneous, as tongue and hand, by the faculty of doing something, the homogeneous by hardness and softness and the other similar conditions. Blood, then, will not be blood, nor flesh flesh, in any and every state. It is clear, then, that that which comes from any part, as blood from blood or flesh from
723a1 flesh, will not be synonymous with that part. But if it is something different from which the blood comes, the coming of the semen from all the parts will not be the cause of the resemblance, as is held by the supporters of this theory. For if blood is formed from something which is not blood, it is enough that the semen come from one part only; for why should not all the parts be formed from one part? Indeed, this theory seems to be the same as that of Anaxagoras, that none of the homogeneous parts come into being, except that these theorists assume, in the case of the generation of animals, what he assumed of everything.

Then, again, how will these parts that came from all the body grow? It is true that Anaxagoras plausibly says that flesh out of the food is added to the flesh. But if

[12]Drossaart Lulofs excises 'to a certain . . . otherwise'.
[13]Frag. 63 Diels-Kranz.
[14]Frag. 57 Diels-Kranz.

we do not say this (while saying that semen comes from all parts of the body), how will the foetus become greater by the addition of something else if that which is added remain unchanged? But if that which is added *can* change, then why not say that the semen from the very first is of such a kind that blood and flesh can be made out of it, instead of saying that it itself *is* blood and flesh? Nor can we say that it is increased later by a process of mixing, as wine when water is poured into it. For in that case each element would be itself *at first* while still unmixed, but the fact rather is that flesh and bone and each of the other parts is such *later*. And to say that some part of the semen is sinew and bone is quite above us, as the saying is.

Besides all this there is a difficulty if the sex is determined in conception (as Empedocles says: 'it is shed in clean vessels; some wax female, if they fall in with cold').[15] Anyhow, it is plain that both men and women change not only from infertile to fertile, but also from bearing female to bearing male offspring, which looks as if the cause does not lie in the semen coming from all the parent or not, but in the mutual proportion or disproportion of that which comes from the woman and the man, or in something of this kind. It is clear, then, if we are to put this down as being so, that the female sex is not determined by the semen coming from any particular part, and consequently neither is the special sexual part so determined (if really the same semen can become either a male or female child, which shows that the sexual part does not exist in the semen). Why, then, should we assert this of *this* part any more than of the others? For if semen does not come from the uterus, the same account may be given of the others.

Again, some creatures come into being neither from parents of the same kind nor from parents of a different kind, as flies and the various kinds of what are called fleas; from these are produced animals indeed, but not in this case of similar nature, but a kind of grub. It is plain in this case that the young of a different kind are not produced by semen coming from all parts of the parent, for they would then resemble them, if indeed resemblance is a sign of its coming from all parts.

Further, even among animals some produce many young from a single coition (and something like this is universal among plants, for it is plain that they bear all the fruit of a whole season from a single movement). And yet how would this be possible if the semen were secreted from all the body? For from a single coition and a single segregation must follow only a single secretion. Nor is it possible for it to be separated in the uterus; for this would no longer be a separation of semen, but, as it were, a severance from an animal.

Again, the cuttings from a plant bear seed; clearly, therefore, even before they were cut, they bore their fruit from their own mass alone, and the seed did not come from *all* the plant.

But the greatest proof of all is derived from observations we have sufficiently established on insects. For, if not in all, at least in most of these, the female in the act of copulation inserts a part of herself into the male, This, as we said before, is the way they copulate; for the females manifestly insert this from below into the males above, not in all cases, but in most of those observed. Hence it seems clear that,

[15]Frag. 65 Diels-Kranz.

when the males do emit semen, then also the cause of the generation is not its coming from all the body, but something else which must be investigated hereafter. For even if it were true that it comes from all the *body,* as they say, they ought not to claim that it comes from all *parts* of it, but only from the creative part—from the workman, so to say, not the material he works in. Instead of that, they talk as if one were to say that the semen comes from the shoes; for, generally speaking, if a son is like his father, the shoes he wears are like his father's shoes.

As to the vehemence of pleasure in sexual intercourse, it is not because the semen comes from all the body, but because there is a strong friction (wherefore if this intercourse is often repeated the pleasure is diminished in the persons concerned). Moreover, the pleasure is at the end of the act, but it ought, on the theory, to be in each of the parts, and not at the same time, but sooner in some and later in others.

If mutilated young are born of mutilated parents, it is for the same reason as that for which they are like them. And the young of mutilated parents are not always mutilated, just as they are not always like their parents; the cause of this must be inquired into later, for this problem is the same as that.

Again, if the female does not produce semen, it is reasonable to suppose it does not come from all the body of the male either. And if it does not come from all the male it is not unreasonable to suppose that it does not come from the female, but that the female is cause of the generation in some other way. Into this we must next inquire, since it is plain that the semen is not secreted from all the parts.

In this investigation and those which follow from it, the first thing to do is to understand what semen is, for then it will be easier to inquire into its operations and the phenomena connected with it. Now the object of semen is to be of such a nature that from it as their origin come into being those things which are naturally formed,† not because there is any agent which makes them from it as . . . but simply because this is the semen.†[16] Now we speak of one thing coming *from* another in many senses; it is one thing when we say that night comes *from* day or a man becomes man *from* boy, meaning that the one comes after the other; it is another if we say that a statue is made *from* bronze and a bed *from* wood, and so on in all the other cases where we say that the thing made is made *from* a material, meaning that the whole is formed from something pre-existing, which is put into shape. In a third sense a man becomes unmusical *from* being musical, sick *from* being well, and generally in this sense contraries arise from contraries. Fourthly, as in the 'climax' of Epicharmus; thus *from* slander comes railing and *from* this fighting, and all these are *from* something in the sense that it is the efficient cause.[17] In this last class sometimes the efficient cause is in the things themselves, as in the last mentioned (for the slander is a part of the whole trouble), and sometimes external, as the art is external to the work of art or the torch to the burning house.

Now the semen plainly falls under one of the two following senses—either the semen is the material from which it is made, or it is the first efficient cause. For

[16]The obelized passage is textually corrupt.
[17]Reading ᾗ ἀρχή.

assuredly it is not in the sense of one thing being *after* another, as the voyage comes *from* the Panathenaea; nor yet as contraries come from contraries, for then one of the two contraries ceases to be, and a third substance must exist as an immediate underlying basis from which the new thing comes into being. We must discover, then, in which of the two other classes the semen is to be put, whether it is to be regarded as matter, and therefore acted upon by something else, or as a form, and therefore acting upon something else, or as both at once. For perhaps at the same time we shall see clearly also how all the products of semen come into being from contraries, since coming into being from contraries is also a natural process, for some animals do so, i.e. from male and female, others from only one parent, as is the case with plants and all those animals in which male and female are not separately differentiated. Now that which comes from the generating parent is called the seminal fluid, being that which first has in it a principle of generation, in the case of all animals whose nature it is to unite; semen is that which has in it the principles from *both* united parents (as in the case of plants and of those animals in which male and female are not separated), as the first mixture which arises from the union of male and female, be it a foetus or an egg, for these already have in them that which comes from both. (Semen and fruit differ only in the one being earlier and the other later, fruit in that it comes from something else, and seed in that something else comes from *it*, for both are really the same thing.)

We must again take up the question what the primary nature of what is called semen is.[18] Everything which we find in the body must either be one of the natural parts, whether homogeneous or heterogeneous, or an unnatural part such as a growth, or a residue or waste-product, or nutriment. (By residue I mean what is left of the nutriment, by waste-product that which is given off from the growth by an unnatural decomposition.)

Now that semen cannot be a part of the body is plain; for it is homogeneous, but from it nothing is composed, as things are from sinew or flesh; nor is it separated as are all the other parts. But neither is it contrary to nature nor a defect; for it exists in all alike, and the natural organism comes from it. Nutriment, again, is obviously introduced from without.

It remains, then, that it must be either a waste-product or a residue. Now the ancients seem to think that it is a waste-product; for when they say that it comes from all the body by reason of the heat of the movement, they imply that it is a kind of waste-product. But these are contrary to nature, and from such arises nothing according to nature. So then it must be a residue.

But every residue is either of useless or useful nutriment; by 'useless' I mean that from which nothing further is contributed to natural growth, but which is particularly mischievous to the body if too much of it is consumed; by 'useful' I mean the opposite. Now it is evident that it cannot be of the former character, for such is most abundant in persons of the worst condition of body through age or sickness; semen, on the contrary, is least abundant in them, for either they have

[18]Drossaart Lulofs marks lines 12 ('Now that which comes . . .') to 22 ('. . . semen is') as an interpolation.

none at all or it is not fertile, because a useless and morbid residue is mingled with it.

Semen, then, is part of a useful residue. But the *most* useful is the last and that from which finally is formed each of the parts of the body. For residues are either earlier or later; of the nutriment in the first stage the residue is phlegm and the like, for phlegm also is a residue of the useful nutriment, an indication of this being that if it is mixed with pure nutriment it is nourishing, and that it is used up in cases of illness. The final residue is the smallest in proportion to the quantity of nutriment. But we must reflect that the daily nutriment by which animals and plants grow is but small; for if a very little added of the same thing is the size of it will become excessive.

So we must say the opposite of what the ancients said. For whereas *they* said that semen is that which comes *from* all the body, *we* shall say it is that whose nature is to go *to* all of it, and what they thought a waste-product seems rather to be a residue. For it is more reasonable to suppose that the last extract of the nutriment which goes to all parts resembles it, just as part of a painter's colour is often left over resembling that which he has used up. Waste-products, on the contrary, are always due to corruption and to a departure from nature.

A further proof that it is not a waste-product, but rather a residue, is the fact that the large animals have few young, the small many. For the large must have more waste and less residue, since the great size of the body causes most of the nutriment to be used up, so that the residue is small.

Again, no place has been set apart by nature for waste-products but they flow
725b1 wherever they can find an easy passage in the body, but a place has been set apart for all the natural residues; thus the lower intestine serves for the excretion of the solid nutriment, the bladder for that of the liquid; for the useful part of the nutriment we have the upper intestine, for the spermatic secretions the uterus and pudenda and breasts, for it is collected and flows together into them.

And the resulting phenomena are evidence that semen is what we have said, and these result because such is the nature of the residue. For the exhaustion consequent on the loss of even a very little of the semen is conspicuous because the body is deprived of the ultimate gain drawn from the nutriment. With some few persons, it is true, during a short time in the flower of their youth the loss of it, if it be excessive in quantity, is an alleviation (just as in the case of the nutriment in its first stage, if too much have been taken, since getting rid of this also makes the body more comfortable), and so it may be also when other residues come away with it, for in that case it is not only semen that is lost but also other influences come away mingled with it,[19] and these are morbid. That is why, with some men at least, that which comes from them proves sometimes incapable of procreation because the seminal element in it is so small. But still in most men and as a general rule the result of intercourse is exhaustion and weakness rather than relief, for the reason given. Moreover, semen does not exist in them either in childhood or in old age or in sickness—in the last case because of weakness, in old age because their constitution

[19]Reading τούτῳ.

does not concoct enough, and in childhood because they are growing and so all the nutriment is used up too soon—for in about five years, in the case of human beings at any rate, the body seems to gain half the height that is gained in all the rest of life.

In many animals and plants we find a difference in this connexion not only between kinds as compared with kinds, but also between similar individuals of the same kind as compared with each other, e.g. man with man or vine with vine. Some have much semen, others little, others again none at all, not through weakness but the contrary, at any rate in some cases. This is because the nutriment is used up to form the body, as with some human beings, who, being in good condition and developing much flesh or getting rather too fat, produce less semen and are less desirous of intercourse. Like this is what happens with those vines which 'play the goat', that is, luxuriate through too much nutrition, for he-goats when fat are less inclined to mount the female; for which reason they thin them before breeding from 726a1
them, and say that the vines 'play the goat', so calling it from the condition of the goats. And fat people, women as well as men, appear to be less fertile than others from the fact that the residue when in process of concoction turns to fat with those who are too well-nourished. For fat also is a healthy residue due to good living.

In some cases no semen is produced at all, as by the willow and poplar. This condition is due to each[20] of the two causes, weakness and strength; the former prevents concoction of the nutriment, the latter causes it to be all consumed, as said above. In like manner other animals produce much semen through weakness as well as through strength, [when a great quantity of a useless residue is mixed with it; this sometimes results in actual disease when a passage is not found to carry off the impurity, and though some recover of this, others actually die of it. For they are affected by waste-products here as in the urine, which also has been known to cause disease.

Further, the same passage serves for residue and semen; and whatever animals have both kinds of excrement, that of liquid and that of solid nutriment, discharge the semen by the same passage as the liquid excrement (for it is a residue of a liquid, since the nutriment of all animals is rather liquid than solid), but those which have no liquid excrement discharge it at the passage of the solid residua. Moreover, waste-products are always morbid, but the removal of the residue is useful; now the discharge of the semen participates in both characteristics because it takes up some of the non-useful nutriment. But if it were a waste-product it would be always harmful; as it is, it is not so.][21]

From what has been said, it is clear that semen is a residue of useful nutriment, and that in its last stage, whether it is produced by all or no.

19 · After this we must distinguish of what sort of nutriment it is a residue, and must discuss the menstrual discharges which occur in certain of the vivipara. For thus we shall make it clear whether the female also produces semen like the

[20]Reading ἑκάτεραι for καὶ ἕτεραι.
[21]Drossaart Lulofs regards the bracketed passage as an interpolation.

male and the foetus is a mixture of two semens, or whether no semen is secreted by the female, and, if not, whether she contributes nothing else either to generation but only provides a receptacle, or whether she does contribute something, and how and
726b1 in what manner she does so.

We have previously stated that the final nutriment is the blood in the sanguinea and the analogous fluid in the other animals. Since the semen is also a residue of the nutriment, and that in its final stage, it follows that it will be either blood or that which is analogous to blood, or something formed from this. But since it is from the blood, when concocted and somehow divided up, that each part of the body is made, and since the semen if properly concocted is quite of a different character from the blood when it is separated from it, but if not properly concocted has been known in some cases to issue in a bloody condition if one forces oneself too often to coition, therefore it is plain that semen will be a residue of the nutriment when reduced to blood, being that which is finally distributed to the parts of the body. And this is the reason why it has so great power, for the loss of the pure and healthy blood is an exhausting thing; for this reason also it is natural that the offspring should resemble the parents, for that which goes to all the parts of the body resembles that which is left over. So that the semen which is to form the hand or the face or the whole animal is already the hand or face or whole animal undifferentiated, and what each of them is actually such is the semen potentially, either in virtue of its own mass or because it has a certain power in itself. (For we have not yet made it clear from the distinctions drawn hitherto whether it is the matter of the semen that is the cause of generation, or whether it has in it some faculty and efficient cause thereof). For the hand also or any other bodily part is not hand or other part in a true sense if it be without soul or some other power, but is only called by the same name.

[It is clear also that in cases where seminal waste-products occur, they too are residues. This happens when it is dissolved into what preceded it—as when plaster falls away at once from the wall; for what comes away is the same as what was at first applied. In the same way, the last residue is the same as the first waste-product.][22]

On this subject, then, so much may be laid down. But since it is necessary that the weaker animal also should have a residue greater in quantity and less concocted, and that being of such a nature it should be a mass of sanguineous liquid, and since that which has by nature a smaller portion of heat is weaker, and since it has already been stated that such is the character of the female—it is necessary that the
727a1 sanguineous matter discharged by the female is also a residue. And such is the discharge of the so-called menstrual fluid.

It is plain, then, that the menstrual discharge is a residue, and that it is analogous in females to the semen in males. The circumstances connected with them are evidence that this view is correct. For the semen begins to appear in males and to be emitted at the same time of life that the menstrual flow begins in females, and that they change their voice and their breasts begin to develop. So, too, in the

[22]Drossaart Lulofs excises this paragraph.

decline of life the generative power fails in the one sex and the menstrual discharge in the other.

The following signs also indicate that this discharge in females is a residue. Generally speaking women suffer neither from haemorrhoids nor bleeding at the nose nor anything else of the sort except when the menstrual discharges are ceasing, and if anything of the kind occurs the flow is interfered with because the discharge is diverted to it.

Further, the blood-vessels of women stand out less than those of men, and women are rounder and smoother because the residue which in men goes to these vessels is drained away with the menstrual discharge. We must suppose, too, that the same cause accounts for the fact that the bulk of the body is smaller in females than in males among the vivipara, since this is the only class in which menstrual fluids are discharged from the body. And in this class the fact is clearest in women, for the discharge is greater in women than in the other animals. That is why her pallor and the absence of prominent blood-vessels is always most conspicuous, and the deficient development of her body compared with a man's is obvious.

Now since this is what corresponds in the female to the semen in the male, and since it is not possible that two seminal discharges should be found together, it is plain that the female does not contribute semen to the generation of the offspring. For if she had semen she would not have the menstrual fluid; but, as it is, because she has the latter she has not the former.

It has been stated then that the menstrual fluids are a residue as the semen is, and confirmation of this view may be drawn from some of the phenomena of animals. For fat creatures produce less semen than lean ones, as observed before. The reason is that fat also, like semen, is a residue and is in fact concocted blood, only not concocted in the same way as the semen. Thus, if the residue is consumed to form fat the semen is naturally deficient. And so among the bloodless animals the cephalopoda and crustacea are in best condition about the time of producing eggs, for, because they are bloodless and no fat is formed in them, that which is analogous in them to fat is at that season drawn off to form the seminal residue.

And a sign that the female does not emit similar semen to the male, and that the offspring is not formed by a mixture of both, as some say, is that often the female conceives without the sensation of pleasure in intercourse, and if again the pleasure is experienced by her no less than by the male and the two sexes reach their goal together, yet often no conception takes place unless the liquid of the menstrual discharge is present in a right proportion. Hence the female does not produce young if the discharge is absent altogether, nor often when, it being present, the efflux still continues; but she does so *after* the purgation. For in the one case she has not the nutriment or material from which the foetus can be framed by the power coming from the male and inherent in the semen, and in the other it is washed away with the discharge because of its abundance. But when after its occurrence the greater part has been evacuated, the remainder is formed into a foetus. Cases of conception when the discharge does not occur at all, or of conception during the discharge instead of after it, are due to the fact that in the former instance there is only so much liquid to begin with as remains behind after the discharge in fertile women, and no greater quantity is secreted so as to come away from the body, while in the latter instance the mouth of the uterus closes after the discharge. When, therefore, the quantity already expelled from the body is great but the discharge still continues, only not on such a scale as to wash away the semen, then it is that conception accompanies coition. Nor is it at all strange that the discharges should still continue after conception (for even after it they recur to some extent, but are scanty and do not last during all the period of gestation; this, however, is a morbid phenomenon, and that is why it is found only in a few cases and seldom, whereas it is that which happens as a regular thing that is according to nature).

It is clear then that the female contributes the material for generation, and that this is in the substance of the menstrual discharges, and that they are a residue.

20 · Some think that the female contributes semen in coition because the pleasure she experiences is sometimes similar to that of the male, and also is attended by a liquid discharge. But this discharge is not seminal; it is merely proper to the part concerned in each case. For there is a discharge from the uterus which occurs in some women but not in others. It is found in those who are fair-skinned and of a feminine type generally, but not in those who are dark and of a masculine appearance. The amount of this discharge, when it occurs, is sometimes on a different scale from the emission of semen and far exceeds it. Moreover, different kinds of food cause a great difference in the quantity of such discharges; for instance some pungently-flavoured foods cause them to be conspicuously increased. And as to the pleasure which accompanies coition it is due to emission not only of semen, but also of a breath, the coming together of which precedes the emission. This is plain in the case of boys who are not yet able to emit semen, but are near the proper age, and of men who are impotent, for all these are capable of pleasure by rubbing. And those who have been injured in the generative organs sometimes suffer from diarrhoea because the residue, which they are not able to concoct and turn into semen, is diverted into the intestine. Now a boy is like a woman in form, and the woman is as it were an impotent male, for it is through a certain incapacity that the female is female, being incapable of concocting the nutriment in its last stage into semen (and this is either blood or that which is analogous to it in animals which are bloodless) owing to the coldness of her nature. As then diarrhoea is caused in the bowels by the insufficient concoction of the blood, so are caused in the blood-vessels all discharges of blood, including the menstrual blood, for this also is such a discharge, only it is natural whereas the others are morbid.

Thus it is clear that it is reasonable to suppose that generation comes from this. For the menstrual blood is semen not in a pure state but in need of working up, just as in the formation of fruits the nutriment is present, when it is not yet sifted thoroughly, but needs working up to purify it. Thus the menstrual blood causes generation by mixture with the semen, as this impure nutriment in plants is nutritious when mixed with pure nutriment.

And a sign that the female does not emit semen is the fact that the pleasure of intercourse is caused by touch in the same region of the female as of the male; and yet is it not from thence that this flow proceeds. Further, it is not all females that have it at all, but only the sanguinea, and not all even of these, but only those whose uterus is not near the hypozoma and which do not lay eggs; it is not found in the animals which have no blood but only the analogous fluid (for what is blood in the former is represented by another fluid in the latter). The reason why neither the latter nor those sanguinea mentioned (i.e. those whose uterus is low and which do not lay eggs)[23] have this effluxion is the dryness of their bodies; this allows but little matter to be secreted, only enough for generation but not enough to be discharged from the body. All animals that are viviparous without producing eggs first (such are man and all quadrupeds which bend their hind-legs inwards; for all these are viviparous without producing eggs)—all these have the menstrual flow, unless they are defective in development as the mule, only the efflux is not abundant as in women. Details of the facts in each animal have been given in the *History of Animals*.[24]

The menstrual flow is more abundant in women than in the other animals, and men emit the most semen in proportion to their size. The reason is that the composition of their bodies is liquid and hot compared to others, for more matter must be secreted in such a case. Further, man has no such parts in his body as those to which the superfluous matter is diverted in the other animals; for he has no great quantity of hair in proportion to his body, nor outgrowths of bones, horns, and teeth.

There is evidence that the semen is in the menstrual blood, for, as said before, this residue appears in the male at the same time of life as the menstrual flow in the female; this indicates that the parts destined to receive each of these residues are differentiated at the same time in both sexes; and as the neighbouring parts in both become swollen the hair of puberty springs forth in both alike. As the parts in question are on the point of differentiating they are distended by the breath; this is clearer in males in the testes, but appears also about the breasts; in females it is more marked in the breasts, for it is when they have risen two fingers' breadth that the menstrual flow generally begins.

Now, in all living things in which the male and female are not separated the semen is a sort of embryo; by embryo I mean the first mixture of male and female; hence, from one semen comes one body,—for example, one stalk of wheat from one grain, as one animal from one egg (for twin eggs are really two eggs). But in whatever kinds the sexes are distinguished, in these many animals may come from one emission of semen, showing that the semen differs in its nature in plants and animals. A sign of this is that animals which can bear more than one young one at a time do so in consequence of only one coition. Hence, too, it is plain that the semen does not come from the whole of the body; for neither would the different parts of the semen already be separated as soon as discharged from the same part, nor could they be separated in the uterus if they had once entered it all together; but what

[23]Drossaart Lulofs excises the parenthetical sentence.
[24]See *History of Animals* VI 18.

does happen is just what one would expect, since what the male contributes to generation is the form and the efficient cause, while the female contributes the material. In fact, as in the coagulation of milk, the milk being the material, the fig-juice or rennet is that which contains the curdling principle, so acts the secretion of the male, being divided into the parts in the female. Why it is sometimes divided into more or fewer parts, and sometimes not divided at all, will be the subject of another discussion. But because it does not differ in kind at any rate, several offspring are produced provided only that the divided semen is proportionate to the material, being neither too little to concoct it and fix it into form, nor too much so as to dry it up; and from this first formative semen, if it remains one, and is not divided, only one young one comes into being.

That, then, the female does not contribute semen to generation, but does contribute something, and that this is the matter of the menstrual flow, or that which is analogous to it in bloodless animals, is clear from what has been said, and also from a general survey of the question. For there must needs be that which generates and that from which it generates; even if these be one, still they must be distinct in form and their essence must be different; and in those animals that have these powers separate in two sexes the body and nature of the active and the passive sex must also differ. If, then, the male stands for the effective and active, and the female for the passive, it follows that what the female would contribute to the semen of the male would not be semen but material for the semen to work upon. This is just what we find to be the case, for the menstrual blood has in its nature an affinity to the primitive matter.

21 · So much for the discussion of this question. At the same time the answer to the next question we have to investigate is clear from these consider-
729b1 ations, I mean how it is that the male contributes to generation and how it is that the semen from the male is the cause of the offspring. Does it exist in the body of the embryo as a part of it from the first, mingling with the material which comes from the female? Or does the semen communicate nothing to the material body of the embryo but only to the power and movement in it? For this power is that which acts and makes, while that which is made and receives the form is the residue of the secretion in the female. Now the latter alternative appears to be the right one both *a priori* and in view of the facts. For, if we consider the question on general grounds, we find that, whenever one thing is made from two of which one is active and the other passive, the active agent does not exist in that which is made; and, still more generally, the same applies when one thing moves and another is moved. But the female, as female, is passive, and the male, as male, is active, and the principle of the movement comes from him. Therefore, if we take the highest genera under which they each fall, the one being active and motive and the other passive and moved, that one thing which is produced comes from them only in the sense in which a bed comes into being from the carpenter and the wood, or in which a ball comes into being from the wax and the form. It is plain then that it is not necessary that anything at all should come away from the male, and if anything does come away it does not follow that this gives rise to the embryo as being in the embryo, but only as

that which imparts the motion and as the form; so the medical art cures the patient.

This *a priori* argument is confirmed by the facts. For it is for this reason that some males which unite with the female do not, it appears, insert any part of themselves into the female, but on the contrary the female inserts a part of herself into the male; this occurs in some insects. For the effect produced by the semen in the female is produced in the case of these insects by the heat and power in the male animal itself when the female inserts that part of herself which receives the residue. And therefore such animals remain united a long time, and when they are separated the young are produced quickly. For the union lasts until that which is analogous to the semen has done its work, and when they separate the female produces the embryo quickly; for the young is imperfect inasmuch as all such creatures give birth to grubs.

What occurs in birds and oviparous fishes is the greatest proof that neither does the semen come from all parts of the male nor does he emit anything of such a nature as to exist within that which is generated, as part of the material embryo, but that he only makes a living creature by the power which resides in the semen (as we said in the case of those insects whose females insert a part of themselves into the male). For if a hen-bird is in process of producing wind-eggs and is then trodden by the cock before the egg has begun to whiten and while it is all still yellow, then they become fertile instead of being wind-eggs. And if while it is still yellow she be trodden by another cock, the whole brood of chicks turn out like the second cock. Hence some of those who are anxious to rear fine birds act thus; they change the cocks for the first and second treading, not as if they thought that the semen is mingled with the egg or exists in it, or that it comes from all parts of the cock; for if it did it would have come from both cocks, so that the chick would have all its parts doubled. But it is by its force that the semen of the male gives a certain quality to the material and the nutriment in the female, for the second semen added to the first can produce this effect by heat and concoction, as the egg acquires nutriment so long as it is growing.

The same thing happens in the generation of oviparous fishes. When the female has laid her eggs, the male sprinkles the milt over them, and those eggs are fertilized which it reaches, but not the others; this shows that the male does not contribute anything to the quantity but only to the quality of the embryo.

From what has been said it is plain that the semen does not come from the whole of the body of the male in those animals which emit it, and that the contribution of the female to the generative product is not the same as that of the male, but the male contributes the principle of movement and the female the material. This is why the female does not produce offspring by herself, for she needs a principle, i.e. something to begin the movement in the embryo and to define the form it is to assume. Yet in some animals, as birds, the nature of the female unassisted can generate to a certain extent, for they do form something, only it is incomplete; I mean the so-called wind-eggs.

22 · For the same reason the development of the embryo takes place in the

female; neither the male himself nor the female emits semen into the male, but the
730b1 female receives within herself the share contributed by both, because in the female is the material from which is made the resulting product. Not only must the mass of material exist there from which the embryo is formed in the first instance, but further material must constantly be added that it may increase in size. Therefore the birth must take place in the female. For the carpenter must keep in close connexion with his timber and the potter with his clay, and generally all workmanship and the ultimate movement imparted to matter must be connected with the material concerned, as, for instance, architecture is *in* the buildings it makes.

From these considerations we may also gather how it is that the male contributes to generation. The male does not emit semen at all in some animals, and where he does this is no part of the resulting embryo; just so no material part comes from the carpenter to the material, i.e. the wood in which he works, nor does any part of the carpenter's art exist within what he makes, but the shape and the form are imparted from him to the material by means of the motion he sets up. It is his hands that move his tools, his tools that move the material; it is his knowledge of his art, and his soul, in which is the form, that move his hands or any other part of him with a motion of some definite kind, a motion varying with the varying nature of the object made. In like manner, in the male of those animals which emit semen, nature uses the semen as a tool and as possessing motion in actuality, just as tools are used in the products of any art, for in them lies in a certain sense the motion of the art. Such, then, is the way in which these males contribute to generation. But when the male does not emit semen, but the female inserts some part of herself into the male, this is parallel to a case in which a man should carry the material to the workman. For by reason of weakness in such males nature is not able to do anything by any secondary means, but the movements imparted to the material are scarcely strong enough when nature itself watches over them. Thus here nature resembles a modeller in clay rather than a carpenter, for she does not touch the work she is forming by means of tools, but with her own hands.

23 · In all animals which can move about, the sexes are separated, one individual being male and one female, though both are the same in species, as with
731a1 man and horse. But in plants these powers are mingled, female not being separated from male. That is why they generate out of themselves, and do not emit semen but produce an embryo, what is called the seed. Empedocles puts this well in the line: 'and thus the tall trees lay their eggs; first olives . . .'[25] For as the egg is an embryo, a certain part of it giving rise to the animal and the rest being nutriment, so also from a part of the seed springs the growing plant, and the rest is nutriment for the shoot and the first root.

In a certain sense the same thing happens also in those animals which have the sexes separate. For when there is need for them to generate the sexes are no longer separated any more than in plants, their nature desiring that they shall become one; and this is plain to view when they copulate and are united [that one animal is made out of both].[26]

[25] Frag. 79 Diels-Kranz. [26] Excised by Drossaart Lulofs.

It is the nature of those creatures which do not emit semen to remain united a long time until the male element has formed the embryo, as with those insects which copulate. The others so remain only until the male has discharged from the parts of himself introduced something which will form the embryo in a longer time, as among the sanguinea. For the former remain paired some part of a day, while the semen forms the embryo in several days. And after emitting this they cease their union.

And animals seem to be almost like divided plants, as though one should separate and divide them, when they bear seed, into the male and female existing in them.

In all this nature acts like an intelligent workman. For to the essence of plants belongs no other function or business than the production of seed; since, then, this is brought about by the union of male and female, nature has mixed these and set them together in plants, so that the sexes are not divided in them. Plants, however, have been investigated elsewhere. But the function of the animal is not only to generate (which is common to all living things), but they all of them participate also in a kind of knowledge, some more and some less, and some very little indeed. For they have sense-perception, and this is a kind of knowledge. (If we consider the value of this we find that it is of great importance compared with the class of lifeless objects, but of little compared with the use of the intellect. For against the latter the mere participation in touch and taste seems to be practically nothing, but beside plants and stones it seems most excellent; for it would seem a treasure to gain even this kind of knowledge rather than to lie in a state of death and non-existence.) Now it is by sense-perception that an animal differs from those organisms which have only life. But since, if it is a living animal, it must also live; therefore, when it is necessary for it to accomplish the function of that which has life, it unites and copulates, becoming like a plant, as we said before.

Testaceous animals, being intermediate between animals and plants, perform the function of neither class as belonging to both. As plants they have no sexes, and one does not generate in another; as animals they do not bear fruit from themselves like plants; but they are formed and generated from a liquid and earthy concretion. However, we must speak later of the generation of these animals.[27]

BOOK II

1 · That the male and female are the principles of generation has been previously stated, as also what is their power and their essence. But why is it that one thing becomes and is male, another female? It is the business of our discussion as it proceeds to try and point out that the sexes arise from necessity and the first efficient cause, from what sort of material they are formed. That they exist because

[27]See III 11.

it is better and on account of the final cause, takes us back to a principle still further remote.

Now some existing things are eternal and divine whilst others admit of both existence and non-existence. But that which is noble and divine is always, in virtue of its own nature, the cause of the better in such things as admit of being better or worse, and what is not eternal does admit of existence and non-existence, and can partake in the better and the worse. And soul is better than body, and the living, having soul, is thereby better than the lifeless which has none, and being is better than not being, living than not living. These, then, are the reasons of the generation of animals. For since it is impossible that such a class of things as animals should be of an eternal nature, therefore that which comes into being is eternal in the only way possible. Now it is impossible for it to be eternal as an individual—for the substance of the things that are is in the particular; and if it were such it would be eternal—but it is possible for it as a species. This is why there is always a class of men and animals and plants. But since the male and female are the first principles of these, they will exist in those things that possess them for the sake of generation. Again, as the first efficient or moving cause, to which belong the definition and the form, is better and more divine in its nature than the material on which it works, it is better that the superior principle should be separated from the inferior. Therefore, wherever it is possible and so far as it is possible, the male is separated from the female. For the first principle of the movement, whereby that which comes into being is male, is better and more divine, and the female is the matter. The male, however, comes together and mingles with the female for the work of generation, because this is common to both.

A thing lives, then, in virtue of participating in the male and female principles; that is why even plants have some kind of life; but the class of animals exists in virtue of sense-perception. The sexes are divided in nearly all of these that can move about, for the reasons already stated, and some of them, as said before, emit semen in copulation, others not. The reason for this is that the higher animals are more independent in their nature, so that they have greater size, and this cannot exist without vital heat; for the greater body requires more force to move it, and heat is a motive force. Therefore, taking a general view, we may say that sanguinea are of greater size than bloodless animals, and those which move about than those which remain fixed. And these are just the animals which emit semen on account of their heat and size.

So much for the cause of the existence of the two sexes. Some animals bring to perfection and produce into the world a creature like themselves, as all those which bring their young into the world alive; others produce something undeveloped which has not yet acquired its own form; in this latter division the sanguinea lay eggs, the bloodless animals give birth to a grub. The difference between egg and grub is this: an egg is that from a part of which the young comes into being, the rest being nutriment for it; but the whole of a grub is developed into the whole of the young animal. Of the vivipara, which bring into the world an animal like themselves, some are internally viviparous (as men, horses, cattle, and of marine animals dolphins and the other cetacea); others first lay eggs within themselves, and only after this are externally viviparous (as the selachia). Among the ovipara some produce the egg in a perfect condition (as birds and all oviparous quadrupeds and footless animals, e.g. lizards and tortoises and most snakes; for the eggs of all these do not increase when once laid). The eggs of others are imperfect; such are those of fishes, crustaceans, and cephalopods, for their eggs increase after being produced.

All the vivipara and ovipara are sanguineous, and the sanguinea are either viviparous or oviparous, except those which are altogether infertile. Among bloodless animals the insects produce a grub, both those that are generated by copulation and those that copulate themselves though not so generated. For there are some insects of this sort, which though they come into being by spontaneous generation are yet male and female; from their union something is produced, only it is imperfect; the reason of this has been previously stated.

These classes admit of much cross-division. Not all bipeds are viviparous (for birds are oviparous), nor are they all oviparous (for man is viviparous), nor are all quadrupeds oviparous (for horses, cattle, and countless others are viviparous), nor are they all viviparous (for lizards, crocodiles, and many others lay eggs). Nor does the presence or absence of feet make the difference between them, for not only are some footless animals viviparous, as vipers and the Selachia, while others are oviparous, as the other fishes and serpents, but also among those which have feet many are oviparous and many viviparous, as the quadrupeds above mentioned. And some which are bipeds, as man, and some which have no feet, as the whale and dolphin, are internally viviparous. By this character then it is not possible to divide them, nor is any of the locomotive organs the cause of this difference, but it is those animals which are more perfect in their nature and participate in a purer element which are viviparous, for nothing is internally viviparous unless it receives and breathes out air. But the more perfect are those which are hotter in their nature and have more moisture and are not earthy in their composition. And the measure of natural heat is the lung when it has blood in it, for generally those animals which have a lung are hotter than those which have not, and in the former class again those whose lung is not spongy nor solid nor containing only a little blood, but soft and full of blood. And as the animal is perfect but the egg and the grub are imperfect, so the perfect is naturally produced from the perfect. If animals are hotter as shown by their possessing a lung but drier in their nature, or are colder but have more moisture, then they either lay a perfect egg or are viviparous after laying an egg within themselves. For birds and scaly reptiles because of their heat produce a perfect egg, but because of their dryness it is only an egg; the Selachia have less heat than these but more moisture, so that they are intermediate, for they are both oviparous and viviparous within themselves, the former because they are cold, the latter because of their moisture; for moisture is vivifying, whereas dryness is furthest removed from what has life. Since they have neither feathers nor scales such as either reptiles or other fishes have, all which are signs rather of a dry and earthy nature, the egg they produce is soft; for the earthy matter does not come to the surface in their eggs any more than in themselves. This is why they lay eggs in themselves, for if the egg were laid externally it would be destroyed, having no protection.

Animals that are cold and rather dry than moist also lay eggs, but the egg is imperfect; at the same time, because they are of an earthy nature and the egg they produce is imperfect, therefore it has a hard integument that it may be preserved by the protection of the shell-like covering. Hence fishes, because they are scaly, and crustacea, because they are of an earthy nature, lay eggs with a hard integument.

The cephalopods, having themselves bodies of a sticky nature, preserve in the same way the imperfect eggs they lay, for they deposit a quantity of sticky material about the embryo.

All insects produce a grub. Now all the insects are bloodless, which is why all creatures that produce a grub from themselves are so. But we cannot say simply that all bloodless animals produce a grub; for there is an overlap between the insects that produce a grub and those animals that lay their egg imperfect, as the scaly fishes, the crustacea, and the cephalopoda. For the eggs of these latter resemble a grub, in that they increase after oviposition, and the grub of insects again as it develops resembles an egg; how so we shall explain later.

We must observe how rightly nature orders generation in regular gradation. The more perfect and hotter animals produce their young perfect in respect of quality (in respect of quantity this is so with no animal, for the young always increase in size after birth), and these generate living animals within themselves from the first. The second class do not generate perfect animals within themselves from the first (for they are only viviparous after first laying eggs), but still they are externally viviparous. The third class do not produce a perfect animal, but an egg, and this egg is perfect. Those whose nature is still colder than these produce an egg, but an imperfect one, which is perfected outside the body, as the class of scaly fishes, the crustacea, and the cephalopods. The fifth and coldest class does not even lay an egg from itself; but so far as the young ever attain to this condition at all, it is outside the body of the parent, as has been said already. For insects produce a grub first; the grub after developing becomes egg-like (for the so-called chrysalis is equivalent to an egg); then from this it is that a perfect animal comes into being, reaching the end of its development in the third change.

Some animals then, as said before, do not come into being from semen, but all the sanguinea do so which are generated by copulation, the male emitting semen into the female; when this has entered into her the young are formed and assume their peculiar character, some within the animals themselves when they are viviparous, others in eggs.[1]

There is a considerable difficulty in understanding how the plant is formed out of the seed or any animal out of the semen. Everything that comes into being or is made must be made out of something, be made by the agency of something, and must become something. Now that out of which it is made is the material; this some animals have in its first form within themselves, taking it from the female parent, as all those which are not born alive but produced as a grub or an egg; others receive it from the mother for a long time by sucking, as the young of all those which are not only externally but also internally viviparous. Such, then, is the material out of which things come into being, but we now are inquiring not out of what the parts of

[1]Omitting καὶ σπέρμασι . . . ἀποκρίσεσιν.

an animal are made, but by what agency. Either it is something external which makes them, or else something existing in the seminal fluid and the semen; and this must either be soul or a part of soul, or something containing soul. 734a1

Now it would appear irrational to suppose that any of either the internal organs or the other parts is made by something external, since one thing cannot set up a motion in another without touching it, nor can a thing be affected in any way by anything that does not set up a motion in it. Something then of the sort we require exists in the embryo itself, being either a part of it or separate from it. To suppose that it should be something else separate from it is irrational. For after the animal has been produced does this something perish or does it remain in it? But nothing of the kind appears to be in it, nothing which is not a part of the whole plant or animal. Yet, on the other hand, it is absurd to say that it perishes after making either all the parts or only some of them. If it makes some of the parts and then perishes, what is to make the rest of them? Suppose this something makes the heart and then perishes, and the heart makes another organ, by the same argument either all the parts must perish or all must remain. Therefore it is preserved. Therefore it is a part of the embryo itself which exists in the semen from the beginning; and if indeed there is no part of the soul which does not exist in some part of the body, it would also be a part containing soul in it from the beginning.

How, then, does it make the other parts? Either all the parts, as heart, lung, liver, eye, and all the rest, come into being together or in succession, as is said in the verse ascribed to Orpheus, for there he says that an animal comes into being in the same way as the knitting of a net. That the former is not the fact is plain even to the senses, for some of the parts are clearly visible as already existing in the embryo while others are not; that it is not because of their being too small that they are not visible is clear, for the lung is of greater size than the heart, and yet appears later than the heart in the original development. Since, then, one is earlier and another later, does the one make the other, and does the later part exist on account of the part which is next to it, or rather does the one come into being only *after* the other? I mean, for instance, that it is not the fact that the heart, having come into being first, then makes the liver, and the liver again another organ, but that the liver only comes into being *after* the heart, and not by the agency of the heart, as a man becomes a man *after* being a boy, not by his agency. An explanation of this is that, in all the productions of nature or of art, what already exists potentially is brought into being only by what exists actually; therefore if one organ formed another the form and the character of the later organ would have to exist in the earlier, e.g. the form of the liver in the heart. And otherwise also the theory is strange and fictitious.

Yet again, if the whole animal or plant is formed from semen or seed, it is impossible that any part of it should exist ready made in the semen or seed, whether that part be able to make the other parts or no. For it is plain that, if it exists in it from the first, it was made by that which made the semen. But semen must be made 734b1
first, and that is the function of the generating parent. So, then, it is not possible that any part should exist in it, and therefore it has not within itself that which makes the parts.

But neither can this agent be external, and yet it must needs be one or other of the two. We must try, then, to solve this difficulty, for perhaps some one of the statements made cannot be made without qualification, e.g. the statement that the parts cannot be made by what is external to the semen. For if in a certain sense they cannot, yet in another sense they can. (Now it makes no difference whether we say 'the semen' or 'that from which the semen comes', in so far as the semen has in itself the movement initiated by the other.) It is possible, then, that A should move B, and B move C; that, in fact, the case should be the same as with the automatic puppets. For the parts of such puppets while at rest have a sort of potentiality of motion in them, and when any external force puts the first of them in motion, immediately the next is moved in actuality. As, then, in these automatic puppets the external force moves the parts in a certain sense (not by touching any part at the moment, but by having touched one previously), in like manner also that from which the semen comes, or in other words that which made the semen, sets up the movement in the embryo and makes the parts of it by having first touched something though not continuing to touch it. In a way it is the innate motion that does this, as the act of building builds the house. Plainly, then, while there is something which makes the parts, this does not exist as a definite object, nor does it exist in the semen at the first as a complete part.

But how is each part formed? We must answer this by starting in the first instance from the principle that, in all products of nature or art, a thing is made by something actually existing out of that which is potentially such as the finished product. Now the semen is of such a nature, and has in it such a principle of motion, that when the motion is ceasing each of the parts comes into being, and that as a part having life or soul. For there is no such thing as face or flesh without soul in it; it is only homonymously that they will be called face or flesh if the life has gone out of them, just as if they had been made of stone or wood. And the homogeneous parts and the organic come into being together. And just as we should not say that an axe or other instrument or organ was made by the fire alone, so neither shall we say that foot or hand were made by heat alone. The same applies also to flesh, for this too has a function. While, then, we may allow that hardness and softness, stickiness and brittleness, and whatever other qualities are found in the parts that have life and soul, may be caused by mere heat and cold, yet, when we come to the principle in virtue of which flesh is flesh and bone is bone, that is no longer so; what makes them is the movement set up by the male parent, who is in actuality what that out of which the offspring is made is in potentiality. This is what we find in the products of
735a1 art; heat and cold may make the iron soft and hard, but what makes a sword is the movement of the tools employed, this movement containing the principle of the art. For the art is the starting-point and form of the product; only it exists in something else, whereas the movement of nature exists in the product itself, issuing from another nature which has the form in actuality.

Has the semen soul, or not? The same argument applies here as in the question concerning the parts. As no part, if it participate not in soul, will be a part except homonymously (as the eye of a dead man is still called an eye), so no soul will exist in anything except that of which it is soul; it is plain therefore that semen both has soul, and is soul, potentially.

But a thing existing potentially may be nearer or further from its realization in actuality, just as a sleeping geometer is further away than one awake and the latter than one actually studying. Accordingly it is not any part that is the cause of the soul's coming into being, but it is the first moving cause from outside. (For nothing generates itself, though when it has come into being it thenceforward increases itself.) Hence it is that only one part comes into being first and not all of them together. But that must first come into being which has a principle of increase (for this nutritive power exists in all alike, whether animals or plants, and this is the same as the power that enables an animal or plant to generate another like itself, that being the function of them all if naturally perfect). And this is necessary for the reason that whenever a living thing is produced it must grow. It is produced, then, by something else of the same name, as e.g. man is produced by man, but it is increased by means of itself. There is, then, something which increases it. If this is a single part, this must come into being first. Therefore if the heart is first made in some animals, and what is analogous to the heart in the others which have no heart, it is from this or its analogue that the first principle of movement would arise.

We have thus discussed the difficulties previously raised on the question what is the efficient cause of generation in each case, as the first moving and formative power.

2 · The next question to be mooted concerns the nature of semen. For whereas when it issues from the animal it is thick and white, yet on cooling it becomes liquid as water, and its colour is that of water. This would appear strange, for water is not thickened by heat; yet semen is thick when it issues from within the animal's body which is hot, and becomes liquid on cooling. Again, watery fluids freeze, but semen, if exposed in frosts to the open air, does not freeze but liquefies, as if it was thickened by the opposite of cold. Yet it is unreasonable, again, to suppose that it is thickened by heat. For it is only substances having a predominance of earth in their composition that coagulate and thicken on boiling, e.g. milk. It ought then to solidify on cooling, but as a matter of fact it does not become solid in any part but the whole of it goes like water.

This then is the difficulty. If it is water, water evidently does not thicken through heat, whereas the semen is thick and both it and the body whence it issues are hot. If it is made of earth or a mixture of earth and water, it ought not to liquefy entirely.

Perhaps, however, we have not discriminated all the possibilities. It is not only the liquids composed of water and earthy matter that thicken, but also those composed of water and air; foam, for instance, becomes thicker and white, and the smaller and less visible the bubbles in it, the whiter and firmer does the mass appear. The same thing happens also with oil; on mixing with air it thickens, wherefore that which is whitening becomes thicker, the watery part in it being separated off by the heat and turning to air. And if oxide of lead is mixed with water or even with oil and stirred, the mass increases greatly and changes from liquid and dark to firm and white, the reason being that air is mixed in with it which increases the mass and makes the white shine through, as in foam and snow (for snow is foam). And water itself on mingling with oil becomes thick and white, because air is entangled in it by the act of pounding them together, and oil itself has much air in it (for shininess is a property of air, not of earth or water). This too is why it floats on the surface of the water, for the air contained in it as in a vessel bears it up and makes it float, being the cause of its lightness. So too oil is thickened without freezing in cold weather and frosts; it does not freeze because of its heat (for the air is hot and will not freeze), but because the air is forced together and compressed the oil becomes thicker by the cold. These are the reasons why semen is firm and white when it issues from within the animal; it has a quantity of hot air in it because of the internal heat; afterwards, when the heat has evaporated and the air has cooled, it turns liquid and dark; for the water, and any small quantity of earthy matter there may be, remain in semen as it dries, as they do in phlegm.

736a1 Semen, then, is a compound of breath and water, and the former is hot air; hence semen is liquid in its nature because it is made of water. What Ctesias the Cnidian has asserted of the semen of elephants is manifestly untrue; he says that it hardens so much in drying that it becomes like amber. But this does not happen, though it is true that one semen must be more earthy than another, and especially so with animals that have much earthy matter in them because of the bulk of their bodies. And it is thick and white because it is mixed with breath, for it is also an invariable rule that it is white, and Herodotus does not report the truth when he says that the semen of the Ethiopians is black, as if everything must needs be black in those who have a black skin, and that too when he saw their teeth were white. The reason of the whiteness of semen is that it is a foam, and foam is white, especially that which is composed of the smallest parts, small in the sense that each bubble is invisible, which is what happens when water and oil are mixed and stirred, as said before. (Even the ancients seem to have noticed that semen is of the nature of foam; at least it was from this they named the goddess who presides over union.)[2]

This then is the explanation of the problem proposed, and it is plain too that this is why semen does not freeze; for air will not freeze.

3 · The next question to raise and to answer is this. If, in the case of those animals which emit semen into the female, that which enters makes no part of the resulting embryo, where is the material part of it diverted if (as we have seen) it acts by means of the power residing in it? It is not only necessary to decide whether what is forming in the female receives anything material, or not, from that which has entered her, but also concerning the soul in virtue of which an animal is so called (and this is in virtue of the sensitive part of the soul)—does this exist originally in the semen and in the embryo or not, and if it does whence does it come? For nobody would put down the embryo as soulless or in every sense bereft of life (since both the semen and the embryo of an animal have every bit as much life as a plant), and it is

[2] 'Aphrodite' from ἀφρός.

productive up to a certain point. That then they possess the nutritive soul is plain (and plain is it from the discussions elsewhere about soul why this soul must be acquired first). As they develop they also acquire the sensitive soul in virtue of 736b1 which an animal is an animal, . . .[3] For e.g. an animal does not become at the same time an animal and a man or a horse or any other particular animal. For the end is developed last, and the peculiar character of the species is the end of the generation in each individual. Hence arises a question of the greatest difficulty, which we must strive to solve to the best of our ability and as far as possible. When and how and whence is a share in reason acquired by those animals that participate in this principle? It is plain that the semen and the embryo, while not yet separate, must be assumed to have the nutritive soul potentially, but not actually, until (like those embryos that are separated from the mother) it absorbs nourishment and performs the function of the nutritive soul. For at first all such embryos seem to live the life of a plant. And it is clear that we must be guided by this in speaking of the sensitive and the rational soul. For all three kinds of soul, not only the nutritive, must be possessed potentially before they are possessed in actuality. And it is necessary either that they should all come into being in the embryo without existing previously outside it, or that they should all exist previously, or that some should so exist and others not. Again, it is necessary that they should either come into being in the material supplied by the female without entering with the semen of the male, or come from the male and be imparted to the material in the female. If the latter, then either all of them, or none, or some must come into being in the male from outside.

Now that it is impossible for them all to pre-exist is clear from this consideration. Plainly those principles whose activity is bodily cannot exist without a body, e.g. walking cannot exist without feet. For the same reason also they cannot enter from outside. For neither is it possible for them to enter by themselves, being inseparable from a body, nor yet in a body, for the semen is only a residue of the nutriment in process of change. It remains, then, for the reason alone so to enter and alone to be divine, for no bodily activity has any connexion with the activity of reason.

Now it is true that the faculty of all kinds of soul seems to have a connexion with a matter different from and more divine than the so-called elements; but as one soul differs from another in honour and dishonour, so differs also the nature of the corresponding matter. All have in their semen that which causes it to be productive; I mean what is called vital heat. This is not fire nor any such force, but it is the breath included in the semen and the foam-like, and the natural principle in the breath, being analogous to the element of the stars. Hence, whereas fire generates 737a1 no animal and we do not find any living thing forming in either solids or liquids under the influence of fire, the heat of the sun and that of animals does generate them. Not only is this true of the heat that works through the semen, but whatever other residue of the animal nature there may be, this also has still a vital principle in

[3]Drossaart Lulofs marks a lacuna in the text here.

it. From such considerations it is clear that the heat in animals neither is fire nor derives its origin from fire.

Let us return to the material of the semen, in and with which is emitted[4] the principle of soul. Of this principle there are two kinds; the one is not connected with matter, and belongs to those animals in which is included something divine (to wit, what is called the reason), while the other is inseparable from matter. This material of the semen dissolves and evaporates because it has a liquid and watery nature. Therefore we ought not to expect it always to come out again from the female or to form any part of the embryo that has taken shape from it; the case resembles that of the fig-juice which curdles milk, for this too changes without becoming any part of the curdling masses.

It has been settled, then, in what sense the embryo and the semen have soul, and in what sense they have not; they have it potentially but not actually.

Now semen is a residue and is moved with the same movement as that in virtue of which the body increases (this increase being due to subdivision of the nutriment in its last stage). When it has entered the uterus it puts into form the corresponding residue of the female and moves it with the same movement wherewith it is moved itself. For the female's contribution also is a residue, and has all the parts in it potentially though none of them actually; it has in it potentially even those parts which differentiate the female from the male, for just as the young of mutilated parents are sometimes born mutilated and sometimes not, so also the young born of a female are sometimes female and sometimes male instead. For the female is, as it were, a mutilated male, and the menstrual fluids are semen, only not pure; for there is only one thing they have not in them, the principle of soul. For this reason, whenever a wind-egg is produced by any animal, the egg so forming has in it the parts of both sexes potentially, but has not the principle in question, so that it does not develop into a living creature, for this is introduced by the semen of the male. When such a principle has been imparted to the residue of the female it becomes an embryo.

Liquid by corporeal substances become surrounded by a solid layer like that which forms on boiled foods when cooling. All bodies are held together by the glutinous; this quality, as the embryo develops and increases in size, is acquired by the sinewy substance, which holds together the parts of animals, being actual sinew in some and its analogue in others. To the same class belong also skin, blood-vessels, membranes and the like, for these differ in being more or less glutinous and generally in excess and deficiency.[5]

4 · In those animals whose nature is comparatively imperfect, when a perfect embryo (which, however, is not yet a perfect animal) has been formed, it is cast out from the mother, for reasons previously stated. An embryo is then complete when it is either male or female, in the case of those animals who possess this distinction; for some (i.e. all those which are not themselves produced from a male or female parent

[4]Omitting τὸ σπέρμα.
[5]Drossaart Lulofs regards this paragraph as misplaced.

nor from a union of the two) produce an offspring which is neither male nor female. Of the generation of these we shall speak later.

The perfect animals, those internally viviparous, keep the developing embryo within themselves and in close connexion until they give birth to a complete animal and bring it to light.

A third class is externally viviparous but first internally oviparous; they develop the egg into a perfect condition, and then in some cases the egg is set free as with creatures externally oviparous, and the animal is produced from the egg within the mother's body; in other cases, when the nutriment from the egg is consumed, development is completed by connexion with the uterus, and therefore the egg is not set free from the uterus. This character marks the Selachian fish, of which we must speak later by themselves.[6]

Here we must make our first start from the first class; these are the perfect or viviparous animals, and of these the first is man. Now the secretion of the semen takes place in all of them just as does that of any other residual matter. For each is conveyed to its proper place without any force from the breath or compulsion of any other cause, as some assert, saying that the generative parts attract the semen like cupping-glasses, aided by the force of the breath, as if it were possible for either this residue or that of the solid and liquid nutriment to go anywhere else than they do without the exertion of such a force. Their reason is that the discharge of both is attended by holding the breath, but this is a common feature of all cases when it is necessary to move anything, because strength arises through holding the breath. For even without this force the residues are discharged in sleep if the parts concerned are full of them and are relaxed. One might as well say that it is by the breath that the seeds of plants are always segregated to the places where they are wont to bear fruit. No, the real cause, as has been stated already, is that there are special parts for receiving all the residues, alike the useless (as the residues of the liquid and solid[7] nutriment), and the blood, which has the so-called blood-vessels.

To consider now the region of the uterus in the female—the two blood-vessels, the great vessel and the aorta, divide higher up, and many fine vessels from them terminate in the uterus. These become over-filled from the nourishment they convey, nor is the female nature able to concoct it, because it is colder than man's; so the blood is excreted through very fine vessels into the uterus, these being unable on account of their narrowness to receive the excessive quantity, and the result is a sort of haemorrhage. The period is not accurately defined in women, but tends to return during the waning of the moon. This we should expect, for the bodies of animals are colder when the environment happens to become so, and the time of change from one month to another is cold because of the absence of the moon, whence also it results that this time is stormier than the middle of the month. When then the residue of the nourishment has changed into blood, the menstrual discharges tend to occur at the above-mentioned period, but when it is not concocted a little matter at a

[6]See III 3.
[7]Reading τῆς τε ξηρᾶς καὶ τῆς ὑγρῆς.

time is always coming away, and this is why 'whites' appear in females while still small, in fact mere children. If both these discharges of the residues are moderate, the body remains in good health, for they act as a purification of the residues which are the causes of a morbid state of body; if they do not occur at all or if they are excessive, they are injurious, either causing illness or pulling down the patient; hence whites, if continuous and excessive, prevent girls from growing. This residue then is necessarily discharged by females for the reasons given; for, the female nature being unable to concoct the nourishment thoroughly, there must not only be left a residue of the useless nutriment, but also there must be a residue of the blood in the blood-vessels, and this filling the channels of the finest vessels must overflow. 738b1 Then nature, aiming at the best and the end, uses it up in this place for the sake of generation, that another creature may come into being of the same kind as the former was going to be, for the menstrual blood is already potentially such as the body from which it is discharged.

In all females, then, there must necessarily be such a residue, more indeed in those that have blood and of these most of all in man, but in the others also some matter must be collected in the uterine region. The reason why there is more in those that have blood and most in man has been already given; but why, if all females have such a residue, have not all males one to correspond? For some of them do not emit semen but, just as those which do emit it fashion by the movement in the semen the mass forming from the material supplied by the female, so do the animals in question bring the same to pass and exert the same formative power by the movement within themselves in that part from which the semen is secreted. This is the region about the diaphragm in all those animals which have one, for the heart or its analogue is the first principle of a natural body, while the lower part is a mere addition for the sake of it. Now the reason why it is not all males that have a generative residue, while all females do, is that the animal is a body with soul; the female always provides the material, the male that which fashions it, for this is the power that we say they each possess, and this is what it is for them to be male and female. Thus while it is necessary for the female to provide a body and a material mass, it is not necessary for the male, because it is not within what is produced that the tools or the maker must exist. While the body is from the female, it is the soul that is from the male, for the soul is the substance of a particular body. For this reason if animals of a different kind are crossed (and this is possible when the periods of gestation are equal and conception takes place nearly at the same season and there is no great difference in the size of the animals), the first cross has a common resemblance to both parents, as the hybrid between fox and dog, partridge and domestic fowl, but as time goes on and one generation springs from another, the final result resembles the female in form, just as foreign seeds produce plants varying in accordance with the country in which they are sown. For it is the soil that gives to the seeds the material and the body of the plant. And hence the part of the female which receives the semen is not a mere passage, but the uterus has a 739a1 considerable width, whereas the males that emit semen have only passages for this purpose, and these are bloodless.

Each of the residues becomes such at the moment when it is in its proper place; before that there is nothing of the sort unless with much violence and contrary to nature.

We have thus stated the reason for which the generative residues are formed in animals. But when the semen from the male (in those animals which emit semen) has entered, it puts into form the purest part of the female residue (for the greater part of the menstrual flow is useless, being fluid, as is the most fluid part of the male secretion, i.e. in a single emission, the earlier discharge being in most cases apt to be infertile rather than the later, having less vital heat through want of concoction, whereas that which is concocted is thick and of a more material nature).

If there is no external discharge, either in women or other animals, on account of there not being much useless residue in the secretion, then the quantity forming within the female altogether is as much as what is retained within those animals which have an external discharge; this is put into form by the power of the male residing in the semen secreted by him, or, as is clearly seen to happen in some insects, by the part in the female analogous to the uterus being inserted into the male.

It has been previously stated that the discharge accompanying sexual pleasure in the female contributes nothing to the embryo. The chief argument for the opposite view is that what are called wet dreams occur by night with women as with men; but this is no proof, for the same thing happens to young men also who do not yet emit semen, and to those who do emit semen but whose semen is infertile.

It is impossible to conceive without the emission of the male in union and without the residue of the female, whether it be discharged externally or whether there is only enough within the body. Women conceive, however, without experiencing the pleasure usual in such intercourse, if the part chance to be in heat and the uterus to have descended. But generally speaking the opposite is the case, because the mouth of the uterus is not closed when the discharge takes place which is usually accompanied by pleasure in women as well as men, and when this is so there is a readier way from the semen of the male to be drawn into the uterus.

The actual discharge does not take place within the uterus as some think, the mouth being too narrow, but it is in the region in front of this, where the female discharges the moisture found in some cases, that the male emits the semen. 739b1
Sometimes it remains in this place; at other times, if the uterus chance to be conveniently placed and hot on account of the purgation, it draws it within itself. A proof of this is that pessaries, though wet when applied, are removed dry. Moreover, in all those animals which have the uterus near the hypozoma, as birds and viviparous fishes, it is impossible that the semen should be so discharged as to enter it; it must be drawn into it. This region, on account of the heat which is in it, attracts the semen. The discharge and collection of the menstrual blood also excite heat in this part. Hence it acts like cone-shaped vessels which, when they have been washed out with hot water, their mouth being turned downwards, draw water into themselves. And this is the way things are drawn up, but some say that nothing of the kind happens with the organic parts concerned in copulation. Precisely the

opposite is the case of those who say the woman emits semen as well as the man, for if she emits it outside the uterus this must then draw it back again into itself if it is to be mixed with the semen of the male. But this is a superfluous proceeding, and nature does nothing superfluous.

When the material secreted by the female in the uterus has been fixed by the semen of the male (this acts in the same way as rennet acts upon milk, for rennet is a kind of milk containing vital heat, which brings into one mass and fixes the similar material, and the relation of the semen to the menstrual blood in the same, milk and the menstrual blood being of the same nature)—when, I say, the more solid part comes together, the liquid is separated off from it, and as the earthy parts solidify membranes form all round it; this is both a necessary result and for the sake of something, the former because the surface of a mass must solidify on heating as well as on cooling, the latter because the foetus must not be in a liquid but be separated from it. Some of these are called membranes and others choria, the difference being one of more or less, and they exist in ovipara and vivipara alike.

When the embryo is once formed, it acts like the seeds of plants. For seeds also contain the first principle of growth in themselves, and when this (which previously exists in them only potentially) has been differentiated, the shoot and the root are sent off from it, and it is by the root the plant gets nourishment; for it needs growth. So also in the embryo all the parts exist potentially in a way, but the first principle is furthest on the road to realization. Therefore the heart is first differentiated in actuality. This is clear not only to the senses (for it is so) but also on theoretical grounds. For whenever the young animal has been separated from both parents it must be able to manage itself, like a son who has set up house away from his father. Hence it must have a first principle from which comes the ordering of the body at a later stage also, for if it is to come in from outside at a later period to dwell in it, not only may the question be asked at what time it is to do so, but also we may object that, when each of the parts is separating from the rest, it is necessary that this principle should exist first from which comes growth and movement to the other parts. (That is why all who say, as did Democritus, that the external parts of animals are first differentiated and the internal later, are much mistaken; it is as if they were talking of animals of stone or wood. For such as these have no principle of growth at all, but all animals have, and have it within themselves.) Therefore it is that the heart appears first distinctly marked off in all the sanguinea, for this is the first principle of both homogeneous and heterogeneous parts, since from the moment that the animal or organism needs nourishment, from that moment does this deserve to be called its principle. For that which exists grows, and the nutriment, in its final stage, of an animal is the blood or its analogue, and of this the blood-vessels are the receptacle, and that is why the heart is the principle of these also. (This is clear from the *Histories*[8] and the *Anatomies*.)

Since the embryo is already potentially an animal but an imperfect one, it must obtain its nourishment from elsewhere; accordingly it makes use of the uterus and the mother, as a plant does of the earth, to get nourishment, until it is perfected to

[8]See *History of Animals* III 3.

the point of being now an animal potentially locomotive. So nature has first designed the two blood-vessels from the heart, and from these smaller vessels branch off to the uterus, forming what is called the umbilicus. For the umbilicus is a blood-vessel, consisting of one or more vessels in different animals. Round these is a skin-like integument, because the weakness of the vessels needs protection and shelter. The vessels join on to the uterus like the roots of plants, and through them the embryo receives its nourishment. This is why the animal remains in the uterus, not, as Democritus says, that the parts of the embryo may be moulded in conformity with those of the mother. This is plain in the ovipara, for they have their parts differentiated in the egg after separation from the matrix.

Here a difficulty may be raised. If the blood is the nourishment, and if the heart, which first comes into being, already contains blood, and the nourishment comes from outside, whence did the first nourishment enter? Perhaps it is not true that *all* of it comes from outside. Just as in the seeds of plants there is something of this nature, the substance which at first appears milky, so also in the material of the animal embryo the superfluous matter of which it is formed is its nourishment from the first.

The embryo, then, grows by means of the umbilicus in the same way as a plant by its root, or as animals themselves, when separated, from the nutriment within themselves—of this we must speak later at the time appropriate for discussing them. But the parts are not differentiated, as some suppose, because like is naturally carried to like. Besides many other difficulties involved in this theory, it results from it that the homogeneous parts ought to come into being each one separate from the rest, as bones and sinews by themselves, and flesh by itself, if one should accept this cause. The real cause why each of them comes into being is that the residue of the female is potentially such as the animal is naturally, and all the parts are potentially present in it, but none actually. It is also because when the active and the passive come in contact with each other in that way in which the one is active and the other passive (I mean in the right manner, in the right place, and at the right time), straight-way the one acts and the other is acted upon. The female, then, provides matter, the male the principle of motion. And as the products of art are made by means of the tools of the artist, or to put it more truly by means of their movement, and this is the activity of the art, and the art is the form of what is made in something else, so is it with the power of the nutritive soul. As later on in the case of mature animals and plants this soul causes growth from the nutriment, using heat and cold as its tools (for in these is the movement of the soul and each comes into being in accordance with a certain formula), so also from the beginning does it form the product of nature. For the material by which this latter grows is the same as that from which it is constituted at first; consequently also the power which acts upon it is identical with that at the beginning (but greater than it); thus if it is the nutritive soul, it is also the generative soul, and this is the nature of every organism, existing in all animals and plants. But the other parts of the soul exist in some living things and not in others. In plants, then, the female is not separated from the male, but in those animals in which it is separated the female needs the male besides.

5 · And yet the question may be raised why it is that, if indeed the female possesses the same soul and if it is the residue of the female which is the material of the embryo, she needs the male besides instead of generating entirely from herself. The reason is that the animal differs from the plant by having sense-perception; if the sensitive soul is not present, either actually or potentially, and either with or without qualification, it is impossible for face, hand, flesh, or any other part to exist; it will be no better than a corpse or part of a corpse. Thus if it is the male that has the power of making the sensitive soul, then where the sexes are separated it is impossible for the female to generate an animal from itself alone, for the process in question was what being male is. Certainly that there is a good deal in the difficulty stated is plain in the case of the birds that lay wind-eggs, showing that the female can generate up to a certain point unaided. But this still involves a difficulty; in what way are we to say that their eggs live? It is neither possible that they should live in the same way as fertile eggs (for then they would produce a chick actually alive), nor yet can they be called eggs only in the sense in which an egg of wood or stone is so called, for the fact that these eggs go bad shows that they previously participate in some way in life. It is plain, then, that they have some soul potentially. What sort of soul will this be? It must be the lowest surely, and this is the nutritive, for this exists in all animals and plants alike. Why then does it not perfect the parts and the animal? Because they must have a sensitive soul, for the parts of animals are not like those of a plant. And so the female animal needs the help of the male, for in these animals we are speaking of the male is separate. This is exactly what we find, for the wind-eggs become fertile if the male tread the female in a certain space of time. About the cause of these things, however, we shall enter into detail later.

If there is any kind of animal which is female and has no male separate from it, it is possible that this may generate a young one from itself. No instance of this worthy of credit has been observed up to the present at any rate, but one case in the class of fishes makes us hesitate. No male of the so-called erythrinus has ever yet been seen, but females, and specimens full of roe, have been seen. Of this, however, we have as yet no proof worthy of credit. Again, some members of the class of fishes
741b1 are neither male nor female, as eels and a kind of mullet found in stagnant waters. But whenever the sexes are separate the female cannot generate perfectly by herself alone, for then the male would exist in vain, and nature makes nothing in vain. Hence in such animals the male always perfects the work of generation, for he imparts the sensitive soul, either by means of the semen or by himself. Now the parts of the embryo already exist potentially in the material, and so when once the principle of movement has been imparted to them they develop in a chain one after another, as in the case of the automatic puppets. When some of the natural philosophers say that like is brought to like, this must be understood, not in the sense that the parts are moved as changing place, but that they stay where they are and the movement is a change of quality (such as softness, hardness, colour, and the other differences of the homogeneous parts); thus they become in actuality what they previously were in potentiality. And what comes into being first is the first

principle; this is the heart in the sanguinea and its analogue in the rest, as has been often said already. This is plain not only to the senses (that it is first to come into being), but also in view of its end; for life fails in the heart last of all, and it happens in all cases that what comes in to being last fails first, and the first last, nature running a double course, so to say, and turning back to the point from whence she started. For the process of becoming is from the non-existent to the existent, and that of perishing is back again from the existent to the non-existent.

6 · After this, as said already, the internal parts come into being before the external. The greater become visible before the less, even if some of them do not come into being before them. First the parts above the hypozoma are differentiated and are superior in size; the part below is both smaller and less differentiated. This happens in all animals in which exists the distinction of upper and lower, except in the insects; the growth of those that produce a grub is towards the upper part, for this is smaller in the beginning. The cephalopoda are the only locomotive animals in which the distinction of upper and lower does not exist. What has been said applies to plants also, that the upper portion is earlier in development than the lower, for the roots push out from the seed before the shoots.

The agency by which the parts of animals are differentiated is air, not however that of the mother nor yet of the embryo itself, as some of the physicists say. This is manifest in birds, fishes, and insects. For some of these are separated from the 742a1
mother and produced from an egg, within which the differentiation takes place; other animals do not breathe at all, but are produced as a grub or an egg; those which do breathe and whose parts are differentiated within the mother's uterus yet do not breathe until the lung is perfected, and the lung and the preceding parts are differentiated before they breathe. Moreover, all polydactylous quadrupeds, as dog, lion, wolf, fox, jackal, produce their young blind, and the eyelids do not separate till after birth. Manifestly the same holds also in all the other parts; as the qualitative, so also the quantitative differentia comes into being, pre-existing potentially but being actualized later by the same causes by which the qualitative distinction is produced, and so the eyelids become two instead of one. Of course air must be present, because heat and moisture are present, the former acting and the latter being acted upon.

Some of the ancient nature-philosophers made an attempt to state which part comes into being after which, but were not sufficiently acquainted with the facts. It is with the parts as with other things; one naturally exists prior to another. But the word 'prior' is used in more senses than one. For there is a difference between the end or final cause and that which exists for the sake of it; the latter is prior in order of development, the former is prior in essence. Again, that which exists for the sake of the end admits of division into two classes, first the origin of the movement, and then that which is used by the end; I mean, for instance, that which can generate, and that which serves as an instrument to what is generated, for the one of these, that which makes, must exist first, as the teacher before the learner, and the other later, as the pipes are later than he who learns to play upon them, for it is superfluous that men who do not know how to play should have pipes. Thus there are three things: first, the end, by which we mean that for the sake of which something else exists; secondly, the principle of movement and of generation, existing for the sake of the end (for that which can make and generate, considered simply as such, exists only in relation to what is made and generated); thirdly, the useful, that is to say what the end uses. Accordingly, there must first exist some part in which is the principle of movement (I say a part because this is from the first one part of the end and the most important part too); next after this the whole and the end; thirdly and lastly, the organic parts serving these for certain uses. Hence if there is anything of this sort which must exist in animals, containing the principle and end of all their nature, this must be the first to come into being—first, that is, considered as the moving power, but simultaneous with the whole embryo if considered as a part of the end. Therefore all the organic parts whose nature is to bring others into being must always themselves exist before them, for they are for the sake of something else, as the beginning for the sake of the end; all those parts which are for the sake of something else but are not of the nature of beginnings must come into being later. So it is not easy to distinguish which of the parts are prior, those which are for the sake of another or that for the sake of which are the former. For the parts which cause the movement, being prior to the end in order of development, come in to cause confusion, and it is not easy to distinguish these as compared with the organic parts. And yet it is in accordance with this method that we must inquire what comes into being after what; for the end is later than some parts and earlier than others. And for this reason that part which contains the first principle comes into being first, next to this the upper half of the body. This is why the parts about the head, and particularly the eyes, appear largest in the embryo at an early stage, while the parts below the umbilicus, as the legs, are small; for the lower parts are for the sake of the upper, and are neither parts of the end nor able to form it.

But they do not say well nor do they assign a necessary cause who say simply that it always happens so, and imagine that this is a first principle in these cases. Thus Democritus of Abdera says that there is no beginning of the infinite;[9] now the cause is a beginning, and the eternal is infinite; in consequence, to ask the cause of anything of this kind is to seek for a beginning of the infinite. Yet according to this argument, which forbids us to seek the cause, there will be no proof of any eternal truth whatever; but we see that there is a proof of many such, whether by 'eternal' we mean what always happens or what exists eternally; it is an eternal truth that the angles of a triangle are always equal to two right angles, or that the diagonal of a square is incommensurable with the side, and nevertheless a cause and a proof can be given for these truths. While, then, it is well said that we must not take on us to seek a beginning of all things, yet this is not well said of all things whatever that always are or always happen, but only of those which really are first principles of the eternal things; for it is by another method, not by proof, that we acquire

[9]Omitting ἀεὶ καί.

knowledge of the first principle. Now in that which is immovable and unchanging the first principle is simply the essence of the thing, but when we come to those things which come into being the principles are more than one, varying in kind and not all of the same kind; one of this number is the principle of movement, and therefore in all the sanguinea the heart is formed first, as was said at the beginning, and in the other animals that which is analogous to the heart.

From the heart the blood-vessels extend throughout the body as in the 743a1 anatomical diagrams which are represented on the walls, for the parts lie round these because they are formed out of them. The homogeneous parts are formed by heat and cold, for some are put together and solidified by the one and some by the other. The difference between these has already been discussed elsewhere, and it has been stated what kinds of things are soluble by liquid and fire, and what are not soluble by liquid and cannot be melted by fire. The nutriment then oozes through the blood-vessels and the passages in each of the parts, like water in unbaked pottery, and thus is formed the flesh or its analogues, being solidified by cold, which is why it is also dissolved by fire. But all the particles given off which are too earthy, having but little moisture and heat, cool as the moisture evaporates along with the heat; so they become hard and earthy in character, as nails, horns, hoofs, and beaks, and therefore they are softened by fire but none of them is melted by it, while some of them, as egg-shells, are soluble in liquids. The sinews and bones are formed by the internal heat as the moisture dries, and hence the bones are insoluble by fire like pottery, for like it they have been as it were baked in an oven by the heat in the process of development. But it is not anything whatever that is made into flesh or bone by the heat, but only something naturally fitted for the purpose; nor is it made in any place or time whatever, but only in a place and time naturally so fitted. For neither will that which exists potentially be made except by that moving agent which possesses the actuality, nor will that which possesses the actuality make anything out of anything whatever; the carpenter would not make a box except out of wood, nor will a box be made out of the wood without the carpenter. The heat exists in the seminal residue, and the movement and activity in it is sufficient in kind and in quantity to correspond to each of the parts. In so far as there is any deficiency or excess, the resulting product is in worse condition or physically defective, in like manner as in the case of external substances which are thickened by boiling that they may be more palatable or for any other purpose. But in the latter case it is we who apply the heat in due measure for the motion required; in the former it is the nature of the male parent that gives it, or with animals spontaneously generated it is the movement and heat imparted by the right season of the year that is the cause.

Cooling, again, is mere deprivation of heat. Nature makes use of both; they have of necessity the power of bringing about different results, but in the 743b1 development of the embryo we find that the one cools and the other heats for some definite purpose, and so each of the parts is formed; thus it is in one sense by necessity, in another for a final cause, that they make the flesh soft, the sinews solid and elastic, the bones solid and brittle. The skin, again, is formed by the drying of the flesh, like the scum upon boiled substances; it is so formed not only because it is on the outside, but also because what is glutinous, being unable to evaporate, remains on the surface. While in other animals the glutinous is dry, for which reason the covering of the bloodless animals is testaceous or crustaceous, in the sanguinea it is rather of the nature of fat. In all of these which are not of too earthy a nature the fat is collected under the covering of the skin, a fact which points to the skin being formed out of such a glutinous substance, for fat is somewhat glutinous. As we said, all these things must be understood to be formed in one sense of necessity, but in another sense not of necessity but for a final cause.

The upper half of the body, then, is first marked out in the order of development; as time goes on the lower also reaches its full size in the sanguinea. All the parts are first marked out in their outlines and acquire later on their colour and softness or hardness, exactly as if nature were a painter producing a work of art, for painters, too, first sketch in the animal with lines and only after that put in the colours.

Because the source of the sensations is in the heart, therefore this is the part first formed in the whole animal, and because of the heat of this organ the cold forms the brain, where the blood-vessels terminate above, corresponding to the heat of the heart. Hence the parts about the head begin to form next in order after the heart, and surpass the other parts in size, for the brain is from the first large and fluid.

There is a difficulty about what happens with the eyes of animals. Though from the beginning they appear very large in all creatures, whether they walk or swim or fly, yet they are the last of the parts to be formed completely, for in the intervening time they collapse. The reason is this. The sense-organ of the eyes is set upon certain passages, as are the other sense-organs. Whereas those of touch and
744a1 taste are simply the body itself or some part of the body of animals, those of smell and hearing are passages connecting with the external air and full themselves of innate breath; these passages end at the small blood-vessels about the brain which run thither from the heart. But the eye is the only sense-organ that has a bodily constitution peculiar to itself. It is fluid and cold, and does not exist from the first in the place which it occupies later in the same way as the other parts do, for they exist potentially to begin with and actually come into being later, but the eye is the purest part of the liquidity about the brain drained off through the passages which are visible running from them to the membrane round the brain. A proof of this is that, apart from the brain, there is no other part in the head that is cold and fluid except the eye. Of necessity therefore this region is large at first but falls in later. For the same thing happens with the brain: at first it is liquid and large, but in course of evaporation and concoction it becomes more solid and falls in—and so does the size of the eyes. The head is very large at first, on account of the brain, and the eyes appear large because of the liquid in them. They are the last organs to reach completion because the brain is formed with difficulty; for it is at a late period that it gets rid of its coldness and fluidity; this applies to all animals possessing a brain, but especially to man. For this reason the anterior fontanelle is the last of the bones

to be formed; even after birth this bone is still soft in children. The cause of this being so with men more than with other animals is the fact that their brain is the most fluid and largest. This again is because the heat in man's heart is purest. His intellect shows how well he is tempered, for man is the wisest of animals. And babies for a long time have no control over their heads on account of the heaviness of the brain; and the same applies to the parts which it is necessary to move, for it is late that the principle of motion gets control over the upper parts, and last of all over those whose motion is not connected directly with it, as that of the legs is not. Now the eyelid is such a part. But since nature makes nothing superfluous nor in vain, it is clear also that she makes nothing too late or too soon, for if she did the result would be either in vain or superfluous. Hence it is necessary that the eyelids should be separated at the same time as the heart is able to move them. So then the eyes of animals are perfected late because of the amount of concoction required by the brain, and last of all the parts because the motion must be very strong before it can affect parts so far from the first principle of motion and so cold. And it is plain that such is the nature of the eyelids, for if the head is affected by the slightest heaviness through sleepiness or drunkenness or anything else of the kind, we cannot raise the eyelids though their own weight is so small. So much for the question how the eyes come into being, and why and for what cause they are the last to be fully developed.

Each of the other parts is formed out of the nutriment, the noblest and those participating in the sovereign principle from the nutriment which is first and purest and fully concocted, those which are only necessary for the sake of the former parts from the inferior nutriment and the residues left over from the other. For nature, like a good householder, is not in the habit of throwing away anything from which it is possible to make anything useful. Now in a household the best part of the food that comes in is set apart for the free men, the inferior and the residue of the best for the slaves, and the worst is given to the animals that live with them. Just as the intellect acts thus from outside with a view to the growth of the persons concerned, so in the case of the embryo itself does nature form from the purest material the flesh and the body of the other sense-organs, and from the residues thereof bones, sinews, hair, and also nails and hoofs and the like; hence these are last to assume their form, for they have to wait till the time when nature has some residue to spare.

The bones, then, are made in the first conformation of the parts from the seminal residue. As the animal grows the bones also grow from the natural nourishment, being the same as that of the sovereign parts,[4] but of this they only take up the superfluous residues. For everywhere the nutriment may be divided into two kinds, the first and the second; the former is nutritious, being that which brings into being both the whole and the parts; the latter is concerned with growth, being that which causes quantitative increase. But these must be distinguished more fully later on. The sinews are formed in the same way as the bones and out of the same materials, the seminal and nutritious residue. Nails, hair, hoofs, horns, beaks, the spurs of cocks, and any other similar parts, are on the contrary formed from the nutriment which is taken later and only concerned with growth, in other words that which is derived from the mother, or from the outer world after birth. For this reason the bones on the one hand only grow up to a certain point (for there is a limit of size in all animals, and therefore also of the growth of the bones; if these had been always able to grow, all animals that have bone or its analogue would grow as long as they lived, for these set the limit of size to animals. What is the reason of their not always increasing in size must be stated later). Hair, on the contrary, and growths akin to hair go on growing as long as they exist at all, and increase yet more in diseases and when the body is getting old and wasting, because more residual matter is left over, as owing to old age and disease less is expended on the important parts, though when the residual matter also fails through age the hair fails with it. But the contrary is the case with the bones, for they waste away along with the body and the other parts. Hair actually goes on growing after death; it does not, however, begin growing then.

About the teeth a difficulty may be raised. They have actually the same nature as the bones, and are formed out of the bones, but nails, hair, horns, and the like are formed out of the skin, and that is why they change in colour along with it, for they become white, black, and all sorts of colours according to that of the skin. But the teeth do nothing of the sort, for they are made out of the bones in all animals that have both bones and teeth. Of all the bones they alone go on growing through life, as is plain with the teeth which grow out of the straight line so as no longer to touch each other. The reason for their growth, as a final cause, is their function, for they would soon be worn down if there were not some means of saving them; even as it is they are altogether worn down in old age in some animals which eat much and have not large teeth, for they are worn away faster than they grow. And so nature has contrived well to meet the case in this also, for she causes the failure of the teeth to synchronize with old age and death. If life lasted for a thousand or ten thousand years the original teeth would have had to be very large indeed, and many sets of them would have had to have been produced, for even if they had grown
745b1 continuously they would still have been worn smooth and become useless for their work. The final cause of their growth has been now stated, but besides this as a matter of fact the nature of the teeth is not the same as that of the other bones. The latter all come into being in the first formation of the embryo and none of them later, but the teeth do so later. Therefore it is possible for them to grow again after the first set falls out, for though they touch the bones they are not naturally connected to them. They are formed, however, out of the nutriment distributed to the bones, and so have the same nature, even when the bones have their own number complete.

Other animals are born in possession of teeth or their analogue (unless in cases contrary to nature), because when they are set free from the parent they are more perfect than man; but man (also unless in cases contrary to nature) is born without them.

The reason will be stated later why some teeth are formed and fall out but others do not fall out.

It is because such parts are formed from a residue that man is the most naked in body of all animals and has the smallest nails in proportion to his size; he has the least amount of earthy residue, but what is not concocted is the residue, and the earthy part in the bodies of all animals is the least concocted. We have now stated how each of the parts is formed and what is the cause of their generation.

7 · In viviparous animals, as said before, the embryo gets its growth through the umbilical cord. For since the nutritive power of the soul, as well as the others, is present in animals, it straightway sends off this cord like a root to the uterus. The cord consists of blood-vessels in a sheath, more numerous in the larger animals as cattle and the like, one in the smallest, two in those of intermediate size. Through this cord the embryo receives its nourishment in the form of blood, for the uterus is the termination of many blood-vessels. All non-ambidentates and all ambidentates whose uterus has not one great blood-vessel running through it but many close together instead—all these have in the uterus the so-called cotyledons with which the umbilical cord connects and is closely united; for the vessels which pass through the cord run backwards and forwards and split up all over the uterus; where they terminate, there are found the cotyledons. Their convexity is turned towards the uterus, the concavity towards the embryo. Between uterus and embryo are the chorion and the membranes. As the embryo grows and approaches perfection the cotyledons become smaller and finally disappear when it is perfected. For nature sends the sanguineous nutriment for the embryo into this part of the uterus as it were into breasts, and because the cotyledons are gradually aggregated from many into a few the body of the cotyledon becomes like an eruption or inflammation. So long as the embryo is comparatively small, being unable to receive much nutriment, they are plain and large, but when it has increased in size they shrink.

But most of the animals which are stunted and ambidentate have no cotyledons in the uterus, but the umbilical cord runs to meet one blood-vessel, which is large and extends throughout the uterus. Of such animals some produce one young at a time, some more than one, but the same description applies to both these classes. (This should be studied with the aid of the examples drawn in the *Anatomies* and the *Histories*.) For the young are attached each to its umbilical cord, and this to the blood-vessel; they are arranged next to one another along the stream of the blood-vessel as along a canal; and each embryo is enclosed in its membranes and chorion.

Those who say that children are nourished in the uterus by sucking some lump of flesh or other are mistaken. If so, the same would have been the case with other animals, but as it is we do not find this (and this can easily be observed by dissection). Secondly, all embryos alike, whether of creatures that fly or swim or walk, are surrounded by fine membranes separating them from the uterus and from the fluids which are formed in it; but neither in these themselves is there anything of the kind, nor is it possible for the embryo to take nourishment by means of any of them. And it is plain that all creatures developed in eggs grow when separated from the uterus. Thus those, e.g. Democritus, who put forward this view are mistaken.

Copulation takes place naturally between animals of the same kind. However, those also unite whose nature is near akin and whose form is not very different, if their size is much the same and if the periods of gestation are equal. In other animals such cases are rare, but they occur with dogs and foxes and wolves and jackals; the Indian dogs also spring from the union of a dog with some wild dog-like 746b1 animal. A similar thing has been seen to take place in those birds that are salacious, as partridges and hens. Among birds of prey hawks of different form are thought to unite, and the same applies to some other birds. Nothing worth mentioning has been observed in the inhabitants of the sea, but the so-called 'rhinobates' especially is thought to spring from the union of the rhinè and the batus. And the proverb about Libya, that Libya is always producing something new, is said to have originated from animals of different species uniting with one another in that country, for it is said that because of the want of water all meet at the few places where springs are to be found, and that even different kinds unite in consequence.

Of the animals that arise from such union all except mules are found to copulate again with each other and to be able to produce young of both sexes, but mules alone are sterile, for they do not generate by union with one another or with other animals. The problem why any individual, whether male or female, is sterile is a general one, for some men and women are sterile, and so are other animals in their several kinds, as horses and sheep. But this kind, that of mules, is universally so. The causes of sterility in other animals are several. Both men and women are sterile from birth when the parts useful for union are imperfect, so that men never grow a beard but remain like eunuchs, and women do not attain puberty; the same thing may befall others as their years advance, sometimes on account of the body being too well nourished (for in men who are in too good condition and women who are too fat the seminal residue is taken up into the body, and the former have no semen, the latter no menstrual discharge); at other times by reason of sickness men emit the semen in a cold and liquid state, and the discharges of women are bad and full of morbid residues. Often, too, in both sexes this state is caused by deformities in the parts and regions contributory to copulation. Some such cases are curable, others incurable, but the subjects especially remain sterile if anything of the sort has happened in the first formation of the parts in the embryo, for then are produced 747a1 women of a masculine and men of a feminine appearance, and in the former the menstrual discharge does not occur, in the latter the semen is thin and cold. Hence it is with good reason that the semen of men is tested in water to find out if it is infertile, for that which is thin and cold is quickly spread out on the surface, but the fertile sinks to the bottom, for that which is well concocted is hot indeed, but that which is firm and thick is well concocted. They test women by pessaries to see if the smells permeate from below upwards to the breath from the mouth, and by colours smeared upon the eyes to see if they colour the saliva. If these results do not follow it is a sign that the passages of the body, through which the residue is secreted, are clogged and closed. For the region about the eyes is, of all the head, the most seminal part; a proof of this is that it alone is visibly changed in sexual intercourse, and those who indulge too much in this are seen to have their eyes sunken in. The reason is that the nature of the semen is similar to that of the brain, for the material of it is watery (the heat being acquired later). And the seminal discharges are from the region of the diaphragm, for the first principle of nature is there, so that the movements from the pudenda are communicated to the chest, and the smells from the chest are all perceived through the respiration.

8 · In men, then, and in other kinds, as said before, such deficiency occurs sporadically, but the whole of the mule kind is sterile. The reason has not been rightly given by Empedocles and Democritus, of whom the former expresses himself obscurely, the latter more intelligibly. For they offer a single demonstration for all animals which unite against their affinities. Democritus says that the genital passages of mules are spoilt in the mother's uterus because the animals from the first are not produced from parents of the same kind. But we find that though this is so with other animals they are none the less able to generate; yet, if this were the reason for their sterility, all others that unite in this manner ought to be sterile. Empedocles assigns as his reason that the mixture of the seeds becomes dense, each of the two seminal fluids out of which it is made being soft, for the hollows in each 747b1
fit into the densities of the other, and in such cases a hard substance is formed out of soft ones, like bronze mingled with tin. Now he does not give the correct reason in the case of bronze and tin—we have spoken of them in the *Problems*—nor, to take general ground, does he take his principles from the intelligible. For how do the hollows and solids fit into one another to make the mixing, e.g. in the case of wine and water? This saying is quite beyond us; for how we are to understand the hollows of the wine and water is too far beyond our perception. Again, when, as a matter of fact, horse is born of horse, ass of ass, and mule of horse and ass (it does not matter which is the male and which the female), why in the last case does there result something so dense that the offspring is sterile, whereas the offspring of male and female horse, male and female ass, is not sterile? And yet the generative fluid of the male and female horse is soft. But both sexes of the horse cross with both sexes of the ass, and the offspring of both crosses are sterile, according to Empedocles, because from both is produced something dense, the seeds being soft. If so, the offspring of stallion and mare ought also to be sterile. If one of them alone united with the ass, it might be said that the cause of the mule's being unable to generate was the unlikeness of that one to the generative fluid of the ass; but, as it is, whatever be the character of that generative fluid with which it unites in the ass, such it is also in the animal of its own kind. Then, again, the demonstration is intended to apply to both male and female mules alike, but the male alone does generate at seven years of age, it is said, whereas the female is entirely sterile, and even she is so only because she does not complete the development of the embryo, for a female mule has been known to conceive.

Perhaps an abstract proof might appear to be more plausible than those already given; I call it abstract because the more general it is the further is it removed from the appropriate principles. It runs somewhat as follows. From male and female of the same species there are born in course of nature male and female of the same species as the parents, e.g. male and female puppies from male and female dog. From parents of different species is born a young one different in species; thus if a dog is different from a lion, the offspring of male dog and lioness or of lion and bitch will be different from both parents. If this is so, then since mules are produced of both sexes and are not different in species from one another, and a mule is born of horse and ass and these are different in species from mules, it is impossible that anything should be produced from mules. For another kind cannot be, because the product of male and female of the same species is also of the same species, and a mule cannot be, because that is the product of horse and ass which are different in form, and it was laid down that from parents different in form is born a different animal. Now this theory is too general and empty. For all theories not based on the appropriate principles are empty; they only appear to be connected with the facts without being so really. As geometrical arguments must start from geometrical principles, so it is with the others; that which is empty may seem to be something, but is really nothing. Now the basis of this particular theory is not true, for many animals produced from different species are fertile, as was said before. So we must not inquire into questions of natural science in this fashion any more than any other questions; we shall be more likely to find the reason by considering the facts peculiar to the two kinds concerned, horse and ass. In the first place, each of them, if mated with its own kind, bears only one young one; secondly, the females are not always able to conceive from the male (that is why breeders put the horse to the mare again at intervals). Indeed, the mare is deficient in menstrual flow, discharging less than any other quadruped, and the she-ass does not admit the impregnation, but ejects the semen with her urine, which is why men follow flogging her after intercourse. Again the ass is an animal of cold nature, and so is not wont to be produced in wintry regions because it cannot bear cold, as in Scythia and the neighbouring country and among the Celts beyond Iberia, for this country also is cold. For this cause they do not put the jackasses to the females at the equinox, as they do with horses, but about the summer solstice, in order that the ass-foals may be born in a warm season, for the mothers bear at the same season as that in which they are impregnated, the period of gestation in both horse and ass being one year. The animal, then, being, as has been said, of such a cold nature, its semen also must be cold. A proof of this is that if a horse mount a female already impregnated by an ass he does not destroy the impregnation of the ass, but if the ass be the second to mount her he does destroy that of the horse because of the coldness of his own semen. When, therefore, they unite with each other, the generative elements are preserved by the heat of the one of them, that contributed by the horse being the hotter; for in the ass both the semen and the material are cold, and those of the horse are hotter. Now when either hot is added to cold or cold to hot so as to mix, the result is that the embryo itself arising from these is preserved and thus these animals are fertile when crossed with one another, but the animal produced by them is no longer fertile but unable to produce perfect offspring.

And in general each of these animals naturally tends towards sterility. The ass has all the disadvantages already mentioned, and if it should not begin to generate after the first shedding of teeth, it no longer generates at all; so near is the constitution of the ass to being sterile. The horse is much the same; it tends naturally towards sterility, and to make it entirely so it is only necessary that its generative secretion should become colder; now this is what happens to it when mixed with the corresponding secretion of the ass. The ass in like manner comes very near generating a sterile animal when mated with its own species. Thus when the difficulty of a cross contrary to nature is added to the difficulty they have in producing a single young one when united with their own species, the result of the cross, being still more sterile and contrary to nature, will need nothing further to make it sterile, but will be so of necessity.

We find also that the bodies of mules grow large because the matter which is secreted in other animals to form the menstrual flow is diverted to growth. But since the period of gestation in such animals is a year, the mule must not only conceive but must also nourish the embryo till birth, and this is impossible if there is no menstrual discharge. But there is none in the mule; the useless part of the nutriment is discharged with the excretion from the bladder—this is why male mules do not sniff at the pudenda of the females, as do the other solid-hoofed animals, but only at the excretion itself—and the rest of the nutriment is used up to increase the size of the body. Hence it is sometimes possible for the female to conceive, as has been known to happen before now, but it is impossible for her to complete the process of nourishing the embryo and bringing it to birth.

The male, again, may sometimes generate, both because the male sex is naturally hotter than the female and because it does not contribute any material substance to the mixture. The result in such cases is a ginnus, that is to say, a deformed mule; for ginni are produced also from the crossing of horse and ass when the embryo is diseased in the uterus. The ginnus is in fact like the so-called metachoera in swine, for a metachoerum also is a pig deformed in the uterus; this may happen to any pig. The origin of human dwarfs is similar, for these also have their parts and their whole development deformed during gestation, and resemble ginni and metachoera.

BOOK III

1 · We have now spoken about the sterility of mules, and about those animals which are viviparous both externally and within themselves. The generation of the oviparous sanguinea is to a certain extent similar to that of the animals that walk, and all may be embraced in the same general statement; but in other respects there are differences in them both as compared with each other and with those that walk. All alike are generated from sexual union, the male emitting semen into the female. But among the ovipara birds produce a perfect hard-shelled egg, unless it be injured by disease, and the eggs of birds are all two-coloured. The Selachian fishes, as has been often said already, are oviparous internally but produce the young alive, the egg changing previously from one part of the uterus to another; and their egg is soft-shelled and of one colour. One of this class alone does not produce the young from the egg within itself, the so-called fishing-frog; the

reason of which must be stated later. All other oviparous fishes produce an egg of one colour, but this is imperfect, for its growth is completed outside the mother's body by the same cause as are those eggs which are perfected within.

Concerning the uterus, what differences there are among them and for what reasons, has been stated previously. For in some of the viviparous creatures it is high up near the hypozoma, in others low down by the pudenda; the former in the Selachia, the latter in animals both internally and externally viviparous, such as man and horse and the rest; in the ovipara it is sometimes low, as in the oviparous fish, and sometimes high, as in birds.

Some embryos are formed in birds spontaneously, which are called wind-eggs
749b1 and 'zephyria' by some; these occur in birds which are not given to flight nor rapine but which produce many young, for these birds have much residual matter, whereas in the birds of prey such secretion is diverted to the wings and feathers, while the body is small and dry and hot; and the menstrual secretion and the semen are residues. Since then both the wings and the semen are made from residual matter, nature cannot afford to spend much upon both. And for this same reason the birds of prey are neither given to treading much nor to laying many eggs, as are the heavy birds and those flying birds whose bodies are bulky, as the pigeon and so forth. For such residual matter is secreted largely in the heavy birds not given to flying, such as fowls, partridges, and so on, and that is why their males tread often and their females produce much material. Of such birds some lay many eggs at a time and some lay often; for instance, the fowl, the partridge, and the Libyan ostrich lay many eggs, while the pigeon family do not lay many but lay often. For these are between the birds of prey and the heavy ones; they are flyers like the former, but have bulky bodies like the latter; hence, because they are flyers and the residue is diverted that way, they lay few eggs, but they lay often because of their having bulky bodies and their stomachs being hot and very active in concoction, and because moreover they can easily procure their food, whereas the birds of prey do so with difficulty.

Small birds also tread often and are very fertile, as are sometimes small plants, for what causes bodily growth in others turns in them to a seminal residuum. Hence the Adrianic fowls lay most eggs, for because of the smallness of their bodies the nutriment is used up in producing young. And low-bred birds are more fertile than high-bred ones; for their bodies are more fluid and bulkier, whereas those of the latter are leaner and drier, since a high-bred spirit is found rather in such bodies as the latter. Moreover the thinness and weakness of the legs contribute to making the
750a1 former class of birds naturally inclined to tread and to be fertile, as we find also in the human species; for the nourishment which otherwise goes to the legs is turned in such into a seminal secretion, what nature takes from the one place being added at the other. Birds of prey, on the contrary, have a strong walk and their legs are thick owing to their habits, so that for all these reasons they neither tread nor lay much. The kestrel is the most fertile; for this is nearly the only bird of prey which drinks, and its moisture, both innate and acquired, along with its heat is favourable to generative products. Even this bird does not lay very many eggs, but four at the outside.

The cuckoo, though not a bird of prey, lays few eggs, because it is of a cold nature, as is shown by the cowardice of the bird, whereas a generative animal should be hot and moist. That it is cowardly is plain, for it is pursued by all the birds and lays eggs in the nests of others.

The pigeon family are in the habit of laying two for the most part, for they neither lay one (no bird does except the cuckoo, and even that sometimes lays two) nor yet many, but they frequently produce two, or three at the most, generally two, for these numbers lie between one and many.

It is plain from the facts that with the birds that lay many eggs the nutriment is diverted to the semen. For most trees, if they bear too much fruit, wither away after the crop when nutriment is not reserved for themselves, and this seems to be what happens to annuals, as leguminous plants, corn, and the like. For they consume all their nutriment to make seed, their kind being prolific. And some fowls after laying too much, so as even to lay two eggs in a day, have died after this. For both the birds and the plants become as it were purged, and this condition is an excess of secretion of residual matter. A similar condition is the cause of the later sterility of the lioness, for at the first birth she produces five or six, then in the next year four, and again three cubs, then the next number down to one, then none at all, showing that the residue is being used up and the semen is failing along with the advance of years.

We have now stated in which birds wind-eggs are found, and also what sort of 750b1
birds lay many eggs or few, and for what reasons. And wind-eggs, as said before, come into being because while seminal material exists in the female, birds have no menstrual discharge like viviparous sanguinea (for they occur in all these latter, more in some, less in others, and in some only enough in quantity just to mark the class). The same applies to fish as to birds, and so in them too is found an embryonic formation without impregnation, but it is less obvious because their nature is colder. The secretion corresponding to the menstrual fluid of vivipara is formed in birds at the appropriate season for the discharge of residue, and, because the region near the hypozoma is hot, it is perfected so far as size is concerned, but in birds and fishes alike it is imperfect for generation without the seminal fluid of the male; the cause of this has been previously given. Wind-eggs are not formed in the flying birds, for the same reason as prevents their laying many eggs; for the residual matter in birds of prey is small, and they need the male to give an impulse for the discharge of it. The wind-eggs are produced in greater numbers than the impregnated but smaller in size for one and the same reason; they are smaller in size because they are imperfect, and because they are smaller in size they are more in number. They are less pleasant for food because they are less concocted, for in all foods the concocted is more agreeable. It has been sufficiently observed, then, that neither birds' nor fishes' eggs are perfected for generation without the males. As for embryos being formed in fish also (though in a less degree) without the males, the fact has been observed especially in river fish, for some are seen to have eggs from the first, as has been written in the *Histories*[1] concerning them. And generally

[1] *History of Animals* 567a30.

speaking in the case of *birds* even the impregnated eggs are not wont for the most part to attain their full growth unless the hen be trodden continually. The reason of 751a1 this is that just as with women intercourse with men draws down the secretion (for the uterus being heated attracts the moisture and the passages are opened), so this happens also with birds; the residual matter corresponding to the menstrual fluid advances a little at a time, and is not discharged externally, because its amount is small and the uterus is high up by the hypozoma, but trickles together into the uterus itself. For as the embryo of the vivipara grows by means of the umbilical cord, so the egg grows through this matter flowing to it through the uterus. For when once the hens have been trodden, they all continue to have eggs almost without intermission, though very small ones. Hence some are wont to speak of wind-eggs as not coming into being independently but as mere relics from a previous impregnation. But this is a false view, for sufficient observations have been made of their arising without impregnation in chickens and goslings. Also the female partridges which are taken out to act as decoys, whether they have ever been impregnated or not, immediately on smelling the male and hearing his call, become filled with eggs in the latter case and lay them in the former. The reason why this happens is the same as in men and quadrupeds, for if their bodies chance to be in rut they emit semen at the mere sight of the female or at a slight touch. And such birds are of a lascivious and fertile nature, so that the impulse they need is but small when they are in this excited condition, and the secreting activity takes place quickly in them, wind-eggs forming in the unimpregnated and the eggs in those which have been impregnated growing and reaching perfection swiftly.

Among creatures that lay eggs externally birds produce their egg perfect, fish imperfect, but the eggs of the latter complete their growth outside as has been said before. The reason is that the fish kind is very fertile; now it is impossible for many eggs to reach completion within the mother and therefore they lay them outside. They are quickly discharged, for the uterus of externally oviparous fishes is near the generative passage. While the eggs of birds are two-coloured, those of all fish are one-coloured. The cause of the double colour may be seen from considering the power of each of the two parts, the white and the yolk. For the matter of the egg is secreted from the blood [(no bloodless animal lays eggs)][2] and that the blood is the 751b1 material of the body has been often said already. The one part, then, of the egg is nearer the form of the animal coming into being, that is the hot part; the more earthy part gives the substance of the body and is further removed. Hence in all two-coloured eggs the animal receives the first principle of generation from the white (for the vital principle is in that which is hot), but the nutriment from the yolk. Now in animals of a hotter nature the part from which the first principle arises is separated off from the part from which comes the nutriment, the one being white and the other yellow, and the white and pure is always more than the yellow and earthy; but in the moister and less hot the yolk is more in quantity and more fluid. This is what we find in lake birds, for they are of a moister nature and are colder than the land birds, so that the so-called yolk in the eggs of such birds is large and

[2]Excised by Wimmer.

less yellow because the white is less separated off from it. But when we come to the ovipara which are both of a cold nature and also moister (such is the fish kind), we find the white not separated at all because of the small size of the eggs and the quantity of the cold and earthy matter; therefore all fish eggs are of one colour, and white compared with yellow, yellow compared with white. Even the wind-eggs of birds have this distinction of colour, for they contain that out of which will come each of the two parts, alike that whence arises the principle of life and that whence comes the nutriment; only both these are imperfect and need the influence of the male in addition; for wind-eggs become fertile if impregnated by the male within a certain period. The difference in colour, however, is not due to any difference of sex, as if the white came from the male, the yolk from the female; both on the contrary come from the female, but the one is cold, the other hot. In all cases then where the hot part is considerable it is separated off, but where it is little it cannot be so; hence the eggs of such animals, as has been said, are of one colour. The semen of the male only sets them; and therefore at first the egg in birds appears white and small, but as it advances it is all yellow as more of the sanguineous material is continually mixed with it; finally as the hot part is separated the white takes up a position all round it and equally distributed on all sides, as when a liquid boils; for the white is naturally 752a1
liquid and contains in itself the vital heat; therefore it is separated off all round, but the yellow and earthy part is inside. And if we enclose many eggs together in a bladder or something of the kind and boil them over a fire so as not to make the movement of the heat quicker than the separation of the white and yolk in the eggs, then the same process takes place in the whole mass of the eggs as in a single egg, all the yellow part coming into the middle and the white surrounding it.

We have thus stated why some eggs are of one colour and others of two.

2 · The principle of the male is separated off in eggs at the point where the egg is attached to the uterus, and the reason why two-coloured eggs are unsymmetrical, and not perfectly round but sharper at one end, is that the part of the white in which is contained this principle must differ from the rest. Therefore the egg is harder at this point than below, for it is necessary to shelter and protect this principle. And this is why the sharp end of the egg comes out of the hen later than the blunt end; for the part attached to the uterus comes out later, and the egg is attached at the point where is the said principle, and the principle is in the sharp end. The same is the case also in the seeds of plants; the principle of the seed is attached sometimes to the twig, sometimes to the husk, sometimes to the pericarp. This is plain in the leguminous plants, for where the two cotyledons of beans and of similar seeds are united, there is the seed attached to the parent plant, and there is the principle of the seed.

A difficulty may be raised about the growth of the egg; how is it derived from the uterus? For if animals derive their nutriment through the umbilical cord, through what do eggs derive it? They do not, like grubs, acquire their growth by their own means. If there is anything by which they are attached to the uterus, what becomes of this when the egg is perfected? It does not come out with the egg as the cord does with animals; for when its egg is perfected the shell forms all round it. This problem is rightly raised, but it is not observed that the shell is at first only a soft membrane, and that it is only after the egg is perfected that it becomes hard and brittle; this is so nicely adjusted that it is still soft when it comes out (for otherwise it would cause pain in laying), but no sooner has it come out than it is fixed hard by cooling, the moisture quickly evaporating because there is but little of 752b1 it, and the earthy part remaining. Now at first a certain part of this membrane at the sharp end of eggs resembles an umbilical cord, and projects like a pipe from them while they are still small. It is plainly visible in small aborted eggs, for if the bird be drenched with water or suddenly chilled in any other way and cast out the egg too soon, it appears still sanguineous and with a small tail like an umbilical cord running through it. As the egg becomes larger this is more twisted round and becomes smaller, and when the egg is perfected this end is the sharp end. Under this is the inner membrane which separates the white and the yolk from this. When the egg is perfected, the whole of it is set free, and naturally the umbilical cord does not appear, for it is now the extreme end of the egg itself.

The egg is discharged in the opposite way from the young of vivipara; the latter are born head-first, the part where is the first principle leading, but the egg is discharged as it were feet first; the reason of this being what has been stated, that the egg is attached at the point where is the first principle.

The young bird is produced out of the egg by the mother's incubating and aiding the concoction, the creature developing out of part of the egg, and receiving growth and completion from the remaining part. For nature not only places the material of the creature in the egg but also the nourishment sufficient for its growth; for since the mother bird cannot perfect her young within herself she produces the nourishment in the egg along with it. Whereas the nourishment, what is called milk, is produced for the young of vivipara in another part, in the breasts, nature does this for birds in the egg. The opposite, however, is the case to what people think and what is asserted by Alcmaeon of Croton. For it is not the white that is the milk, but the yolk, for it is this that is the nourishment of the chick, whereas they think it is the white because of the similarity of colour.

The chick then, as has been said, comes into being by the incubation of the mother; yet if the temperature of the season is favourable, or if the place in which the eggs happen to lie is warm, the eggs get concocted, both those of birds and those of oviparous quadrupeds. For these all lay their eggs upon the ground, where they are concocted by the heat in the earth. Such oviparous quadrupeds as do visit their eggs and incubate do so rather for the sake of protecting them.

753a1 The eggs of these quadrupeds are formed in the same way as those of birds, for they are hard-shelled and two-coloured, and they are formed near the hypozoma as are those of birds, and in all other respects resemble them both internally and externally, so that the inquiry into their causes is the same for all. But whereas the eggs of quadrupeds are hatched out by the mere heat of the weather owing to their strength, those of birds are more exposed to destruction and need the mother-bird. Nature seems to wish to implant in animals a[3] sense of care for their young: in the

[3]Omitting τήν.

inferior animals this lasts only to the moment of giving birth; in others it continues till they are perfect; in all that are more intelligent, during the bringing up of the young also. In those which have the greatest portion in intelligence we find familiarity and love shown also towards the young when perfected, as with men and some quadrupeds; with birds we find it till they have produced and brought up their young, and therefore if the hens do not incubate after laying they get into worse condition, as if deprived of something natural to them.

The young is perfected within the egg more quickly in warm weather, the season aiding in the work, for concoction is the work of heat. For the earth aids in the concoction by its heat, and the brooding hen does the same, for she infuses the heat that is within her. And it is in the hot season, as we should expect, that the eggs are more apt to be spoilt and the so-called 'uria' are produced; for just as wines turn sour in the heats from the sediment getting stirred up (for this is the cause of their being spoilt), so is it with the yolk in eggs, for the sediment and yolk are the earthy part in each case, and that is why the wine becomes turbid when the sediment mixes with it, and the like applies to the eggs that are spoiling because of the yolk. It is reasonable then that such should be the case with the birds that lay many eggs, for it is not easy to give the fitting amount of heat to all, but (while some have too little) others have too much and this makes them turbid, as it were by putrefaction. But this happens none the less with the birds of prey though they lay few eggs, for often one of the two becomes rotten, and the third practically always, for being of a hot nature they make the moisture in the eggs to overboil so to say. For the nature of the white is opposed to that of the yolk; the yolk congeals in frosts but liquefies on 753b1
heating, and therefore it liquefies on concoction in the earth or by reason of incubation, and becoming liquid serves as nutriment for the developing chick. If exposed to heat and roasted it does not become hard, because though earthy in nature it is only so in the same way as wax is; accordingly on heating too much the eggs become watery and rotten, †if they be not from a liquid residue.†[4] The white on the contrary is not congealed by frost but rather liquefies (the reason of which has been stated before), but on exposure to heat becomes solid. Therefore being concocted in the development of the chick it is thickened. For it is from this that the young is formed (whereas the yolk turns to nutriment) and it is from this that the parts derive their growth as they are formed one after another. This is why the white and the yolk are separated by membranes, as being different in nature. The precise details of the relation of the parts to one another both at the beginning of generation and as the animals are forming, and also the details of the membranes and umbilical cords, must be learnt from what has been written in the *Histories*;[5] for the present investigation it is sufficient to understand this much clearly, that, when the heart has been first formed and the great blood-vessel has been marked off from it, two umbilical cords run from the vessel, the one to the membrane which encloses the yolk, the other to the membrane resembling a chorion which surrounds the whole embryo; this latter runs round the membrane of the shell. Through the one of these the embryo receives the nutriment from the yolk, and the yolk becomes larger, for it

[4]The phrase between daggers is corrupt.
[5]See *History of Animals* VI 3.

becomes more liquid by heating. This is because the nourishment, being of a material character, must become liquid, just as it is with plants, and at first this embryo, whether in an egg or in the mother's uterus, lives the life of a plant, for it receives its first growth and nourishment by being attached to something else.

The second umbilical cord runs to the surrounding chorion. For we must understand that, in the case of animals developed in eggs, they have the same relation to the yolk as the embryo of the vivipara has to the mother so long as it is within the mother (for since the nourishment of the embryo of the ovipara is not completed within the mother, the embryo takes part of it away from her); and their relation to the outermost membrane, the sanguineous one, is like that of the viviparous embryo to the uterus. At the same time the egg-shell surrounds both the yolk and the chorion analogous to the uterus, just as if it should be put round both the embryo itself and the whole of the mother. This is so because the embryo must be in the uterus and attached to the mother. Now in the vivipara the uterus is within the mother, but in the ovipara it is the other way about, as if one should say that the mother was in the uterus, for that which comes from the mother, the nutriment, is the yolk. The reason is that the process of nourishment is not completed within the mother.

As the creature grows the umbilicus running to the chorion collapses first, because it is here that the young is to come out; what is left of the yolk, and the umbilical cord running to the yolk, collapse later. For the young must have nourishment as soon as it is hatched; it is not nursed by the mother and cannot immediately procure its nourishment for itself; therefore the yolk enters within it along with its umbilicus and the flesh grows round it.

This then is the manner in which animals produced from perfect eggs are hatched in all those, whether birds or quadrupeds, which lay eggs with a hard shell. These details are plainer in the larger creatures; in the smaller they are obscure because of the smallness of the masses concerned.

3 · The class of fishes is also oviparous. Those among them which have the uterus low down lay an imperfect egg for the reason previously given, but the so-called Selachia produce a perfect egg within themselves but are externally viviparous except one which they call the fishing-frog; this alone lays a perfect egg externally. The reason is the nature of its body, for its head is many times as large as the rest of the body and is spiny and very rough. This is also why it does not receive its young again within itself nor produce them alive to begin with, for as the size and roughness of the head prevents their entering so it would prevent their exit. And while the egg of the Selachia is soft-shelled (for they cannot harden and dry its circumference, being colder than birds), the egg of the fishing-frog alone is solid and firm to protect it outside, but those of the rest are of a moist and soft nature, for they are sheltered within and by the body of the mother.

The young are produced from the egg in the same way both with those externally perfected (the fishing-frogs) and those internally, and the process in these eggs is partly similar to, partly different from that in birds' eggs. In the first place they have not the second umbilicus which runs to the chorion under the surrounding shell. The reason of this is that they have not the surrounding shell, for it is no use to them since the mother shelters them, and the shell is a protection to the laid eggs against external injury. Secondly, the process in these also begins on the surface of the egg but not where it is attached to the uterus; for birds are developed from the sharp end and that is where the egg was attached. The reason is that the egg of birds is separated from the uterus, but in most though not all Selachia the egg is still attached to the uterus when perfect. While the young develops upon the surface the egg is consumed by it just as in birds and the other animals detached from the uterus, and at last the umbilicus of the now perfect fish is left attached to the uterus. The like is the case with all those whose eggs are detached from the uterus, for in some of them the egg is so detached when it is perfect.

The question may be raised why the development of birds and fishes differs in this respect. The reason is that in birds the white and yolk are separate, but fish eggs are one-coloured, the corresponding matter being completely mixed, so that there is nothing to stop the first principle being at the opposite end, for the egg is of the same nature both at the point of attachment and at the opposite end, and it is easy to draw the nourishment from the uterus by passages running from this principle. This is plain in the eggs which are not detached, for in some of the Selachia the egg is not detached from the uterus, but is still connected with it as it comes downwards with a view to the production of the young alive; in these the young fish when perfected is still connected by the umbilicus to the uterus when the egg has been consumed. From this it is clear that previously also, while the egg was still round the young, the passages ran to the uterus. This happens as we have said in the smooth dogfish.

In these respects and for the reasons given, the development of fishes differs from that of birds, but otherwise it takes place in the same way. For they have the one umbilicus in like manner as that of birds connecting with the yolk—only in these fishes it connects with the whole egg (for it is not divided into white and yolk but all one-coloured)—and get their nourishment from this, and as it is being consumed the flesh in like manner encroaches upon and grows round it.

Such is the process of development in those fish that produce a perfect egg within themselves but are externally viviparous.

4 · Most of the other fish are externally oviparous, all laying an imperfect egg except the fishing-frog; the reason for this exception has been previously stated, and the reason also why the others lay imperfect eggs. In these also the development from the egg runs on the same lines as that of the Selachian and internally oviparous fishes, except that the growth is quick and from small beginnings and the outside of the egg is harder. The growth of the egg is like that of a grub, for those animals which produce grubs give birth to a small thing at first and this grows by itself and not through any attachment to the parent. The reason is similar to that of the growth of yeast, for yeast also grows great from a small beginning as the more solid part liquefies and the liquid is aerated. This is effected in animals by the nature of

the vital heat, in yeasts by the heat of the juice commingled with them. The eggs then grow of necessity through this cause (for they have in them a yeasty residue), but also for the sake of what is better; for it is impossible for them to attain their whole growth in the uterus because these animals have so many eggs. Therefore they are very small when set free and grow quickly, small because the uterus is narrow for the multitude of the eggs, and growing quickly that the race may not perish, as it would if much of the time required for the whole development were spent in this growth; even as it is most of those laid are destroyed. Hence the class of fish is prolific, for nature makes up for the destruction by numbers. Some fish actually burst because of the size of the eggs, as the fish called the pipe-fish—for its eggs are large instead of numerous, what nature has taken away in number being added in size.

So much for the growth of such eggs and its reason.

755b1 5 · A proof that these fish also are oviparous is the fact that even viviparous fish, such as the Selachia, are first internally oviparous, for it is plain that the whole class of fishes is oviparous. Where, however, both sexes exist and the eggs are produced in consequence of impregnation, the eggs do not arrive at completion unless the male sprinkle his milt upon them. Some erroneously assert that all fish are female except in the Selachian fishes, for they think that the females of fish differ from what are supposed to be males only in the same way as in those plants where the one bears fruit but the other is fruitless, as olive and oleaster, fig and caprifig. They think the like applies to fish except the Selachia; for they do not dispute the sexes in these. And yet there is no difference in the males of Selachian fishes and those belonging to the oviparous class in respect of the organs for the milt, and semen can be seen oozing out of males of both classes at the right season. The female also has a uterus. But if the whole class were females and some of them unproductive, then not only should those which lay eggs have a uterus but also the others, only the uterus of the latter should be different from that of the former. But, as it is, some of them have organs for milt and others have a uterus, and this distinction obtains in all except two, the erythrinus and the channa, some of them having the milt organs, others a uterus. The difficulty which drives some thinkers to this conclusion is easily solved if we look at the facts. They say quite correctly that no animal which copulates produces many young, for of all those that generate from themselves perfect animals or perfect eggs none is prolific on the same scale as the oviparous fishes, for the number of eggs in these is enormous. But they had overlooked the fact that fish-eggs differ from those of birds in one circumstance. Birds and all oviparous quadrupeds, and any of the Selachia that are oviparous, produce a perfect egg, and it does not increase outside of them, whereas the eggs of fish are imperfect and do so complete their growth. Moreover the same thing applies to cephalopods also and crustacea, yet these animals are actually seen copulating, for their union lasts a long time, and it is plain in these cases that the one is male and the other has a uterus. Finally, it would be strange if this distinction did
756a1 not exist in the whole class, just as male and female in all the vivipara. The cause of the ignorance of those who make this statement is that the differences in the

copulation and generation of various animals are of all kinds and not obvious, and so, basing their study on a few cases, they think the same must hold good in all cases.

So also those who assert that conception in female fishes is caused by their swallowing the semen have not observed certain points when they say this. For the males have their milt and the females their eggs at about the same time of year, and the nearer the female is to laying the more abundant and the more liquid is the milt formed in the male. And just as the increase of the milt in the male and of the egg in the female takes place at the same time, so is it also with their emission, for neither do the females lay all their eggs together, but gradually, nor do the males emit all the milt at once. All these facts are in accordance with reason. For just as the class of birds in some cases has eggs without impregnation, but few and seldom, impregnation being generally required, so we find the same thing, though to a less degree, in fish. But in both classes these spontaneous eggs are infertile unless the male, in those kinds where the male exists, shed his fluid upon them. Now in birds this must take place while the eggs are still within the mother, because they are perfect when discharged, but in fish, because the eggs are imperfect and complete their growth outside the mother in all cases, those outside are preserved by the sprinkling of the milt over them, even if nothing fertile comes into being inside by way of impregnation, and here it is that the milt of the males is used up. Therefore it comes down the ducts and diminishes in quantity at the same time as this happens to the eggs of the females, for the males always attend them, shedding their milt upon the eggs as they are laid. Thus then they are male and female, and all of them copulate (unless in any kind the distinction of sex does not exist), and without the semen of the male no such animal comes into being.

What contributes to their error is also the fact that the union of such fishes is brief, so that it is not observed even by many of the fishermen, for none of them ever watches anything of the sort for the sake of knowledge. Nevertheless their copulation has been seen, for fish (when the tail part does not prevent it)[6] copulate like the dolphins by throwing themselves alongside of one another. But the dolphins take longer to get free again, whereas such fishes do so quickly. Hence, not seeing this, but seeing the swallowing of the milt and the eggs, even the fishermen repeat the same simple tale, so much noised abroad, as does Herodotus the story-teller,[7] as if fish were conceived by the mother's swallowing the milt—not considering that this is impossible. For the passage which enters by way of the mouth runs to the intestines, not to the uterus, and what goes into the intestines must be turned into nutriment, for it is concocted; the uterus, however, is plainly full of eggs, and from whence did they enter it?

6 · A similar story is told also of the generation of birds. For there are some who say that the raven and the ibis unite at the mouth, and among quadrupeds that the weasel brings forth its young by the mouth; so say Anaxagoras and some of the

[6]Reading ὅσοις μή.
[7]See Herodotus II 93.

other natural scientists, speaking too superficially and without consideration. Concerning the birds, they are deceived by a false reasoning, because the copulation of ravens is seldom seen, but they are often seen uniting with one another with their beaks, as do all the birds of the raven family; this is plain with domesticated jackdaws. Birds of the pigeon kind do the same, but, because they also plainly copulate, therefore they have not had the same legend told of them. But the raven family is not amorous, for they are birds that produce few young, though this bird also has been seen copulating before now. It is a strange thing, however, that these theorists do not ask themselves how the semen enters the uterus through the intestine, which always concocts whatever comes into it, as the nutriment; and these birds have a uterus like others, and eggs are found in them near the hypozoma. And the weasel has a uterus in like manner to the other quadrupeds; by what passage is the embryo to get from it to the mouth? But this opinion has arisen because the young of the weasel are very small like those of the other fissipeds, of which we shall
757a1 speak later, and because they often carry the young about in their mouths.

Much deceived also are those who make a foolish statement about the trochus and the hyena. Many say that the hyena, and Herodorus of Heraclea says that the trochus, has two pudenda, those of the male and of the female, and that the trochus impregnates itself but the hyena mounts and is mounted in alternate years. This is untrue, for the hyena has been seen to have only one pudendum, there being no lack of opportunity for observation in some districts, but hyenas have under the tail a line like the pudendum of the female. Both male and female have such a mark, but the males are taken more frequently; this casual observation has given rise to this opinion. But enough has been said of this.

7 · Touching the generation of fish, the question may be raised, why it is that in the selachia neither the females are seen discharging their eggs nor the males their milt, whereas in the non-viviparous fishes this is seen in both sexes. The reason is that the whole selachian class do not produce much semen, and further the females have their uterus near the hypozoma. For the males and females of the one class of fish differ from the males and females of the other class in like manner, for the selachia are less productive of semen. But in the oviparous fish, as the females lay their eggs on account of their number, so do the males shed their milt on account of its abundance. For they have more milt than just what is required for copulation, as nature prefers to expend the milt in helping to perfect the eggs, when the female has deposited them, rather than in forming them at first. For as has been said both further back and in our recent discussions, the eggs of birds are perfected internally but those of fish externally. The latter, indeed, resemble in a way those animals which produce a grub; for the product discharged by them is still more imperfect. It is the male that brings about the perfection of the egg both of birds and of fishes, only in the former internally, as they are perfected internally, and in the latter externally, because the egg is imperfect when deposited; but the result is the same in both cases.

757b1 In birds the wind-eggs become fertile, and those previously impregnated by one kind of male change their nature to that of the later impregnator. And if the eggs be behindhand in growth, then, if the same cock treads the hen again after leaving off treading for a time,[8] he causes them to increase quickly, not, however, at any period whatever, but if the treading take place before the egg changes so far that the white begins to separate from the yolk. But in the eggs of fishes no such limit of time has been laid down, but the males shed their milt quickly upon them to preserve them. The reason is that these eggs are not two-coloured, and hence there is no such limit of time fixed with them as with those of birds. This fact is what we should expect, for by the time that the white and yolk are separated off from one another, the bird's egg already contains the principle that comes from the male parent (for the male contributes this).

Wind-eggs, then, participate in generation so far as is possible for them. That they should be perfected into an animal is impossible, for an animal requires sense-perception; but the nutritive faculty of the soul is possessed by females as well as males, and indeed by all living things, as has been often said; and that is why the egg itself is perfect only as the embryo of a plant, but imperfect as that of an animal. If, then, there had been no male sex in the class of birds, the egg would have been produced as it is in some fishes, if indeed there is any kind of fish of such a nature as to generate without a male; but it has been said of them before that this has not yet been satisfactorily observed. But as it is both sexes exist in all birds, so that, considered as a plant, the egg is perfect (and that is why it does not change again after impregnation); but in so far as it is not a plant it is not perfect, nor does anything else result from it; for neither has it come into being simply like a real plant nor from copulation like an animal. Eggs, however, produced from copulation but already separated into white and yolk take after the first impregnator; for they already contain both principles.

8 · The young are produced in the same way also by the cephalopoda, e.g. cuttlefish and the like, and by the crustacea, e.g. crayfish and their kindred, for these also lay eggs in consequence of copulation, and the male has often been seen uniting with the female. Therefore those who say that all fish are female and lay eggs without copulation are plainly speaking unscientifically from this point of view also. For it is a wonderful thing to suppose that the former animals lay eggs in consequence of copulation and that fish do not; if again they were unaware of this, it is a sign of ignorance. The union of all these creatures lasts a considerable time, as in insects, and naturally so, for they are bloodless and therefore of a cold nature.

In the cuttlefish and calamaries the eggs appear to be two, because the uterus is divided and appears double, but that of the octopus appears to be single. The reason is that the shape of the uterus in the octopus is round in form and spherical, the cleavage being obscure when it is filled with eggs. The uterus of the crayfish is also bifid. All these animals also lay an imperfect egg for the same reason as fishes. In the crayfish and their like the females produce their eggs so as to keep them

[8]The text here is uncertain.

attached to themselves, which is why the side-flaps of the females are larger than those of the males, to protect the eggs; the cephalopoda lay them away from themselves. The males of the cephalopoda sprinkle their milt over the females, as the male fish do over the eggs, and it becomes a continuous and glutinous mass, but in the crayfish and their like nothing of the sort has been seen or can be naturally expected, for the egg is under the female and is hard-shelled. Both these eggs and those of the cephalopoda grow after deposition like those of fishes.

The cuttlefish while developing is attached to the egg by its front part, for here alone is it possible, because this animal alone has its front and back part pointing in the same direction. For the position and attitude of the young while developing you must look at the *Histories*.[9]

9 · We have now spoken of the generation of other animals, those that walk, fly, and swim; it remains to speak of insects and testacea according to the plan laid down. Let us begin with the insects. It was observed previously that some of these are generated by copulation, others spontaneously, and besides this that they produce a grub, and why this is so. For pretty much all creatures seem in a certain way to produce a grub first, since the most imperfect embryo is of such a nature; and in all animals, even the viviparous and those that lay a perfect egg, the first embryo grows in size while still undifferentiated into parts; now such is the nature of the grub. After this stage some of the ovipara produce the egg in a perfect
758b1 condition, others in an imperfect, but it is perfected outside as has been often stated of fish. With animals internally viviparous the embryo becomes egg-like in a certain sense after its original formation, for the liquid is contained in a fine membrane, just as if we should take away the shell of the egg, and that is why they call the abortion of an embryo at that stage an 'efflux'.

Those insects which generate at all generate a grub, and those which come into being spontaneously and not from copulation do so at first from a formation of this nature. For we must put down caterpillars also and the product of spiders as a sort of grub. And yet some even of these and many of the others may be thought to resemble eggs because of their round shape, but we must not judge by shapes nor yet by softness and hardness (for what is produced by some is hard), but by the fact that the whole of them is changed into the body of the creature and the animal is not developed from a part of them. All these products that are of the nature of a grub, after progressing and acquiring their full size, become a sort of egg, for the husk about them hardens and they are motionless during this period. This is plain in the grub of bees and wasps and in caterpillars. The reason of this is that their nature, because of its imperfection, oviposits as it were before the right time, as if the grub, while still growing in size, were a soft egg. Similar to this is also what happens with all other insects which come into being without copulation in wool and other such materials and in water. For all of them after the grub-stage become immovable and their integument dries round them, and after this the latter bursts and there comes

[9] *History of Animals* 550^{a}17ff.

forth as from an egg an animal perfected in its third stage, and of these the winged sort are more numerous than those which walk.

Another point is quite natural, which may be wondered at by many. Caterpillars at first take nourishment, but after this stage do so no longer, but what is called by some the chrysalis is motionless. The same applies to the grub of wasps and bees . . .[10] after this comes into being the so-called pupa, which has nothing of the kind. For an egg is also of such a nature that when it has reached perfection it grows no more in size, but at first it grows and receives nourishment until it is differentiated and becomes a perfect egg. Sometimes the grub contains in itself the material from which, as it feeds, a residue is produced[11]—e.g. the grubs of bees and wasps; 759a1
sometimes it gets its nourishment from outside itself, as caterpillars and some others.

It has thus been stated why such animals go through a threefold development and for what reason they become immovable again after moving. And some of them come into being by copulation, like birds and vivipara and most fishes, others spontaneously, like some plants.

10 · There is much difficulty about the generation of bees. If it is really true that in the case of some fishes there is such a method of generation that they produce eggs without copulation, this may well happen also with bees, to judge from appearances. For they must either bring the young brood from elsewhere, as some say, and if so the young must either be spontaneously generated or produced by some other animal, or they must generate them themselves, or they must bring some and generate others, for this also is maintained by some, who say that they bring the young of the drones only. Again, if they generate them it must be either with or without copulation; if the former, then either each kind must generate its own kind, or some one kind must generate the others, or one kind must unite with another for the purpose (I mean for instance that bees may be generated from the union of bees, drones from that of drones, and kings from that of kings, or that all the others may be generated from one, as from what are called kings and leaders, or from the union of drones and bees, for some say that the former are male, the latter female, while others say that the bees are male and the drones female). But all these views are impossible if we reason first upon the facts peculiar to bees and secondly upon those which apply more generally to other animals also.

For if they do not generate the young but bring them from elsewhere, then bees ought to come into being also, if the bees did not carry them off, in the places from which the old bees carry the seeds. For why, if new bees come into existence when the seeds are transported, should they not do so if the seeds are left there? They ought to do so just as much, whether the seeds are spontaneously generated in the flowers or whether some animal generates them. And if the seeds were of some other animal, then that animal ought to be produced from them instead of bees.

[10]Drossaart Lulofs marks a lacuna here.
[11]Reading ἐπιγίγνεται περίττωμα (Peck).

Again, that they should collect honey is reasonable, for it is their food, but it is strange that they should collect the young if they are neither their own offspring nor food. With what object should they do so? for all animals that trouble themselves about the young labour for what appears to be their own offspring.

759b1 But, again, it is also unreasonable to suppose that the bees are female and the drones male, for nature does not give weapons for fighting to any female, and while the drones are stingless all the bees have a sting. Nor is the opposite view reasonable, that the bees are male and the drones female, for no males are in the habit of working for their offspring, but as it is the bees do this. And generally, since the brood of the drones is found coming into being among them even if there is no mature drone present, but that of the bees is not so found without the presence of the kings (which is why some say that the young of the drones alone is brought in from outside), it is plain that they are not produced from copulation, either of bee with bee or drone with drone or of bees with drones. (That they should import the brood of the drones alone is impossible for the reasons already given, and besides it is unreasonable that a similar state of things should not prevail with all the three kinds alike.) Then, again, it is also impossible that the bees themselves should be some of them male and some female, for in all kinds of animals the two sexes differ. Besides they would in that case generate their own kind, but as it is their brood is not found to come into being if the leaders are not among them, as men say. And an argument against both theories, that the young are generated by union of the bees with one another or with the drones, separately or with one another, is this: none of them has ever yet been seen copulating, whereas this would have often happened if the sexes had existed in them. It remains then, if they are generated by copulation at all, that the kings shall unite to generate them. But the drones are found to come into being even if no leaders are present, and it is not possible that the bees should either import their brood or themselves generate them by copulation. It remains then, as appears to be the case in certain fishes, that the bees should generate the drones without copulation, being indeed female in respect of generative power, but containing in themselves both sexes as plants do. Hence also they have the instrument for fighting, for we ought not to call that female in which the male sex is not separated. But if this is found to be the case with drones, if they come into being without copulation, then it is necessary that the same account should be given of the bees and the kings and that they also should be generated without copulation. Now if the brood of the bees had been found to come into being among them without the
760a1 presence of the kings, it would necessarily follow that the bees also are produced from bees themselves without copulation, but as it is, since those occupied with the tendance of these creatures deny this, it remains that the kings must generate both their own kind and the bees.

As bees are a peculiar and extraordinary kind of animal so also their generation appears to be peculiar. That bees should generate without copulation is a thing which may be paralleled in other animals, but that what they generate should not be of the same kind is peculiar to them, for the erythrinus generates an erythrinus and the channa a channa. The reason is that bees themselves are not generated like flies and similar creatures, but from a kind different indeed but akin to them, for they are produced from the leaders. Hence in a sort of way their generation is analogous. For the leaders resemble the drones in size and the bees in possessing a sting; so the bees are like them in this respect, and the drones are like them in size. For there must needs be some overlapping unless the same kind is always to be produced from each; but this is impossible, for at that rate the whole class would consist of leaders. The bees, then, are assimilated to them in their power of generation, the drones in size; [if the latter had had a sting also, they would have been leaders, but as it is this much of the difficulty remains, for the leaders are like both kinds at once, like the bees in possessing a sting, like the drones in size].[12]

But the leaders also must be generated from something. Since it is neither from the bees nor from the drones, it must be from their own kind. The cells of the kings are produced last and are not many in number.

Thus what happens is this: the leaders generate their own kind but also another kind, that of the bees; the bees again generate another kind, the drones, but do not also generate their own kind—this has been denied them. And since what is according to nature is always in due order, therefore it is necessary that it should be denied to the drones even to generate another kind than themselves. This is just what we find happening, for though the drones are themselves generated, they generate nothing else, but the process reaches its limit in the third stage. And so beautifully is this arranged by nature that the three kinds always continue in 760b1
existence and none of them fails, though they do not all generate.

Another fact is also natural, that in fine seasons much honey is collected and many drones are produced, but in rainy seasons a large brood of ordinary bees. For the wet causes more residual matter to be formed in the bodies of the leaders, the fine weather in that of the bees, for being smaller in size they need the fine weather more than the kings do. It is right also that the kings, being as it were made with a view to producing young, should remain within, freed from the labour of procuring necessaries, and also that they should be of a considerable size, their bodies being, as it were, constituted with a view to bearing young, and that the drones should be idle as having no weapon to fight for their food and because of the slowness of their bodies. But the bees are intermediate between the two other kinds, for this is useful for their work, and they are workers as having to support not only their young but also their fathers. And it agrees with our views that the bees attend upon their kings because they are their offspring (for if nothing of the sort had been the case the facts about their leadership would be unreasonable), and that, while they suffer the kings to do no work as being their parents, they punish the drones as their children, for it is nobler to punish one's children and those who have no work to perform. The fact that the leaders being few generate the bees in large numbers seems to be similar to what obtains in the generation of lions, which at first produce five, afterwards a smaller number each time, at last one and thereafter none. So the leaders at first produce a number of workers, afterwards a few of their own kind; thus the brood of

[12]Excised by Drossaart Lulofs.

the latter is smaller in number than that of the former, but where nature has taken away from them in number she has made it up again in size.

Such appears to be the truth about the generation of bees, judging from theory and from what are believed to be the facts about them; the facts, however, have not yet been sufficiently grasped; if ever they are, then credit must be given rather to observation than to theories, and to theories only if what they affirm agrees with the observed facts.

A further indication that bees are produced without copulation is the fact that the brood appears small in the cells of the comb, whereas, whenever insects are
761a1 generated by copulation, the parents remain united for a long time but produce quickly something of the nature of a grub and of a considerable size.[13]

Concerning the generation of animals akin to them, as hornets and wasps, the facts in all cases are similar to a certain extent, but are devoid of the extraordinary features which characterize bees; this we should expect, for they have nothing divine about them as the bees have. For the so-called 'mothers' generate the young and mould the first part of the combs, but they generate by copulation with one another, for their union has often been observed. As for all the differences of each of these kinds from one another and from bees, they must be investigated with the aid of the illustrations to the *Histories*.

11 · Having spoken of the generation of all insects, we must now speak of the testacea. Here also the facts of generation are partly like and partly unlike those in the other classes. And this is what might be expected. For compared with animals they resemble plants, compared with plants they resemble animals, so that in a sense they appear to come into being from semen, but in another sense not so, and in one way they are spontaneously generated but in another from their own kind, or some of them in the latter way, others in the former. Because their nature answers to that of plants, therefore few or no kinds of testacea come into being on land, e.g. the snails and any others, few as they are, that resemble them; but in the sea and similar waters there are many of all kinds of forms. But the class of plants has but few and one may say practically no representatives in the sea and such places, all such growing on the land. For plants and testacea are analogous; and in proportion as liquid has more life-supporting power than solid, water than earth, so much does the nature of testacea differ from that of plants, since the object of testacea is to be in such a relation to water as plants are to earth, as if plants were, so to say, land-shell fish, shell-fish water-plants.

For such a reason also the testacea in the water vary more in form than those on the land. For the nature of liquid is more plastic than that of earth and yet not much less material, and this is especially true of the inhabitants of the sea, for fresh
761b1 water, though sweet and nutritious, is cold and less material. That is why animals having no blood and not of a hot nature are not produced in lakes nor in the fresher among brackish waters, but only exceptionally; but it is in estuaries and at the mouths of rivers that they come into being, as testacea and cephalopoda and

[13]This paragraph appears to be misplaced.

crustacea, all these being bloodless and of a cold nature. For they seek at the same time the warmth of the sun and food; now the sea is not only water but much more material than fresh water and hot in its nature; it has a share in all the parts of the universe, water and air and earth, so that it also has a share in all living things which are produced in connexion with each of these elements.[14] Plants may be assigned to land, the aquatic animals to water, the land animals to air, but variations of quantity and distance make a great and wonderful difference. The fourth class must not be sought in these regions, though there certainly ought to be some animal corresponding to the element of fire, for this is counted in as the fourth of the elementary bodies. But the form which fire assumes never appears to be peculiar to it, but it always exists in some other of the elements, for that which is ignited appears to be either air or smoke or earth. Such a kind of animal must be sought in the moon, for this appears to participate in the element removed in the third degree from earth. The discussion of these things, however, belongs to another subject.

To return to testacea, some of them are formed spontaneously, some emit a sort of generative substance from themselves, but these also often come into being from a spontaneous formation. To understand this we must grasp the different methods of generation in plants; some of these are produced from seed, some from slips, planted out, some by budding off alongside, as the class of onions. In the last way are produced mussels, for smaller ones are always growing off alongside the original, but the trumpet-shells, the purple-fish, and those which are said to 'honeycomb' emit masses of a liquid slime as if originated by something of a seminal nature. We must not, however, consider that anything of the sort is real semen, but that these creatures participate in the resemblance to plants in the manner stated above. Hence when once one such creature has been produced, then is produced a number of them. For all these creatures are liable to be even spontaneously 762a1
generated, and so to be formed still more plentifully in proportion if some are already existing. For it is natural that each should have some superfluous residue attached to it from the original, and from this buds off each of the creatures growing alongside of it. Again, since the nutriment and its residue possess a like power, it is likely that the product of those testacea which 'honeycomb' should resemble the original formation, and so it is natural that a new animal of the same kind should come into being from this also.

All those which do not bud off or 'honeycomb' are spontaneously generated. Now all things formed in this way, whether in earth or water, manifestly come into being in connexion with putrefaction and an admixture of rain-water. For as the sweet is separated off into the matter which is forming, the residue of the mixture takes such a form. Nothing comes into being by putrefying, but by concocting; putrefaction and the thing putrefied is only a residue of that which is concocted. For nothing comes into being out of the whole of anything, any more than in the products of art; if it did art would have nothing to do, but as it is in the one case art removes the useless material, in the other nature does so. Animals and plants come into being in earth and in liquid because there is water in earth, and air in water,

[14]Omitting ἐν τοῖς τόποις ζῴων.

and in all air is vital heat, so that in a sense all things are full of soul. Therefore living things form quickly whenever this air and vital heat are enclosed in anything. When they are so enclosed, the corporeal liquids being heated, there arises as it were a frothy bubble. Whether what is forming is to be more or less honourable in kind depends on the embracing of the vital principle; this again depends on the medium in which the generation takes place and the material which is included. Now in the sea the earthy matter is present in large quantities, and consequently the testaceous animals are formed from a concretion of this kind, the earthy matter hardening round them and solidifying in the same manner as bones and horns (for these cannot be melted by fire), and the body which contains the life being included within it.

The class of snails is the only class of such creatures that has been seen uniting, but it has never yet been sufficiently observed whether their generation is the result of the union or not.

It may be asked, if we wish to follow the right line of investigation, what it is in
762b1 such animals the formation of which corresponds to the material principle. For in the females this is a residual secretion of the animal, potentially such as that from which it came, by imparting motion to which the principle derived from the male perfects the animal. But here what must be said to correspond to this, and whence comes or what is the moving principle which corresponds to the male? We must understand that even in animals which generate it is from the incoming nourishment that the heat in the animal makes the residue, the beginning of the conception, by secretion and concoction. The like is the case also in plants, except that in these (and also in some animals) there is no further need of the male principle, because they have it mingled with the female principle within themselves, whereas the residual secretion in most animals does need it. The nourishment again of some is earth and water, of others a combination of these, so that what the heat in animals produces from their nutriment, the heat of the warm season in the environment puts together and combines by concoction out of the sea-water and the earth. And the portion of the vital principle which is either included along with it or separated off in the air makes an embryo and puts motion into it. Now in plants which are spontaneously generated the method of formation is uniform; they arise from a part of something, and while some of it is the starting-point of the plant, some is the first nourishment of the young shoots. Other animals are produced in the form of a grub, not only those bloodless animals which are not generated from parents but even some sanguinea, as a kind of mullet and some other river fishes and also the eel kind. For all of these, though they have but little blood by nature, are nevertheless sanguinea, and have a heart with blood in it as the origin of the parts; and the so-called 'entrails of earth', in which comes into being the body of the eel, have the nature of a grub.

Hence one might suppose, in connexion with the origin of men and quadrupeds, that, if ever they were really 'earth-born' as some say, they came into being in one of two ways; that either it was by the formation of a grub at first or else it was out of eggs. For either they must have had in themselves the nutriment for growth (and such a conception is a grub) or they must have got it from elsewhere, and that either from the mother or from part of the conception. If then the former is impossible (I mean that nourishment should flow to them from the earth as it does in animals from the mother), then they must have got it from some part of the conception, and such generation we say is from an egg.

It is plain then that, if there really was any such beginning of the generation of all animals, it is reasonable to suppose it to have been one of these two. But it is less reasonable to suppose that it was from eggs, for we do not see such generation occurring with any animal, but we do see the other both in the sanguinea above mentioned and in the bloodless animals. Such are some of the insects and such are the testacea which we are discussing; for they do not develop out of a part of something (as do animals from eggs), and they grow like a grub. For the grub grows towards the upper part and the first principle, since in the lower part is the nourishment for the upper. And this resembles the development of animals from eggs, except that these latter consume the whole egg, whereas in the grub, when the upper part has grown by taking up into itself part of the substance in the lower part, the lower part is then differentiated out of the rest. The reason is that in later life also the nourishment is absorbed by all animals in the part below the hypozoma.

That the grub grows in this way is plain in the case of bees and the like, for at first the lower part is large in them and the upper is smaller. The details of growth in the testacea are similar. This is plain in the whorls of the spiral-shelled creatures, for always as the animal grows the whorls become larger towards the front and what is called the head of the creature.

We have now pretty well described the manner of the development of these and the other spontaneously generated animals. That all the testacea are formed spontaneously is clear from such facts as these. They come into being on the side of boats when the frothy mud putrefies. In many places where previously nothing of the kind existed, the so-called lagoon-oysters, a kind of testacea, have come into being when the spot turned muddy through want of water; thus when a naval armament cast anchor at Rhodes a number of clay vessels were thrown out into the sea, and after some time, when mud had collected round them, oysters used to be found in them. Here is another proof that such animals do not emit any generative substance from themselves; when certain Chians carried some live oysters over from Pyrrha in Lesbos and placed them in narrow straits of the sea where tides clash, they became no more numerous as time passed, but increased greatly in size. The so-called eggs contribute nothing to generation but are only a sign of good condition, like fat in the sanguinea, and therefore the oysters are savoury eating at these periods. A proof that this substance is not really eggs is the fact that such 'eggs' are always found in some testacea, as in pinnae, trumpet-shells, and purple-fish; only they are sometimes larger and sometimes smaller; in others, as scallops, mussels, and the so-called lagoon-oysters, they are not always present but only in the spring; as the season advances they dwindle and at last disappear altogether; the reason being that the spring is favourable to their being in good condition. In others again, as the ascidians, nothing of the sort is visible. (The details concerning these last, and the places in which they come into being, must be learnt from the *History*.)

BOOK IV

1 · We have thus spoken of the generation of animals both generally and separately in all the different classes. But, since male and female are distinct in the most perfect of them, and since we say that the sexes are first principles of all living things whether animals or plants, only in some of them the sexes are separated and in others not, therefore we must speak first of the origin of the sexes in the latter. For while the animal is still imperfect in its kind the distinction is already made between male and female.

It is disputed, however, whether the embryo is male or female, as the case may be, even before the distinction is plain to our senses, and further whether it is thus differentiated within the mother or even earlier. It is said by some, as by Anaxagoras and other of the physicists, that this antithesis exists from the beginning in the seeds; for the seed, they say, comes from the male while the female only provides the place, and the male is from the right, the female from the left, and so also that the male embryo is in the right of the uterus, the female in the left. Others, as Empedocles, say that the differentiation takes place in the uterus; for he says that if the uterus is hot what enters it becomes male, if cold, female, the cause of the heat or cold being the flow of the menstrual fluids, according as it is colder or hotter, older or more recent. Democritus of Abdera also says that the differentiation of sex takes place within the mother; that however it is not because of heat and cold that one embryo becomes female and another male, but that it depends on the question which parent it is whose semen prevails,—not the whole of the semen, but that which has come from the part by which male and female differ from one another. This is a better theory, for certainly Empedocles has made a rather lighthearted assumption in thinking that the difference between them is due only to cold and heat, when he saw that there was a great difference in the whole of the sexual parts, the difference in fact between the male pudenda and the uterus. For suppose two animals already moulded in embryo, the one having all the parts of the female, the other those of the male; suppose them then to be put into the uterus as into an oven, the former when the oven is hot, the latter when it is cold; then on the view of Empedocles that which has no uterus will be female and that which has will be male. But this is impossible. Thus the theory of Democritus would be the better of the two, at least as far as this goes, for he seeks for the difference in this development and tries to set it forth; whether he does so well or not is another question.

Again, if heat and cold were the cause of the difference of the parts, this ought to have been stated by those who maintain the view of Empedocles; for to explain the origin of male and female is practically the same thing as to explain this, which is the manifest difference between them. And it is no small matter, starting from temperature as a principle, to collect the cause of the origin of these parts, as if it were a necessary consequence for this part which they call the uterus to be formed in the embryo under the influence of cold but not under that of heat. The same applies also to the parts which serve for intercourse, since these also differ in the way stated previously.

Moreover male and female twins are often found together in the same part of the uterus; this we have observed sufficiently by dissection in all the vivipara, both land animals and fish. Now if Empedocles had not seen this it was only natural for him to fall into error in assigning this cause of his; but if he had seen it it is strange that he should still think the heat or cold of the uterus to be the cause, since on his theory both these twins would have become either male or female, but as it is we do not see this to be the fact.

Again he says that the parts of the embryo are sundered, some being in the male and some in the female parent, which is why they desire intercourse with one another. If so it is necessary that the substance of these parts too should be separated from one another and that a union should take place—but not on account of cooling or heating. But perhaps it would be superfluous to discuss thoroughly such a cause[1] as this for its whole character seems to be fanciful. If, however, the facts about semen are such as we have actually stated, if it does not come from the whole of the body of the male parent and if the secretion of the male does not give any material at all to the embryo, then we must make a stand against both Empedocles and Democritus and any one else who argues on the same lines. For then it is not possible that the body of the seed should exist sundered, part in the female parent and part in the male, as Empedocles says in the words: 'But the nature of the limbs hath been sundered, part in the man's . . . ';[2] nor yet that the whole is drawn off from each parent and the combination of the two becomes male or female according as one part prevails over another.

And, to take a more general view, though it is better to say that the one part makes it female by prevailing through some superiority than to assign nothing but heat as the cause without any reflection, yet, as the form of the pudendum also differs, we need an explanation of the fact that both these parts go along with each other. If it is because they are near each other, then each of the other parts also ought to go with them, for one of the prevailing parts is always near another; thus the offspring would be not only female or male but also like its mother or father respectively.

Besides, it is absurd to suppose that these parts should come into being as something isolated, without the body as a whole having changed along with them. Take first and foremost the blood-vessels, round which the whole mass of the flesh lies as round a frame-work. It is not reasonable that these should become of a certain quality because of the uterus, but rather that the uterus should do so on account of them. For though it is true that each is a receptacle of blood of some kind, still the system of the vessels is prior to the other; the moving principle must always be prior to that which it moves, and it is because it is itself of a certain quality that it is the cause of the development. The difference, then, of these parts as compared with each other in the two sexes is a result; not this but something else must be held to be the first principle and the cause, even if no semen is secreted by either male or female, but the embryo is formed in any way you please.

[1]Omitting τοῦ σπέρματος.
[2]Frag. 63 Diels-Kranz.

The same argument as that with which we meet Empedocles and Democritus will serve against those who say that the male comes from the right and the female from the left. If the male contributes no material, there can be nothing in this view. If, as they say, he does contribute something of the sort, we must confront them in the same way as we did the theory of Empedocles, which accounts for the difference between male and female by the heat and cold of the uterus. They make the same mistake as he does, when they account for the difference by their 'right and left', though they see that the sexes differ actually by the whole of the sexual parts; for what reason then is the body of the uterus to exist in those embryos which come from the left and not in those from the right? For if an embryo has come from the left but has not acquired this part, it will be a female without a uterus—or maybe a male with one. Besides, as has been said before, a female embryo has been observed in the right part of the uterus, a male in the left, or again both at once in the same part, and this not only once but several times. [Or the male in the right part, the female in the left; and no less both are formed in the right part.][3]

Some again, persuaded of the truth of a view resembling that of these philosophers, say that if a man copulates with the right or left testis tied up the result is male or female offspring respectively; so at least Leophanes asserted. And some say that the same happens in the case of those who have one or other testis excised, not speaking truth but vaticinating what will happen from probabilities and jumping at the conclusion that it is so before seeing that it proves to be so. Moreover, they know not that these parts of animals contribute nothing to the production of one sex rather than the other; a proof of this is that many animals in which the distinction of sex exists, and which produce both male and female offspring, nevertheless have no testes, as the footless animals; I mean the classes of fish and of serpents.

To suppose, then, either that heat and cold are the causes of male and female, or that the different sexes come from the right and left, is not altogether unreasonable in itself; for the right of the body is hotter than the left, and the concocted semen is hotter than the unconcocted; again, the thickened is concocted, and the more thickened is more fertile. Yet to put it in this way is to seek for the cause from too remote a starting-point; we must draw near the primary causes in so far as it is possible for us.

We have, then, previously spoken elsewhere of both the body as a whole and its parts, explaining what each part is and for what reason it exists. But the male and female are distinguished by a certain capacity and incapacity. (For the male is that which can concoct and form and discharge a semen carrying with it the principle of form—by 'principle' I do not mean a material principle out of which comes into being an offspring resembling the parent, but I mean the first moving cause, whether it have power to act as such in the thing itself or in something else—but the female is that which receives semen, but cannot form it or discharge it.) And all concoction works by means of heat. Therefore the males of animals must needs be hotter than the females. For it is by reason of cold and incapacity that the female is

[3]Excised by Drossaart Lulofs.

more abundant in blood in certain parts of her anatomy, and this abundance is an evidence of the exact opposite of what some suppose, thinking that the female is hotter than the male for this reason, i.e. the discharge of menstrual fluids. It is true that blood is hot, and that which has more of it is hotter. But they assume that this discharge occurs through excess of blood and of heat, as if it were possible for everything to be equally blood if only it be liquid and sanguineous in colour, and as if it might not become less in quantity but purer in quality in those who assimilate nourishment properly. In fact they look upon this residual discharge in the same light as that of the intestines, when they think that a greater amount of it is a sign of a hotter nature, whereas the truth is just the opposite. For consider the production of fruit; the nutriment in its first stage is abundant, but the useful product derived from it is small, indeed the final result is nothing at all compared to the quantity in the first stage. So is it with the body; the various parts receive and work up the nutriment, from the whole of which the final result is quite small. This is blood in some animals, in some its analogue. Now since the one sex is able and the other is unable to reduce the residual secretion to a pure form, and every capacity has a certain corresponding organ, whether the faculty produces the desired results in a lower degree or in a higher degree, and since the two sexes correspond in this manner (the terms 'able' and 'unable' being used in more senses than one)—therefore it is necessary that both female and male should have organs. Accordingly the one has the uterus, the other the male organs.

Again, nature gives both the faculty and the organ to each individual at the same time, for it is better so. Hence each region comes into being along with the secretions and the faculties, as e.g. the faculty of sight is not perfected without the eye, nor the eye without the faculty of sight; and so too the intestine and bladder come into being along with the faculty of forming the residues. And since that from which an organ comes into being and that by which it is increased are the same (i.e. the nutriment), each of the parts will be made out of such a material and such residual matter as it is able to receive. In the second place, again, it is formed, as we say, in a certain sense, out of its opposite. Thirdly, we must understand besides this that, if it is true that when a thing perishes it becomes the opposite of what it was, it is necessary also that what is not under the sway of that which made it must change into its opposite. After these premisses it will perhaps be now clearer for what reason one embryo becomes female and another male. For when the first principle does not bear sway and cannot concoct the nourishment through lack of heat nor bring it into its proper form, but is defeated in this respect, then must the material change into its opposite. Now the female is opposite to the male, and that in so far as the one is female and the other male. And since it differs in its faculty, its organ also is different, so that the embryo changes into this state. And as one part of first-rate importance changes, the whole system of the animal differs greatly in form along with it. This may be seen in the case of eunuchs, who, though mutilated in one part alone, depart so much from their original appearance and approximate closely to the female form. The reason of this is that some of the parts are principles, and when a principle is moved many of the parts that go along with it must change with it.

If then the male is a principle and a cause, and the male is such in virtue of a certain capacity and the female is such in virtue of an incapacity, and if the definition of the capacity and of the incapacity is ability or inability to concoct the nourishment in its ultimate stage, this being called blood in the sanguinea and the analogue of blood in the other animals, and if the cause of this capacity is in the first principle and in the part which contains the principle of natural heat—therefore a heart must be formed in the sanguinea (and the resulting animal will be either male or female), and in the other kinds which possess the sexes must be formed that which is analogous to the heart.

This, then, is the first principle and cause of male and female, and this is the part of the body in which it resides. But the animal becomes definitely female or male by the time when it possesses also the parts by which the female differs from the male, for it is not in virtue of any part you please that it is male or female, any more than it is able to see or hear by possessing any part you please.

To recapitulate, we say that the semen has been laid down to be the ultimate residue of the nutriment. By ultimate I mean that which is carried to every part of the body, and this is also the reason why the offspring is like the parent. For it makes no difference whether we say that the semen comes from all the parts or goes to all of them, but the latter is the better. But the semen of the male differs in that it contains a principle within itself of such a kind as to set up movements also in the embryo and to concoct thoroughly the ultimate nourishment, whereas the secretion of the female contains material alone. If, then, the male element prevails it draws the female element into itself, but if it is prevailed over it changes into the opposite or is destroyed. But the female is opposite to the male, and is female because of its inability to concoct and of the coldness of the sanguineous nutriment. And nature assigns to each of the residues the part fitted to receive it. But the semen is a residue, and this in the hotter animals with blood, i.e. the males, is moderate in quantity, which is why the recipient parts of this residue in males are only passages. But the females, owing to inability to concoct, have a great quantity of blood, for it cannot be worked up into semen. Therefore they must also have a part to receive this, and this part must be unlike the passages of the male and of a considerable size. This is why the uterus is of such a nature, this being the part by which the female differs from the male.

2 · We have thus stated for what reason the one becomes female and the other male. Observed facts confirm what we have said. For more females are produced by the young and by those verging on old age than by those in the prime of life; in the former the heat is not yet perfect, in the latter it is failing. And those of a moister and more feminine state of body are more wont to beget females, and a liquid semen causes this more than a thicker; now all these characteristics come of deficiency in natural heat.

Again, more males are born if copulation takes place when north than when south winds are blowing; for animals' bodies are more liquid when the wind is in the south, so that they produce more residue—and more residue is harder to concoct;

hence the semen of the males is more liquid, and so is the discharge of the menstrual fluids in women.

Also the fact that menstruation occurs in the course of nature rather when the month is waning is due to the same causes. For this time of the month is colder and moister because of the waning and failure of the moon; as the sun makes winter and summer in the year as a whole, so does the moon in the month. This is not due to the turning of the moon, but it grows warmer as the light increases and colder as it wanes.

The shepherds also say that it not only makes a difference in the production of males and females if copulation takes place during northern or southerly winds, but even if the animals while copulating look towards the south or north; so small a thing will sometimes turn the scale and cause cold or heat, and these again influence generation.

The male and female, then, are distinguished generally, as compared with one another in connexion with the production of male and female offspring, for the causes stated. However, they also need a certain correspondence with one another; for all things that come into being as products of art or of nature exist in virtue of a certain ratio. Now if the hot preponderates too much it dries up the liquid; if it is very deficient it does not solidify it; for the product we need the due mean between the extremes. Otherwise it will be as in cooking; too much fire burns the meat, too little does not cook it, and in either case the process is a failure. So also there is need of due proportion in the mixture of the male and female elements. And for this cause it often happens to many of both sexes that they do not generate with one another, but if divorced and remarried to others do generate; and these oppositions show themselves sometimes in youth, sometimes in advanced age, alike as concerns fertility or infertility, and as concerns generation of male or female offspring.

One country also differs from another in these respects, and one water from another, for the same reasons. For the nourishment and the condition of the body are of such or such a kind because of the tempering of the surrounding air and of the food entering the body, especially the water; for men consume more of this than of anything else, and this enters as nourishment into all food, even solids. Hence hard waters cause infertility, and cold waters the birth of females.

3 · The same causes must be held responsible for the facts that some children resemble their parents, while others do not (some being like the father and others like the mother, both in the body as a whole and in each part); and that they resemble their parents more than remoter ancestors, and resemble those ancestors more than any chance individual; and that males rather resemble their fathers, females their mothers; and that some, though resembling none of their relations, yet do at any rate resemble a human being, but others are not even like a human being but a monstrosity. For even he who does not resemble his parents is already in a certain sense a monstrosity; for in these cases nature has in a way departed from the type. The first departure indeed is that the offspring should become female instead of male; this, however, is a natural necessity. (For the class of animals divided into

sexes must be preserved, and as it is possible for the male sometimes not to prevail over the female, either through youth or age or some other such cause, it is necessary that animals should produce female young.) And the monstrosity, though not necessary in regard of a final cause and an end, yet is necessary accidentally. As for the origin of it, we must look at it in this way. If the generative residue in the menstrual fluids is properly concocted, the movement imparted by the male will make the form of the embryo in the likeness of itself. (Whether we say that it is the semen or this movement that makes each of the parts grow, makes no difference; nor again whether we say that it makes them grow or forms them from the beginning, for the formula of the movement is the same in either case.) Thus if this movement prevail, it will make the embryo male and not female, like the father and not like the mother; if it prevail not, the embryo is deficient in that faculty in which it has not prevailed. By 'each faculty' I mean this. That which generates is not only male but also a certain sort of male, e.g. Coriscus or Socrates, and it is not only Coriscus but also a man. In this way some of the characteristics of the father are more near to him, others more remote from him considered simply as a parent and not in reference to his accidental qualities (as for instance if the parent is a scholar or the neighbour of some particular person). Now the peculiar and individual has always more force in generation. Coriscus is both a man and an animal, but his manhood is nearer to what is peculiar to him than is his animal-hood. In generation both the individual and the class are operative, but the individual is the more so of the two, for this is the substance. And the offspring is produced indeed of a certain quality, but also as a certain 'this', and this latter is the substance. Therefore it is from the forces of all such things that the movements come which exist in the semen; potentially from remoter ancestors but in a higher degree from whatever
768a1 individual is nearer (and by the individual I mean e.g. Coriscus or Socrates). Now since everything changes not into anything haphazard but into its opposite, therefore also that which is not prevailed over in generation must change and become the opposite, in respect of that particular force in which the generative and moving element has not prevailed. If then it has not prevailed in so far as it is male, the offspring becomes female; if in so far as it is Coriscus or Socrates, the offspring does not resemble the father but the mother. For as father and mother are opposed in general, so also the individual father is opposed to the individual mother. The like applies also to the forces that come next in order, for the offspring always changes rather into the likeness of the nearer ancestor, both in the paternal and in the maternal line.

Some of the movements exist actually, others potentially; actually, those of the father and the general type, as man and animal; potentially, those of the female and the remoter ancestors. Now if it lose its own nature, it changes to its opposites, but the movements which form the embryo relapse into those nearly connected with them; for instance, if the movement of the male parent relapses, it changes by a very slight difference into that of his father, and in the next instance into that of his grandfather; and in this way in the female line too the movement of the female parent changes into that of her mother, and, if not into this, then into that of her grandmother; and similarly also with the more remote ancestors.

Naturally then it is most likely that the characteristics of male and of the father will go together, whether they prevail or are prevailed over. For the difference between them is small so that there is no difficulty in both concurring, for Socrates is an individual man with certain characteristics. Hence for the most part the male offspring resemble the father, and the female the mother. For the loss of both characters takes place at once, and the change is into the two opposites; now female is opposed to male, and mother to father.

But if the movement coming from the male principle prevails while that coming from Socrates does not, or vice versa, then the result is that male children are produced resembling the mother and female children resembling the father.

If again the movements relapse, then if the male character remains but the movement coming from the individual Socrates relapses into that of the father of Socrates, the result will be a male child resembling its grandfather or some other of its more remote ancestors in the male line on the same principle. If the male principle be prevailed over, the child will be female and resembling most probably its mother, but, if the movement coming from the mother also relapses, it will resemble its mother's mother or the resemblance will be to some other of its more remote ancestors in the female line on the same principle.

The same applies also to the separate parts, for often some of these take after the father, and others after the mother, and yet others after some of the remoter ancestors. For, as has been often said already, some of the movements which form the parts exist actually and others potentially. We must grasp certain general principles, not only that just mentioned (that some of the movements exist potentially and others actually), but also two others, that if a character be prevailed over it changes into its opposite, and, if it relapse it is resolved into the movement next allied to it—if less, into that which is near, if more, into that which is further removed. Finally, the movements are so confused together that there is no resemblance to any of the family or kindred, but the only character that remains is that common to all, i.e. being a man. The reason for this is that this accompanies all the individual characteristics; man is universal, while Socrates, the father, and the mother, whoever she may be, are individuals.

The reason why the movements relapse is this. The agent is itself acted upon by that on which it acts; thus that which cuts is blunted by that which is cut by it, that which heats is cooled by that which is heated by it, and in general the moving cause (except in the case of the first cause of all) does itself receive some motion in return; e.g. what pushes is itself in a way pushed again and what crushes is itself crushed again. Sometimes it is altogether more acted upon than acting, so that what is heating or cooling something else is itself cooled or heated, sometimes having produced no effect, sometimes less than it has itself received. (This question has been treated in the special discussion of action and reaction, where it is laid down in what classes of things action and reaction exist.) Now that which is acted on escapes and is not mastered, either through deficiency of power in the concocting and moving agent or because what should be concocted and formed into distinct parts is too cold and in too great quantity. Thus the moving agent, mastering it in one part but not in another, makes the embryo in formation to be multiform, as happens with athletes because they eat so much. For owing to the quantity of their food their nature is not able to master it in such a way that their form grows proportionately and remains symmetrical; therefore their limbs develop irregularly, sometimes indeed almost so much that no one of them resembles what it was before. Similar to this is also the disease known as satyriasis, in which the face appears like that of some other creature—a satyr—owing to a quantity of unconcocted humour being diverted into parts of the face.

We have thus discussed the cause of all these phenomena, why female and male offspring are produced, why some are similar to their parents, female to female and male to male, and others the other way about, females being similar to the father and males to the mother, and in general why some are like their ancestors while others are like none of them, and all this as concerns both the body as a whole and each of the parts separately. Different accounts,[4] however, have been given by some of the natural scientists as to why children are like or unlike their parents. They give two versions of the reason. Some say that the child is more like that parent of the two from whom comes more semen, this applying equally both to the body as a whole and to the separate parts, on the assumption that semen comes from every part; if an equal part comes from each, then, they say, the child is like neither. But if this is false, if semen does not come off from the whole body, it is clear that the reason assigned cannot be the cause of likeness and unlikeness. Moreover, they are hard put to it to explain how it is that a female child can be like the father and a male like the mother. For those who assign the same cause of sex as Empedocles or Democritus say what is on other grounds impossible, and those who say that it is determined by the greater or smaller amount of semen coming from the male or female parent, and that this is why one child is male and another female, cannot show how the female is to resemble the father and the male the mother, for it is impossible that more should come from both at once. Again, for what reason is a child generally like its ancestors, even the more remote? None of the semen has come from *them* at any rate.

But those who account for the similarity in the manner which remains to be discussed, explain this point better, as well as the others. For there are some who say that the semen, though one, is as it were a seed-aggregate of many elements; just as, if one should mix many juices in one liquid and then take some from it, it would be possible to take, not an equal quantity always from each juice, but sometimes more of one and sometimes more of another, sometimes some of one and none at all of another, so they say it is with the generative fluid, which is a mixture of many elements, for the offspring resembles that parent from which it has derived most. Though this theory is obscure and in many ways fictitious, it aims at what is better expressed by saying that what is called the seed-aggregate exists potentially, not actually; it cannot exist actually, but it can do so potentially. But if we assign only one sort of cause, it is not easy to explain all the phenomena—the distinction of sex, why the female is often like the father and the male like the mother, and again the resemblance to remoter ancestors, and further the reason why the offspring is

[4] Reading ἕτερα.

sometimes unlike any of these but still a human being, but sometimes, proceeding further on these lines, appears finally to be not even a human being but only some kind of animal, what is called a monstrosity.

For, following what has been said, it remains to give the reason for such monsters. If the movements relapse and the material is not controlled, at last there remains what is most universal, that is to say the animal. Then people say that the child has the head of a ram or a bull, and so on with other animals, as that a calf has the head of a child or a sheep that of an ox. All these monsters result from the causes stated above, but they are none of the things they are said to be; there is only some similarity, such as may arise even where there is no defect of growth. Hence often jesters compare someone who is not beautiful to a goat breathing fire, or again to a ram butting, and a certain physiognomist reduced all faces to those of two or three animals, and his arguments often prevailed on people.

That, however, it is impossible for such a monstrosity to come into existence—I mean one animal in another—is shown by the great difference in the period of gestation between man, sheep, dog, and ox, it being impossible for each to be developed except in its proper time.

This is the description of some of the monsters talked about; others are such because certain parts of their form are multiplied so that they are born with many feet or many heads.

The account of the cause of monstrosities is very close and similar in a way to that of the deformed; for monstrosity is actually a kind of deformity.

4 · Democritus said that monstrosities arose because two emissions of seminal fluid fall into the uterus: the earlier one is operative and is not ejected, and the later also enters the uterus, so that the parts of the embryo grow together and get confused with one another. But in birds, he says, since copulation always takes place quickly, both the eggs and their colour cross one another. But if it is the fact, as it manifestly is, that several young are produced from one emission of semen and a single act of intercourse, it is better not to desert the short road to go a long way about, for in such cases it is absolutely necessary that this should occur when the semen is not separated but all enters the female at once.

If, then, we must attribute the cause to the semen of the male, this will be the way we shall have to state it, but in general we must rather suppose that the cause lies in the material and in the embryo as it is forming. Hence also such monstrosities appear very rarely in animals producing only one young one, more frequently in those producing many, most of all in birds and among birds in the common fowl. For this bird produces many young, not only because it lays often like the pigeon family, but also because it has many embryos at once and copulates all the year round. Therefore it produces many double eggs, for the embryos grow together because they are near one another, as often happens with many fruits. In such double eggs, when the yolks are separated by the membrane, two separate chickens are produced with nothing abnormal about them; when the yolks are continuous, with no division between them, the chickens produced are monstrous, having one body and head but four legs and four wings; this is because the upper parts are formed earlier from the white, their nourishment being drawn from the yolk, whereas the lower part comes into being later and its nourishment is one and indivisible.

A snake has also been observed with two heads for the same reason, this class also being oviparous and producing many young. Monstrosities, however, are rarer among them owing to the shape of the uterus, for by reason of its length the numerous eggs are set in a line.

Nothing of the kind occurs with bees and wasps, because their brood is in separate cells.

But in the fowl the opposite is the case, whereby it is plain that we must hold the cause of such phenomena to lie in the material. So, too, monstrosities are commoner in other animals if they produce many young. Hence they are less common in man, for he produces for the most part only one young one and that perfect; even in man monstrosities occur more often in regions where the women give birth to more than one at a time, as in Egypt. And they are commoner in sheep and goats, since they produce more young. Still more does this apply to the fissipeds,
770b1 for such animals produce many young and imperfect, as the dog, the young of these creatures being generally blind. Why this happens and why they produce many young must be stated later, but in them nature has made an advance towards the production of monstrosities in that what they generate, being imperfect, is so far unlike the parent; now monstrosities also belong to the class of things unlike the parent. Therefore this accident also often invades animals of such a nature. So, too, it is in these that the so-called 'metachoera' are most frequent, and the condition of these also is in a way monstrous, since both deficiency and excess are monstrous. For the monstrosity belongs to the class of things contrary to nature, not any and every kind of nature, but nature taken as what holds for the most part; nothing can happen contrary to nature considered as eternal and necessary, but only in those cases where things generally happen in a certain way but may also happen in another way. In fact, even in the case of monstrosities, whenever things occur contrary indeed to the established order but still always in a certain way and not at random, the result seems to be less of a monstrosity because even that which is contrary to nature is in a certain sense according to nature, whenever, that is, the formal nature has not mastered the material nature. Therefore they do not call such things monstrosities any more than in the other cases where a phenomenon occurs habitually, as in fruits; for instance, there is a vine which some call 'smoky'; if this bear black grapes they do not judge it a monstrosity because it is in the habit of doing this very often. The reason is that it is in its nature intermediate between white and black; thus the change is not a large one nor, so to say, contrary to nature; at least, it is not a change into another nature. But in animals producing many young these things occur because the numerous embryos hinder one another from becoming perfect and interfere with the generative motions.

A difficulty may be raised concerning the production of many young and the multiplication of the parts and concerning the production of few young or only one and the deficiency of the parts. Sometimes animals are born with too many toes, sometimes with one alone, and so on with the other parts, for they may be multiplied or they may be mutilated. Again, they may have the generative parts doubled, the one being male, the other female; this is known in men and especially in goats. For what are called 'tragaenae' are such because they have both male and female generative parts; there is a case also of a goat being born with a horn upon its leg. Changes and deficiencies and multiplications are found also in the internal parts, 771a1 animals either not possessing some at all, or possessing them in a mutilated condition, or too numerous or in the wrong place. No animal, indeed, has ever been born without a heart, but they are born without a spleen or with two spleens or with one kidney; there is no case again of total absence of the liver, but there are cases of its being incomplete. And all these phenomena have been seen in animals perfect and alive. Animals also which naturally have a gall-bladder are found without one; others are found to have more than one. Cases are known, too, of the organs changing places, the liver being on the left, the spleen on the right. These phenomena have been observed, as stated above, in animals whose growth is perfected; at the time of birth great confusion of every kind has been found. Those which only depart a little from nature commonly live; not so those which depart further, when the unnatural condition is in the parts which are sovereign over life.

The question then about all these cases is this. Are we to suppose that a single cause is responsible for the production of a single young one and for the deficiency of the parts, and also for the production of many young and the multiplication of parts, or not?

In the first place it seems only reasonable to wonder why some animals produce many young, others only one. For it is the largest animals that produce one, e.g. the elephant, camel, horse, and the other solid-hoofed ungulates; of these some are larger than all other animals, while the others are of a remarkable size. But the dog, the wolf, and practically all the fissipeds produce many, even the small members of the class, as the mouse family. The cloven-footed animals again produce few, except the pig, which belongs to those that produce many. Now we should expect the large animals to be able to generate more young and to produce more semen. But precisely what we wonder at is the reason for not wondering; it is just because of their size that they do not produce many young, for the nutriment is expended in such animals upon increasing the body. But in the smaller animals nature takes away from the size and adds the excess to the seminal secretion. Moreover, more semen must be used in generation by the larger animal, and little by the smaller. Therefore many small ones may be produced together, but it is hard for many large ones to be so, and to those intermediate in size nature has assigned the intermediate number. We have formerly given the reason why some animals are large, some smaller, and some between the two. Some produce one young, some few, 771b1 some many: for the most part, the solid-hoofed produce one, the cloven-footed few, the fissipeds many. (The reason of this is that, generally speaking, their sizes correspond to this difference.) It is not so, however, in all cases; for it is the largeness and smallness of the body that is cause of few or many young being born, not the fact that the kind of animal has one, two, or many toes. A proof of this is that the elephant is the largest of animals and yet is many-toed, and the camel, the next largest, is cloven-footed. And not only in animals that walk but also in those that fly or swim the large ones produce few, the small many, for the same reason. In like manner also it is not the largest plants that bear most fruit.

We have explained then why some animals naturally produce many young, some but few, and some only one; in the difficulty now stated we may rather be surprised with reason at those which produce many, since such animals are often seen to conceive from a single copulation. Whether the semen of the male contributes to the material of the embryo by itself becoming a part of it and mixing with the semen of the female, or whether, as *we* say, it does not act in this way but brings together and fashions the material within the female and the generative secretion as the fig-juice does the liquid substance of milk, what is the reason why it does not form a single animal of considerable size? For certainly in the parallel case the fig-juice is not separated if it has to curdle a large quantity of milk, but the more the milk and the more the fig-juice put into it, so much the greater is the curdled mass. Now it is no use to say that the several regions of the uterus attract the semen and therefore more young than one are formed, because the regions are many and the cotyledons are more than one. For two embryos are often formed in the same region of the uterus, and they may be seen lying in a row in animals that produce many, when the uterus is filled with the embryos. (This is plain from the dissections.) Rather the truth is this. As animals complete their growth there are certain limits to their size, both upwards and downwards, beyond which they cannot go, but it is in the space between these limits that they exceed or fall short of one another in size, and it is within these limits that one man (or any other animal) is
772a1 larger or smaller than another. So also the generative material from which each animal is formed is not without a quantitative limit in both directions, nor can it be formed from any quantity you please. Whenever, then, an animal, for the cause assigned, discharges more of the secretion than is needed for beginning a single animal, it is not possible that only one should be formed out of all this, but a number limited by the appropriate size in each case; nor will the semen of the male, or the power residing in the semen, form anything either more or less than what is according to nature. In like manner, if the male emits more semen than is necessary, or more powers in different parts of the semen as it is divided, however much it is it will not make anything greater; on the contrary it will dry up the material and destroy it. So fire also does not continue to make water hotter in proportion as it is itself increased, but there is a fixed limit to the heat of which water is capable; if that is once reached and the fire is then increased, the water no longer gets hotter but rather evaporates and at last disappears and is dried up. Now since it appears that the secretion of the female and that from the male need to stand in some proportionate relation to one another (I mean in animals of which the male emits semen), what happens in those that produce many young is this: from the very first the semen emitted by the male has power, being divided, to form several embryos, and the material contributed by the female is so much that several can be formed out of it. (The parallel of curdling milk, which we spoke of before, is no longer in point here, for what is formed by the heat of the semen is not only of a certain

quantity but also of a certain quality, whereas with fig-juice and rennet quantity alone is concerned.) This then is just the reason why in such animals the embryos formed are numerous and do not all unite into one whole; it is because an embryo is not formed out of any quantity you please, but whether there is too much or too little, in either case there will be no result, for there is a limit set alike to the power of the heat which acts and to the material so acted upon.

On the same principle many embryos are not formed, though the secretion is much, in the large animals which produce only one young one, for in them also both the material and that which works upon it are of a certain quantity. So they do not secrete such material in too great quantity for the reason previously stated, and what they do secrete is naturally just enough for one embryo alone to be formed from it. If ever too much is secreted, then twins are born. Hence such cases seem rather to be monstrous because they are contrary to the general and customary rule.

Man belongs to all three classes, for he produces one only and sometimes many or few, though naturally he almost always produces one. Because of the moisture and heat of his body he may produce many (for semen is naturally fluid and hot), but because of his size he produces few or one. On account of this it results that in man alone among animals the period of gestation is irregular; whereas the period is fixed in the rest, there are several periods in man, for children are born at seven months and at ten months and at the times between, for even those of eight months do live though less often than the rest. The reason may be gathered from what has just been said, and the question has been discussed in the *Problems*. Let this explanation suffice for these points.

The reason why the parts may be multiplied contrary to nature is the same as the cause of the birth of twins. For the reason exists already in the embryo, whenever more material gathers than is required by the nature of the part. The result is then that either one of its parts is larger than the others, as a finger or hand or foot or any of the other extremities or limbs; or again if the embryo is cleft there may come into being more than one, as eddies do in rivers; as the water in these is carried along with a certain motion, if it dash against anything two systems come into being out of one, each retaining the same motion; the same thing happens also with the embryos. They generally are attached near one another, but sometimes at a distance because of the movement taking place in the embryo, and especially because of the excess of material returning to that place whence it was taken away while retaining the form of that part whence it arose as a superfluity.

In certain cases we find a double set of generative organs [one male and the other female].[5] When such duplication occurs the one is always functional but not the other, because it is always insufficiently supplied with nourishment as being contrary to nature; it is attached like a tumour (for such growths also receive nourishment though they are a later development than the body proper and contrary to nature). If the formative power prevails, both are similar; if it is altogether vanquished, both are similar; but if it prevail here and be vanquished there, then the one is female and the other male. (For whether we consider the

[5]Excised by Platt.

reason why the whole animal is male or female, or why the parts are so, makes no difference.)

When we meet with deficiency in such parts, e.g. an extremity or one of the other limbs, we must assume the same cause as when the embryo is altogether aborted (abortion of embryos happens frequently).

773a1 Outgrowths differ from the production of many young in the manner stated before; monsters differ from these in that most of them are due to embryos growing together. Some however are also of the following kind, when the monstrosity affects greater and more sovereign parts, as for instance some monsters have two spleens or more than two kidneys. Further, the parts may migrate, the movements being diverted and the material changing its place. We must decide whether the monstrous animal is one or is composed of several grown together by considering the vital principle; thus, if the heart is a part of such a kind then that which has one heart will be one animal, the multiplied parts being mere outgrowths, but those which have more than one heart will be two animals grown together through their embryos having been confused.

It also often happens even in many animals that do not seem to be defective and whose growth is now complete, that some of their passages may have grown together or others may have been diverted from the normal course. Thus in some women before now the os uteri has remained closed, so that when the time for menstruation has arrived pain has attacked them, till either the passage has burst open of its own accord or the physicians have removed the impediment; some such cases have ended in death if the rupture has been made too violently or if it has been impossible to make it at all. In some boys, on the other hand, the end of the penis has not coincided with the end of the passage where the urine is voided, but the passage has ended below, so that they crouch sitting to void it, and if the testes are drawn up they appear from a distance to have both male and female generative organs. The passage of the solid food also has been closed before now in sheep and some other animals; there was a cow in Perinthus which passed fine matter, as if it were sifted, through the bladder, and when the anus was cut open it quickly closed up again nor could they succeed in keeping it open.

We have now spoken of the production of few and many young, and of the outgrowth of superfluous parts and also of monstrosities.

5 · Superfoetation does not occur at all in some animals but does in others; of the former some are able to bring the later formed embryo to birth, while others can only do so sometimes. The reason why it does not occur in some is that they produce 773b1 only one young one, for it is not found in solid-hoofed animals and those larger than these, as owing to their size the secretion is all used up for the one embryo. For all these have large bodies, and when an animal is large its foetus is large in proportion, e.g. the foetus of the elephant is as big as a calf. But superfoetation occurs in those which produce many young because the production of more than one at a birth is itself a sort of superfoetation, one being added to another. Of these all that are large, as man, bring to birth the later embryo, if the second impregnation takes place soon after the first, for such an event has been observed before now. The

reason is that given above, for even in a single act of intercourse the semen discharged is more than enough for one embryo, and this being divided causes more than one child to be born, the one of which is later than the other. But when the embryo has already grown to some size and it so happens that copulation occurs again, superfoetation sometimes takes place, but rarely, since the uterus generally closes in women during the period of gestation. If this ever happens (for this also has occurred) the mother cannot bring the second embryo to perfection, but it is cast out in a state like what are called abortions. For just as, in those animals that bear only one, all the secretion of the female is converted to the first formed embryo because of its size, so it is here also; the only difference is that in the former case this happens at once, in the latter when the foetus has attained to some size, for then they are in the same state as those that bear only one. In like manner—since man naturally would produce many young, and since the size of the uterus and the quantity of the female secretion are both greater than is necessary for one embryo, only not so much so as to bring to birth a second—therefore women and mares are the only animals which admit the male during gestation, the former for the reason stated, and mares both because of the barrenness of their nature and because their uterus is of superfluous size, too large for one but too small to allow a second embryo to be brought to perfection by superfoetation. And the mare is naturally inclined to sexual intercourse because she is in the same case as the barren among women; these latter are barren because they have no monthly discharge (which corresponds to the act of intercourse in males) and mares have exceedingly little. And in all the vivipara the barren females are so inclined, because they resemble the males when the semen has collected in the testes but is not being got rid of. For the discharge of the menstrual fluids is in females an emission of semen, they being unconcocted semen as has been said before. Hence it is that those women also who are incontinent in regard to such intercourse cease from their passion for it when they have borne many children, for, the seminal secretion being then drained off, they no longer desire this intercourse. And among birds the hens are less disposed that way than the cocks, because the uterus of the hen-bird is up near the hypozoma; but with the cock-birds it is the other way, for their testes are drawn up within them so that, if any kind of such birds has much semen naturally, it is always in need of this intercourse. In females then it encourages copulation to have the uterus low down, but in males to have the testes drawn up.

It has been now stated why superfoetation is not found in some animals at all, why it is found in others which sometimes bring the later embryos to birth and sometimes not, and why some such animals are inclined to sexual intercourse while others are not.

Some of those animals in which superfoetation occurs can bring the embryos to birth even if a long time elapses between the two impregnations, if their kind is abundant in semen, if their body is not of a large size, and if they bear many young. For because they bear many their uterus is spacious, because they are abundant in semen the generative discharge is copious, and because the body is not large but the discharge is in greater measure than is required for the nourishment wanted for the embryo, therefore they can not only form animals but also bring them to birth later on. Further, the uterus in such animals does not close up because there is a quantity of the residual discharge left over. This has happened before now even in women, for in some of them the discharge continues during all the time of pregnancy. In women, however, this is contrary to nature, so that the embryo suffers, but in such animals it is according to nature, for their body is so formed from the beginning, as with hares. For superfoetation occurs in these animals, since they are not large and they bear many young (for they have many toes and the many-toed animals bear many), and they abound in semen. This is shown by their hairiness, for the quantity of their hair is excessive, these animals alone having hair under the feet and within the jaws. Now hairiness is a sign of abundance of residual matter, wherefore among men also the hairy are given to sexual intercourse and have much semen rather than the smooth. In the hare it often happens that some of the embryos are imperfect while others of its young are produced perfect.

6 · Some of the vivipara produce their young imperfect, others perfect; the one-hoofed and cloven-footed perfect, most of the many-toed imperfect. The reason for this is that the one-hoofed produce one young one, and the cloven-footed either one or two generally speaking; now it is easy to bring the few to perfection. All the many-toed animals that bear their young imperfect give birth to many. Hence, though they are able to nourish the embryos while newly formed, their bodies are unable to complete the process when the embryos have grown and acquired some size. So they produce them imperfect, like those animals which generate a grub; for some of them when born are scarcely brought into form at all, as the fox, bear, and lion, and some of the rest in like manner; and nearly all of them are blind, as not only the animals mentioned but also the dog, wolf, and jackal. The pig alone produces both many and perfect young, and thus here alone we find any overlapping; it produces many as do the many-toed animals, but is cloven-footed or solid-hoofed (for there certainly are solid-hoofed swine). They bear, then, many young because the nutriment which would otherwise go to increase their size is diverted to the generative secretion (for considered as a solid-hoofed animal the pig is not a large one), and also it is more often cloven-hoofed, striving as it were with the nature of the solid-hoofed animals. For this reason it produces sometimes only one, sometimes two, but generally many, and brings them to perfection before birth because of the good condition of its body, being like a rich soil which has sufficient and abundant nutriment for plants.

The young of some birds also are hatched imperfect and blind; this applies to all small birds which lay many eggs, as crows, jays, sparrows, swallows, and to all those which lay few eggs without producing abundant nourishment along with the young, as ring-doves, turtle-doves, and pigeons. Hence if the eyes of swallows while still young be put out they recover their sight again, for the birds are still developing, not yet developed, when the injury is inflicted, so that the eyes grow and sprout afresh. And in general the production of young before they are perfect is owing to inability to continue nourishing them, and they are born imperfect because they are born too soon. This is plain also with seven-months children, for since they are not perfected it often happens that even the passages, e.g. of the ears and nostrils, are not yet opened in some of them at birth, but only open later as they are growing, and many such infants survive.

In man males are more often born defective than females, but in the other animals this is not the case. The reason is that in man the male is much superior to the female in natural heat, and so the male foetus moves about more than the female, and on account of moving is more liable to injury, for what is young is easily injured since it is weak. For this same reason also the female foetus is not perfected equally with the male in women (but they are so in the other animals, for in them the female is not later in developing than the male). For while within the mother the female takes longer in developing, but after birth everything is perfected more quickly in females than in males; I mean, for instance, puberty, the prime of life, and old age. For females are weaker and colder in nature, and we must look upon the female character as being a sort of natural deficiency. Accordingly while it is within the mother it develops slowly because of its coldness (for development is concoction, and it is heat that concocts, and what is hotter is easily concocted); but after birth it quickly arrives at maturity and old age on account of its weakness, for all inferior things come sooner to their perfection, and as this is true of works of art so it is of what is formed by nature. For the reason just given also twins are less likely to survive in man if one be male and one female, but this is not at all so in the other animals; for in man it is contrary to nature that they should run an equal course, as their development does not take place in equal periods; but the male must needs be too late or the female too early; in the other animals, however, it is not contrary to nature. A difference is also found between man and the other animals in respect of gestation, for animals are in better bodily condition most of the time, whereas in most women gestation is attended with discomfort. Their way of life is partly responsible for this, for being sedentary they are full of more residual matter; among nations where the women live a laborious life gestation is not equally conspicuous and those who are accustomed to work bear children easily both there and elsewhere; for work consumes the residual matter, but those who are sedentary have a great deal of it in them because not only is there no monthly discharge during pregnancy but also they do not work; therefore their travail is painful. But work exercises them so that they can hold their breath, upon which depends the ease or 775b1
difficulty of child-birth. These circumstances then, as we have said, contribute to cause the difference between women and the other animals in this state, but the most important thing is this: in some animals the discharge is small, and in some not visible at all, but in women it is greater than in any other animal, so that when this discharge ceases owing to pregnancy they are troubled (for if they are not pregnant they are afflicted with ailments whenever the discharges do not occur); and they are more troubled as a rule at the beginning of pregnancy, for the embryo is able indeed to stop the discharges but is too small at first to consume any quantity of the secretion: later on it takes up some of it and so alleviates the mother. In the other animals, on the contrary, the residual matter is but small and so corresponds with the growth of the foetus, and as the secretions which hinder nourishment are being consumed by the foetus the mother is in better bodily condition than usual. The same holds good also with aquatic animals and birds. If it ever happens that the

body of the mother is no longer in good condition when the foetus is now becoming large, the reason is that its growth needs more nourishment than the residual matter supplies. (In some few women it happens that the body is in a better state during pregnancy; these are women in whose body the residual matter is small so that it is all used up along with the nourishment that goes to the foetus.)

7 · We must also speak of what is known as a 'mole', which occurs rarely in women but still is found sometimes during pregnancy. For they produce what is called a mole; it has happened before now to a woman, after she had had intercourse with her husband and supposed she had conceived, that at first the size of her belly increased and everything else happened accordingly, but yet when the time for birth came on, she neither bore a child nor was her size reduced, but she continued thus for three or four years until dysentery came on, endangering her life, and she produced a lump of flesh which is called a mole. Moreover this condition may continue till old age and death. Such masses when expelled from the body become so hard that they can hardly be cut through even by iron. Concerning the cause of this phenomenon we have spoken in the *Problems;* the same thing happens to the embryo in the womb as to meats half cooked in roasting, and it is not due to heat, as some say, but rather to the weakness of the heat. (For their nature seems to be weak and unable to perfect or to put the last touches to the process of generation. Hence it is that the mole remains in them till old age or at any rate for a long time, for in its nature it is neither perfect nor altogether a foreign body.) It is want of concoction that is the reason of its hardness, for half-cooking is also a sort of want of concoction.

A difficulty is raised as to why this does not occur in other animals, unless indeed it has entirely escaped observation. We must suppose the reason to be that woman alone among animals is subject to troubles of the uterus, and alone has a superfluous amount of menstrual fluids and is unable to concoct them; when, then, the embryo has been formed of a liquid hard to concoct, then comes the so-called mole into being, and this happens naturally in women alone or at any rate more than in other animals.

8 · Milk is formed in the females of all internally viviparous animals, becoming useful for the time of birth. For nature has made it for the sake of the nourishment of animals after birth, so that it neither fails at this time at all nor yet is at all superfluous; this is just what we find happening, unless anything chance contrary to nature. In the other animals the period of gestation does not vary, and so the milk is concocted in time to suit the moment, but in man, since there are several times of birth, it must be ready at the first of these; hence in women the milk is useless before the seventh month and only then becomes useful. That it is only concocted at the last stages is what we should expect to happen also as being due to a necessary cause. For at first such residual matter when secreted is used up for the development of the embryo; now the nutritious part in all things is the sweetest and the most concocted, and thus when all such elements are removed what remains

must become of necessity bitter and ill-flavoured. As the embryo is perfecting, the residual matter left over increases in quantity because the part consumed by the embryo is less; it is also sweeter since the easily concocted part is less drawn away from it. For it is no longer expended on moulding the embryo but only on slightly increasing its growth, the embryo being now as it were stationary because it has reached perfection (for in a sense there is a perfection even of an embryo). 776b1
Therefore it comes forth from the mother and changes its mode of development, as now possessing what belongs to it; and no longer takes that which does not belong to it; and it is at this season that the milk becomes useful.

The milk collects in the upper part of the body and the breasts because of the original plan of the organism. For the part above the hypozoma is the part that controls life, while that below is concerned with nourishment and residual matter, in order that all animals which move about may contain within themselves nourishment enough to make them independent when they move from one place to another. From this upper part also is produced the generative secretion for the reason mentioned in the opening of our discussion. But both the secretion of the male and the menses of the female are of a sanguineous nature, and the first principle of this blood and of the blood-vessels is the heart, and the heart is in this part of the body. Therefore it is here that the change of such a secretion must first become plain. This is why the voice changes in both sexes when they begin to bear seed (for the first principle of the voice resides there, and is itself changed when its moving cause changes). At the same time the parts about the breasts are raised visibly even in males but still more in females, for the region of the breasts becomes empty and spongy in them because so much material is drained away below. This is so also in those animals which have the breasts low down.

This change in the voice and the parts about the breasts is plain even in other creatures to those who have experience of each kind of animal, but is most remarkable in man. The reason is that in man the production of secretion is greatest in both sexes in proportion to their size as compared with other animals. [I mean menstruation in women and the emission of semen in men.][6] When, therefore, the embryo no longer takes up the secretion in question but yet prevents its being discharged from the mother, it is necessary that all the residual matter should collect in all those empty parts which are set upon the same passages. And such is the position of the breasts in each kind of animals for both causes; it is so both for the sake of what is best and of necessity.

It is here, then, that the nourishment in animals is now formed and becomes concocted. As for the cause of concoction, we may take that already given, or we may take the opposite, for it is a reasonable view also that the embryo being larger 777a1
takes more nourishment, so that less is left over about this time, and the less is concocted more quickly.

That milk has the same nature as the secretion from which each animal is formed is plain, and has been stated previously. For the material which nourishes is

[6]Excised by Drossaart Lulofs.

the same as that from which nature forms the animal in generation. Now this is the sanguineous liquid in the sanguinea, and milk is blood concocted (not corrupted; Empedocles either mistook the fact or made a bad metaphor when he wrote that milk 'on the tenth day of the eighth month comes into being, a white pus',[7] for putrefaction and concoction are opposite things, and pus is a kind of putrefaction but milk is concocted). While women are suckling children menstruation does not occur according to nature, nor do they conceive; if they do conceive, the milk dries up. This is because the nature of the milk and of the menses is the same, and nature cannot be so productive as to supply both at once; if the secretion is diverted in the one direction it must needs cease in the other, unless some violence is done contrary to the general rule. But this is as much as to say that it is contrary to nature, for in all cases where it is not impossible for things to be otherwise than they generally are but where they may so happen, still what is the general rule is what is according to nature.

The time also at which the young animal is born has been well arranged. For when the nourishment coming through the umbilical cord is no longer sufficient for the foetus because of its size, then at the same time the milk becomes useful for the coming nourishment and the blood-vessels round which the so-called umbilical cord lies as a coat collapse as the nourishment is no longer passing through it; for these reasons it is at that time also that the young animal enters into the world.

9 · The natural birth of all animals is head-foremost, because the parts above the umbilical cord are larger than those below. The body then, being suspended from the cord as in a balance, inclines towards the heavy end, and the larger parts are the heavier.

10 · The period of gestation is, as a matter of fact, determined generally in each animal in proportion to the length of its life. For it is reasonable that the development of the long-lived animals should take a longer time. Yet this is not the cause of it, but the correspondence holds for the most part; for though the larger and
777b1 more perfect sanguinea do live a long time, yet the larger are not all longer-lived. Man lives a longer time than any animal of which we have any credible experience except the elephant, and yet the human kind is smaller than that of the bushy-tailed animals and many others. The real cause of long life in any animal is its being tempered in a manner resembling the environing air, along with certain other circumstances of its nature, of which we will speak later; but the cause of the time of gestation is the size of the offspring. For it is not easy for large masses to arrive at their perfection in a small time, whether they be animals or, one may say, anything else whatever. That is why horses and animals akin to them, though living a shorter time than man, yet carry their young longer; for the time in the former is a year, but in the latter ten months at the outside. For the same reason also the time is long in elephants; they carry their young two years on account of their excessive size.

We find, as we might expect, that in all animals the time of gestation and

[7]Frag. 68 Diels-Kranz.

development and the length of life aim naturally at being measured periods. By a period I mean, e.g., a day and night, a month, a year, and the times measured by these, and also the periods of the moon, that is to say, the full moon and her disappearance and the halves of the times between these, for it is by these that the moon's orbit fits in with that of the sun, the month being a period common to both.

The moon is a first principle because of its connexion with the sun and its participation in its light, being as it were a second smaller sun, and therefore she contributes to all generation and development. For heat and cold varying within certain limits make things to come into being and after this to perish, and it is the motions of the sun and moon that fix the limit both of the beginning and of the end of these processes. Just as we see the sea and all bodies of water settling and changing according to the movement or rest of the winds, and the air and winds again according to the course of the sun and moon, so also the things which grow out of these or are in these must follow suit. For it is reasonable that the periods of the 778a1
less important should follow those of the more important. For in a sense a wind, too, has a life and birth and death.

As for the revolutions of the sun and moon, they may perhaps depend on other principles.

It is the aim, then, of nature to count the coming into being and the end of animals by the numbers of these higher periods, but nature does not bring this to pass accurately because matter cannot be easily brought under rule and because there are many principles which hinder generation and decay from being according to nature, and often cause things to fall out contrary to nature.

We have now spoken of the nourishment of animals within the mother and of their birth into the world, both of each kind separately and of all in common.

BOOK V

1 · We must now investigate the qualities by which the parts of animals differ. I mean such qualities of the parts as blueness and blackness of the eyes, height and depth of pitch in the voice, and differences in colour and in hair or feathers. Some such qualities are found to characterize the whole of a kind of animals sometimes, while in other kinds they occur at random, as is especially the case in man. Further, in connexion with the changes in the time of life, all animals are alike in some points, but are opposed in others as in the case of the voice and the colour of the hair, for some do not grow grey visibly in old age, while man is subject to this more than any other animal. And some of these affections appear immediately after birth, while others become plain as age advances or in old age.

Now we must no longer suppose that the cause of these and all such phenomena is the same. For whenever things are not the product of nature in general nor yet characteristic of each separate kind, then none of these things is such as it is or is so developed for the sake of anything. The eye for instance exists

for a final cause, but it is not blue for a final cause unless this condition be characteristic of the kind of animal. In fact in some cases this condition has no connexion with the account of the animal's essence, but we must refer the causes to
778b1 the material and the motive principle on the view that these things come into being by necessity. For, as was said originally in the outset of our discussion, when we are dealing with definite and ordered products of nature, we must not say that each *is* of a certain quality because it *becomes* so, rather that they *become* so and so because they *are* so and so, for the process of becoming attends upon being and is for the sake of being, not *vice versa*.

Past students of nature, however, took the opposite view. The reason for this is that they did not see that the causes were numerous, but only saw the material and efficient and did not distinguish even these, while they made no inquiry at all into the formal and final causes.

Everything then exists for a final cause, and all those things which are included in the definition of each animal, or which either are for the sake of some end or are ends in themselves, come into being both through this cause and the rest. But when we come to those things which come into being without falling under the heads just mentioned, their cause must be sought in the movement or process of coming into being, on the view that the differences which mark them arise in the actual formation of the animal. An eye, for instance, the animal must have of necessity (for an animal is supposed to be of such a sort), but it will have an eye of a particular kind of necessity in another sense, not the sense mentioned just above, because it is its nature to act or be acted on in this or that way.

These distinctions being drawn let us speak of what comes next in order. As soon then as the offspring of all animals are born, especially those born imperfect, they are in the habit of sleeping, because they continue sleeping also within the mother when they first acquire sensation. But there is a difficulty about the earliest period of development, whether the state of wakefulness exists in animals first, or that of sleep. Since they plainly wake up more as they grow older, it is reasonable to suppose that the opposite state, that of sleep, exists in the first stages of development. Moreover the change from not being to being must pass through the intermediate condition, and sleep seems to be in its nature such a condition, being as it were a boundary between living and not living, and the sleeper being neither altogether non-existent nor yet existent. For life most of all appertains to wakefulness, on account of sensation. But on the other hand, if it is necessary that the animal should have sensation and if it is then first an animal when it has acquired sensation, we ought to consider the original condition to be not sleep but only something resembling sleep, such a condition as we find also in plants, for indeed at
779a1 this time animals do actually live the life of a plant. But it is impossible that plants should sleep, for there is no sleep which cannot be broken, and the condition in plants which is analogous to sleep cannot be broken.

It is necessary then for the animal to sleep most of the time because the growth and the weight lie on the upper part of the body (and we have stated elsewhere that such is the cause of sleep). But nevertheless they are found to wake even in the womb (this is clear in dissections and in the ovipara), and then they immediately fall into a sleep again. This is why after birth also they spend most of their time in sleep.

When awake infants do not laugh, but while asleep they both laugh and cry. For animals have sensations even while asleep, not only what are called dreams but also others besides dreams, as those persons who arise while sleeping and do many things without dreaming. For there are some who get up while sleeping and walk about seeing just like those who are awake; these have perception of what is happening, and though they are not awake, yet this perception is not like a dream. So infants presumably have sense-perception and live in their sleep owing to previous habit, being as it were without knowledge of the waking state. As time goes on and their growth is transferred to the lower part of the body, they now wake up more and spend most of their time in that condition. Children continue asleep at first more than other animals, for they are born in a more imperfect condition than other animals that are produced in a perfect state, and their growth has taken place more in the upper part of the body.

The eyes of all children are bluish immediately after birth; later on they change to the colour which is to be theirs permanently. But in the case of other animals this is not visible. The reason for this is that the eyes of other animals are more apt to have only one colour; e.g. cattle are dark-eyed, the eye of all sheep is pale, of others again the whole kind is blue or grey-eyed, and some are yellow as the majority of goats themselves, whereas the eyes of men happen to be of many colours, for they are blue or grey or dark in some cases and yellow in others. Hence, as the individuals in other kinds of animals do not differ from one another in the colour, so neither do they differ from themselves, for they are not of a nature to have more than one colour. Of the other animals the horse has the greatest variety of colour in the eye, for some of them actually have eyes of different colour; this phenomenon is not to be seen in any of the other animals, except in some men.

Why then is it that there is no visible change in the other animals if we compare their condition when newly born with their condition at a more advanced age, but that there is such a change in children? We must consider just this to be a sufficient cause, that the part concerned has only one colour in the former but several colours in the latter. And the reason why the eyes of infants are bluish and have no other colour is that the parts are weaker in the newly born and blueness is a sort of weakness.

We must also gain a general notion about the difference in eyes, for what reason some are blue, some grey, some yellow and some dark. To suppose that the blue are fiery, as Empedocles says, while the dark have more water than fire in them, and that this is why the former, the blue, have not keen sight by day, viz. owing to deficiency of water in their composition, and the latter are in like condition by night, viz. owing to deficiency of fire—this is not well said if indeed we are to assume sight to be connected with water, not fire, in all cases. Moreover it is possible to render another account of the cause of the colours, but if indeed the fact is as was stated before in the treatise on the senses, and still earlier than that in the investigations concerning soul[1]—if this sense organ is composed of water and if we were right in saying for what reason it is composed of water and not of air or fire—then we must assume the water to be the cause of the colours mentioned. For some eyes have too much liquid to be adapted to the movement, others have too little, others the due amount. Those eyes therefore in which there is much liquid are dark because much liquid is not transparent, those which have little are blue; (so we find in the sea that the transparent part of it appears light blue, the less transparent watery, and the unfathomable water is dark or deep-blue on account of its depth). When we come to the eyes between these, they differ only in degree.

We must suppose the same cause also to be responsible for the fact that blue 780a1 eyes are not keen-sighted by day nor dark eyes by night. Blue eyes, because there is little liquid in them, are too much moved by the light and by visible objects in respect of their liquidity as well as their transparency, but sight is the movement of this part in so far as it is transparent, not in so far as it is liquid. Dark eyes are less moved because of the quantity of liquid in them. For the nocturnal light is weak; at the same time also liquid is in general hard to move in the night. But if the eye is to see, it must neither not be moved at all nor yet more than in so far as it is transparent, for the stronger movement drives out the weaker. Hence it is that on changing from strong colours, or on going out of the sun into the dark, men cannot see, for the motion already existing in the eye, being strong, stops that from outside, and in general neither a strong nor a weak sight can see bright things because the liquid is acted upon and moved too much.

The same thing is shown also by the morbid affections of each kind of sight. Cataract attacks the blue-eyed more, but what is called night-blindness the dark-eyed. Now cataract is a sort of dryness of the eyes and therefore it is found more in the aged, for this part also like the rest of the body gets dry towards old age; but night-blindness is an excess of liquidity and so is found more in the younger, for their brain is more liquid.

The sight of the eye which is intermediate between too much and too little liquid is the best, for it has neither too little so as to be disturbed and hinder the movement of the colours, nor too much so as to cause difficulty of movement.

Not only the above-mentioned facts are causes of seeing keenly or the reverse, but also the nature of the skin upon what is called the pupil. This ought to be transparent, and it is necessary that the transparent should be thin and white and even, thin that the movement coming from without may pass straight through it, even that it may not cast a shadow by wrinkling (for this also is a reason why old men have not keen sight, the skin of the eye like the rest of the skin wrinkling and becoming thicker in old age), and white because black is not transparent, for that is just what is meant by 'black', what is not shone through, and that is why lanterns 780b1 cannot give light if they be made of black skin. It is for these reasons then that the sight is not keen in old age nor in the diseases in question, but it is because of the small amount of liquid that the eyes of children appear blue at first.

And the reason why men especially and horses occasionally have eyes of

[1] *Sense and Sensibilia* 2; *On the Soul* III 1.

different colours is the same as the reason why man alone grows grey and the horse is the only other animal whose hairs whiten visibly in old age. For greyness is a weakness of the fluid in the brain and a lack of concoction, and so is blueness of the eyes; excess of thinness or of thickness produces the same effect, according as this liquidity is too little or too much. Whenever then nature cannot make the eyes correspond exactly, either by concocting or by not concocting the liquid in both, but concocts the one and not the other, then the result is differently coloured eyes.

The cause of some animals being keen-sighted and others not so is not simple but double. For things are called keen in two ways (and this is the case in like manner with hearing and smelling). In one sense keen sight means the power of seeing at a distance, in another it means the power of distinguishing as accurately as possible the objects seen. These two faculties do not occur together in the same individual. For the same person, if he shade his eyes with his hand or look through a tube, does not distinguish the differences of colour either more or less in any way, but he will see further; in fact, men in pits or wells sometimes see the stars. Therefore if any animal's brows project far over the eye, but if the liquid in the pupil is not pure nor suited to the movement coming from external objects and if the skin over the surface is not thin, this animal will not distinguish accurately the differences of the colours but it will be able to see from a long distance (just as it can from a short one)[2] better than those in which the liquid and the covering membrane are pure but which have no brows projecting over the eyes. For the cause of seeing keenly in the sense of distinguishing the differences is in the eye itself; as on a clean garment even small stains are visible, so also in a pure sight even small movements are plain and cause sensation. But it is the position of the eyes that is the cause of seeing things far off and of the movements coming to the eyes from distant objects. For animals with prominent eyes do not see well at a distance, whereas those which have their eyes lying deep in the head can see things at a distance because the movement is not dispersed in space but comes straight to the eye. For it makes no difference whether we say, as some do, that seeing is caused by the sight going forth from the eye—on that view, if there is nothing projecting over the eyes, the sight must be scattered and so less of it will fall on the objects of vision and things at a distance will not be seen so well—or whether we say that seeing is due to the movement coming from the objects; for the sight also must see, in a manner resembling the movement. Things at a distance, then, would be seen best if there were, so to say, a continuous tube straight from the sight to its object, for the movement from the object would not then be dissipated; but, if that is impossible, still the further the tube extends the more accurately must distant objects be seen.

Let these, then, be given as the causes of the difference in eyes.

2 · It is the same also with hearing and smell; to hear and smell accurately mean in one sense to perceive as precisely as possible all the distinctions of the objects of perception, in another sense to hear and smell far off. As with sight, so here the sense-organ is the cause of distinguishing well the distinctions, if both that

[2]Drossaart Lulofs excises the sentence in parentheses.

organ itself and the membrane round it be pure. For the passages of all the sense-organs, as has been said in the treatise on sensation, run to the heart, or to its analogue in creatures that have no heart. The passage of the hearing, then, since this sense-organ is of air, ends at the place where the innate breath causes in some animals the pulsation and in others respiration;[3] and that is why we are able to understand what is said and repeat what we have heard, for as[4] was the movement which entered through the sense-organ, such again is the movement which is caused by means of the voice, being as it were of one and the same stamp, so that a man can say what he has heard. And we hear less well during a yawn or expiration than during inspiration, because the starting-point of the sense-organ of hearing is set upon the part concerned with breathing and is shaken and moved as the organ moves the breath, for while setting the breath in motion it is moved itself. The same thing happens in wet weather or a damp climate.[5] . . . And the ears seemed to be filled with air because their starting-point is near the region of breathing.[6]

Accuracy then in judging the differences of sounds and smells depends on the purity of the sense-organ and of the membrane lying upon its surface, for then all the movements become clear in such cases, as in the case of sight.[7] Perception and non-perception at a distance also depend on the same things as with sight. For those animals can perceive at a distance which have channels, so to say, running through the parts concerned and projecting far in front of the sense-organs. Therefore all animals whose nostrils are long, as the Laconian hounds, are keen-scented, for the sense-organ being above them, the movements from a distance are not dissipated but go straight to the mark, just as with those who shadow the eyes with the hand.

Similar is the case of animals whose ears are long and project far like the eaves of a house, as in some quadrupeds, with the internal spiral passage long; these also catch the movement from afar and pass it on to the sense-organ.

In respect of sense-perception at a distance, man is, one may say, the worst of all animals in proportion to his size, but in respect of judging the differences he is the best of all. The reason is that the sense-organ is pure and least earthy and material, and he is by nature the thinnest-skinned of all animals for his size.

The workmanship of nature is admirable also in the seal, for though a viviparous quadruped it has no ears but only passages for hearing. This is because its life is passed in the water; now the ear is a part added to the passages to preserve the movement of the air at a distance; therefore an ear is no use to it but would even bring about the contrary result by receiving a mass of water into itself.

We have thus spoken of sight, hearing, and smell.

3 · As for hair, men differ in this themselves at different ages, and also from all other kinds of animals that have hair. These are almost all which are internally viviparous, for even when the covering of such animals is spiny it must be considered as a kind of hair, as in the hedgehog and any other such animal among the vivipara.

[3]Omitting *καὶ εἰσπνοήν*.
[4]Reading *οἷα*.
[5]There appears to be a lacuna in the text here.
[6]Reading *τὴν ἀρχὴν τῷ πνευματικῷ τόπῳ*. [7]Drossaart Lulofs marks 781^{a}20-^{b}5 as a later addition.

Hairs differ in respect of hardness and softness, length and shortness, straightness and curliness, quantity and scantiness, and in addition to these qualities, in their colours, whiteness and blackness and the intermediate shades. They differ also in some of these respects according to age, as they are young or growing old. This is especially plain in man; the hair gets thicker as time goes on, and some go bald on the front of the head; children indeed do not go bald, nor do women, but men do so by the time their age is advancing. Human beings also go grey on the head as they grow old, but this is not visible in practically any other animal, though more so in the horse than others. Men go bald on the front of the head, but turn grey first on the temples; no one goes bald on these or on the back of the head. Some such affections occur in a corresponding manner also in animals which have not hair but something analogous to it, as the feathers of birds and scales in the class of fish.

For what purpose nature has made hair for animals has been previously stated in the work dealing with the causes of the parts of animals; it is the business of the present inquiry to show under what circumstances and for what necessary causes each particular kind of hair occurs. The principal cause then of thickness and thinness is the skin, for this is thick in some animals and thin in others, rare in some and dense in others. The different quality of the included moisture is also a helping cause, for in some animals this is greasy and in others watery. For generally speaking the skin is of an earthy nature; being on the surface of the body it becomes solid and earthy as the moisture evaporates. Now the hairs on their analogue are not formed out of the flesh but out of the skin, the moisture evaporating and exhaling in them, and therefore thick hairs arise from a thick skin and thin from a thin. If then the skin is rarer and thicker, the hairs are thick because of the quantity of earthy matter and the size of the pores, but if it is denser they are thin because of the narrowness of the pores. Further, if the moisture be watery it dries up quickly and the hairs do not gain in size, but if it be greasy the opposite happens, for the greasy is not easily dried up. Therefore the thicker-skinned animals are as a general rule thicker-haired; however, the thickest-skinned are not more so than other thick-skinned ones, for the causes mentioned, as is shown by the class of swine compared to that of oxen and to the elephant and many others. And for the same reason also the hairs of the head in man are thickest, for this part of his skin is thickest and lies over most moisture and besides is very rare.

The cause of the hairs being long depends on the evaporating moisture not being easily dried. Of this there are two causes, quantity and quality; if the liquid is much it does not dry up easily nor if it is greasy. And for this reason the hairs of the head are longest in man, for the brain, being fluid and cold, supplies great abundance of moisture.

The hairs become straight or curly on account of the vapour arising in them. If it be smoke-like, it is hot and dry and so makes the hair curly, for it is twisted as being carried with a double motion, the earthy part tending downwards and the hot upwards. Thus, being easily bent, it is twisted owing to its weakness, and this is what is meant by curliness in hair. It is possible then that this is the cause, but it is also possible that, owing to its having but little moisture and much earthy matter in it, it is dried by the surrounding air and so coiled up together. For what is straight becomes bent, if the moisture in it is evaporated, and runs together as a hair does when burning upon the fire; curliness will then be a contraction owing to deficiency of moisture caused by the heat of the environment. A sign of this is the fact that curly hair is harder than straight, for the dry is hard. And animals with much moisture are straight-haired; for in these hairs the moisture advances as a stream, not in drops. For this reason the Scythians on the Black Sea and the Thracians are straight-haired, for both they themselves and the environing air are moist, whereas the Aethiopians and men in hot countries are curly-haired, for their brains and the surrounding air are dry.

Some, however, of the thick-skinned animals are fine-haired for the cause previously stated, for the finer the pores are the finer must the hairs be. Hence the class of sheep have such hairs (for wool is a multitude of hairs).

There are some animals whose hair is soft and yet less fine, as is the case with the class of hares compared with that of sheep; in such animals the hair is on the surface of the skin, and so is not long but in much the same state as the scrapings from linen, for these also are not long but are soft and do not admit of weaving.

The condition of sheep in cold climates is opposite to that of man; the hair of the Scythians is soft but that of Sarmatian sheep is hard. The reason for this is the same as it is also in all wild animals. The cold hardens and solidifies them by drying them, for as the heat is pressed out the moisture evaporates, and both hair and skin become earthy and hard. In wild animals then their open-air life is the cause, in the others the nature of their location. A proof of this is also what happens in the sea-urchins which are used as a remedy in stranguries. For these, too, though small themselves, have large and hard spines because the sea in which they live is cold on account of its depth (for they are found in sixty fathoms and even more). The spines are large because the growth of the body is diverted to them, since having little heat in them they do not concoct their nutriment and so have much residual matter and it is from this that spines, hairs, and such things are formed; they are hard and petrified through the congealing effect of the cold. In the same way also plants are found to be harder, more earthy, and stony, if the region in which they grow looks to the north than if it looks to the south, and those in windy places than those in sheltered, for they are all more chilled and their moisture evaporates.

Hardening, then, comes of both heat and cold, for both cause the moisture to evaporate, heat *per se* and cold *per accidens* (since the moisture goes out of things along with the heat, there being no moisture without heat), but whereas cold not only hardens but also condenses, heat makes a substance rarer.

For the same reason, as animals grow older, the hairs become harder in those which have hairs, and the feathers and scales in the feathered and scaly kinds. For their skins become harder and thicker as they get older, for they are dried up, and old age, as the word implies,[8] is earthy because the heat fails and the moisture along with it.

Men go bald visibly more than any other animal, but still such a state is

[8] 'γῆρας' ('old age') connected with 'γῆ' ('earth').

something general, for among plants also some are evergreens while others are deciduous, and birds which hibernate shed their feathers. Similar to this is the condition of baldness in those human beings to whom it is incident. For leaves are shed by all plants, from one part of the plant at a time, and so are feathers and hairs by those animals that have them; it is when they are all shed together that the condition is described by the terms mentioned, for it is called 'going bald' and 'the fall of the leaf' and 'moulting'. The cause of the condition is deficiency of hot moisture, such moisture being especially the greasy and hence greasy plants are more evergreen. (However, we must elsewhere state the cause of this—for other causes also contribute to it.) It is in winter that this happens to plants (for the change from summer to winter is more important to them than the time of life), and to those animals which hibernate (for these, too, are by nature less hot and moist than man); in men it is the seasons of life that correspond to summer and winter. Hence no one goes bald before the time of sexual intercourse, and at that time it is in those naturally inclined to such intercourse that baldness appears, for the brain is naturally the coldest part of the body and sexual intercourse makes men cold, being a loss of pure natural heat. Thus we should expect the brain to feel the effect of it first, for a little cause turns the scale where the thing concerned is weak and in poor condition. Thus if we reckon up these points, that the brain itself has but little heat, and further that the skin round it must needs have still less, and again that the hair must have still less than the skin inasmuch as it is the furthest removed from the brain, we should reasonably expect baldness to come about this age upon those who have much semen. And it is for the same reason that the front part of the head alone goes bald in man and that he is the only animal to do so; the front part goes bald because the brain is there, and man is the only animal to go bald because his brain is much the largest and the moistest. Women do not go bald because their nature is like that of children, both alike being incapable of producing seminal secretion. Eunuchs do not become bald, because they change into the female condition. And as to the hair that comes later in life, eunuchs either do not grow it at all, or lose it if they happen to have it, with the exception of the pubic hair; for women also grow that though they have not the other, and this mutilation is a change from the male to the female condition.

The reason why the hair does not grow again in cases of baldness, although both hibernating animals recover their feathers or hair and trees that have shed their leaves grow leaves again, is this. The seasons of the year are the turning-points of their lives so that when these seasons change they change with them by growing and losing feathers, hairs, or leaves respectively. But the winter and summer, spring and autumn of man are defined by his age, so that, since his ages do not return, neither do the conditions caused by them return, although the cause is similar.

We have now spoken pretty much of all the other conditions of hair.

4 · But as to their colour, it is the nature of the skin that is the cause of this in other animals (and also of their being unicoloured or varicoloured); but in man it is not the cause, except of the hair going grey through disease (not through old age), for in what is called leprosy the hairs become white; on the contrary, if the hairs are

white because of old age, the whiteness does not derive from the skin. The reason is that the hairs grow out of skin; if, then, the skin is diseased and white the hair becomes diseased with it, and the disease of hair is greyness. But the greyness of hair which is due to age results from weakness and deficiency of heat. For as the body declines in vigour we tend to be cold at every time of life, and especially in old age,[9] this age being cold and dry. We must remember that the nutriment coming to each part of the body is concocted by the heat appropriate to the part; if the heat is inadequate the part perishes, and deformity or disease results. (We shall speak more in detail of causes in the treatise on growth and nutrition.) Whenever, then, the hair in man has naturally little heat and too much moisture enters it, its own proper heat is unable to concoct the moisture and so it is decayed by the heat in the environing air. All decay is caused by heat—not the innate heat, as has been stated elsewhere. And as there is a decay of water, of earth, and all such material bodies, so there is also of the earthy vapour, for instance what is called mould (for mould is a decay of earthy vapour). Thus also the liquid nutriment in the hair decays because it is not concocted, and what is called greyness results. It is white because mould also, practically alone among decayed things, is white. The reason for this is that it has much air in it, all earthy vapour being equivalent to thick air. For mould is, as it were, the antithesis of hoar-frost; if the ascending vapour be frozen it becomes hoar-frost, if it be decayed, mould. Hence both are on the surface of things, for vapour is superficial. And so the comic poets make a good metaphor in jest when they call grey hairs 'mould of old age' and 'hoar-frost'. For the one is generically the same as greyness, the other specifically; hoar-frost generically (for both are a vapour), mould specifically (for both are a form of decay). A proof that this is so is this: grey hairs have often grown on men in consequence of disease, and later on dark hairs instead of them after restoration to health. The reason is that in sickness the whole body is deficient in natural heat and so the parts besides, even the very small ones, participate in this weakness; and again, much residual matter is formed in the body and all its parts, so that the incapacity in the flesh to concoct the nutriment causes the grey hairs. But when men have recovered health and strength again they change, becoming as it were young again instead of old; in consequence the states change also. Indeed, we may rightly call disease an acquired old age, old age a natural disease; at any rate, some diseases produce the same effects as old age.

Men go grey on the temples first, because the back of the head is empty of moisture owing to its containing no brain, and the fontanelle has a great deal of moisture, a large quantity not being liable to decay; the hair on the temples, however, has neither so little that it can concoct it nor so much that it cannot decay, for this region of the head being between the two extremes is exempt from both states. The cause of greyness in man has now been stated.

5 · The reason why this change does not take place visibly on account of age in other animals is the same as that already given in the case of baldness; their brain

[9]Reading καὶ ἐν τῷ γήρᾳ.

is small and less fluid than in man, so that the heat required for concoction does not altogether fail. Among them it is most clear in horses of all animals that we know, because the bone about the brain is thinner in them than in others in proportion to their size. A sign of this is that a blow on this spot is fatal to them—thus Homer also has said: 'where the first hairs grow on the skull of horses, and a wound is most fatal'.[10] As then the moisture easily flows to these hairs because of the thinness of the bone, whilst the heat fails on account of age, they go grey. The reddish hairs go grey sooner than the black, redness also being a sort of weakness of hair and all weak things ageing sooner.

It is said that cranes become darker as they grow old. The reason for this would be that their feathers are naturally finer than others and as they grow old the moisture in the feathers is too much to decay easily.

Greyness comes about by some sort of decay, and is not, as some think, a withering. A sign is the fact that hair protected by hats or other coverings goes grey sooner (for the winds prevent decay and the protection keeps off the winds), and the fact that it is aided by anointing with a mixture of oil and water. For, though water cools things, the oil mingled with it prevents the hair from drying quickly, water being easily dried up. That the process is not a withering, that the hair does not whiten as grass does by withering, is shown by the fact that some hairs grow grey from the first, whereas nothing springs up in a withered state. Many hairs also whiten at the tip, for there is least heat in the extremities and thinnest parts.

When the hairs of other animals are white, this is caused by nature, not by any 785b1
affection. The cause of the colours in other animals is the skin; if they are white, the skin is white, if they are dark it is dark, if they are piebald in consequence of a mixture of the hairs, it is found to be white in the one part and dark in the other. But in man the skin is in no way the cause, for even white-skinned men have very dark hair. The reason is that man has the thinnest skin of all animals in proportion to his size and therefore it has not strength to change the hairs; on the contrary the skin itself changes its colour through its weakness and is darkened by sun and wind, while the hairs do not change along with it at all. But in the other animals the skin, owing to its thickness, has the influence belonging to the soil in which a thing grows: that is why the hairs change according to the skin but the skin does not change at all in consequence of the winds and the sun.

6 · Of animals some are uni-coloured (I mean by this term those of which the kind as a whole has one colour, as all lions are tawny; and this condition exists also in birds, fish, and the other classes of animals alike); others though many-coloured are yet whole-coloured (I mean those whose body as a whole has the same colour, as a bull is white as a whole or dark as a whole); others are vari-coloured. This last term is used in two ways; sometimes the whole kind is vari-coloured, as leopards and peacocks, and some fish, e.g. the so-called 'thrattai'; sometimes the kind as a whole is not so, but such individuals are found in it, as with cattle and goats and, among birds, pigeons; the same applies also to other kinds of birds. The whole-coloured

[10] *Iliad* VIII 83.

change much more than the uniformly coloured, both into the simple colour of another individual of the same kind (as dark changing into white and *vice versa*) and into both colours mingled. This is because it is a natural characteristic of the kind as a whole not to have one colour only, the kind being easily moved in both directions so that the colours both change more into one another and are more varied. The opposite holds with the uniformly coloured; they do not change except by an affection, and that rarely; but still they do so change, for before now white individuals have been observed among partridges, ravens, sparrows, and bears. This happens when the course of development is perverted, for what is small is easily spoilt and easily moved, and what is developing is small, the beginning of all such things being on a small scale.

Change is especially found in those animals of which by nature the individual is whole-coloured but the kind many-coloured. This is owing to the water which they drink, for hot waters make the hair white, cold makes it dark, an effect found also in plants. The reason is that the hot have more air than water in them, and the air shining through causes whiteness, as also in froth. As, then, skins which are white by reason of some affection differ from those white by nature, so also in the hair the whiteness due to disease or age differs from that due to nature in that the cause is different; the latter are whitened by the natural heat, the former by the external heat. Whiteness is caused in all things by the vaporous air imprisoned in them. Hence also in all animals not uniformly coloured all the part under the belly is whiter. For practically all white animals are both hotter and better flavoured for the same reason; the concoction of their nutriment makes them well-flavoured, and heat causes the concoction. The same cause holds for those animals which are uniformly-coloured, but either dark or white; heat and cold are the causes of the nature of the skin and hair, each of the parts having its own special heat.

The tongue also varies in the simply coloured as compared with the vari-coloured animals, and again in the simply coloured which differ from one another, as white and dark. The reason is that assigned before, that the skins of the vari-coloured are vari-coloured, and the skins of the white-haired and dark-haired are white and dark in each case. Now we must conceive of the tongue as one of the external parts, not taking into account the fact that it is covered by the mouth but looking on it as we do on the hand or foot; thus since the skin of the vari-coloured animals is not uniformly coloured, this is the cause of the skin on the tongue being also vari-coloured.

Some birds and some wild quadrupeds change their colour according to the seasons of the year. The reason is that, as men change according to their age, so the same thing happens to them according to the season; for this makes a greater difference to them than the change of age.

The more omnivorous animals are more vari-coloured to speak generally, and this is what might be expected; thus bees are more uniformly coloured than hornets and wasps. For if the food is responsible for the change, we should expect varied food to increase the variety in the movements and in the residual matter of the food, from which come into being hairs and feathers and skins.

So much for colours and hairs.

7 · As to the voice, it is deep in some animals, high in others, in others again well-pitched and in due proportion between both extremes. Again, in some it is loud, in others small, and it differs in smoothness and roughness, flexibility and inflexibility. We must inquire then into the causes of each of these distinctions.

We must suppose then that the same cause is responsible for high and deep voices as for the change which they undergo in passing from youth to age. The voice is higher in all other animals when younger, but in cattle that of calves is deeper. We find the same thing also in the male and female sexes; in the other kinds of animals the voice of the female is higher than that of the male (this being especially plain in man, for nature has given this faculty to him in the highest degree because he alone of animals makes use of speech and the voice is the material of speech), but in cattle the opposite obtains, for the voice of cows is deeper than that of bulls.

Now the purpose for which animals have a voice, and what is voice and sound generally, has been stated partly in the treatise on sensation, partly in that on the soul. But since lowness of voice depends on the movement being slow and its highness on its being quick, there is a difficulty in knowing whether it is that which moves or that which is moved that is the cause of the slowness or quickness. For some say that what is much is moved slowly, what is little quickly, and that this is the cause of some animals having a deep and others a high voice. Up to a certain point this is well said (for it seems to be rightly said in a general way that the depth depends on a certain amount of the air put in motion), but not altogether, for if this were true it would not be easy to speak both soft and deep at once, nor again both loud and high. Again, the depth seems to belong to the nobler nature, and in songs the deep note is better than the high-pitched ones, the better lying in superiority, and depth of tone being a sort of superiority. But then depth and height in the voice are different from loudness and softness, and some high-voiced animals are loud-voiced, and in like manner some soft-voiced ones are deep-voiced, and the same applies to the tones lying between these extremes. And by what else can we define these (I mean loudness and softness of voice) except by the large and small amount of the air put in motion? If then height and depth are to be decided in accordance with the distinction postulated, the result will be that the same animals will be deep- and loud-voiced, and the same will be high- and soft-voiced; but this is false.

The reason of the difficulty is that the words 'great' and 'small', 'much' and 'little' are used sometimes absolutely, sometimes relatively to one another. Whether an animal has a great voice depends on the air which is moved being much *absolutely*, whether it has a small voice depends on its being little *absolutely;* but whether they have a deep or high voice depends on their being thus differentiated in relation to one another. For if that which is moved surpasses the strength of that which moves it, what is moved must go slowly; if the opposite, quickly. The strong, then, on account of their strength, sometimes move much air and make the movement slow, sometimes, having complete command over it, make the movement swift. On the same principle the weak either move too much air for their strength and so make the movement slow, or if they make it swift move but little because of their weakness.

These, then, are the reasons of these contrarieties, that neither are all young animals high-voiced nor all deep-voiced, nor are all the older, nor yet are the two sexes thus opposed, and again that not only the sick speak in a high voice but also those in good bodily condition, and, further, that as men verge on old age they become higher-voiced, though this age is opposite to that of youth.

Most young animals, then, and most females set but little air in motion because of their want of power, and are consequently high-voiced, for a little air is carried along quickly, and in the voice what is quick is high. But in calves and cows, in the one case because of their age, in the other because of their female nature, the part by which they set the air in motion is not strong; at the same time they set a great quantity in motion and so are deep-voiced; for that which is borne along slowly is heavy, and much air is borne along slowly. And these animals set much in movement whereas the others set but little, because the vessel through which the breath is first borne has in them a large opening and necessarily sets much air in motion, whereas in the rest the air is better dispensed. As their age advances this part which moves the air gains more strength in each animal, so that they change into the opposite condition, the high-voiced becoming deeper-voiced than they were, and the deep-voiced higher-voiced, which is why bulls have a higher voice than calves and cows. Now the strength of all animals is in their sinews, and so those in the prime of life are stronger, the young being weaker in the joints and sinews; moreover, in the young they are not yet tense, and in those now growing old the tension relaxes; hence both these ages are weak and powerless for movement. And bulls are particularly sinewy, even their hearts, and therefore that part by which they set the air in motion is in a tense state, like a sinewy string stretched tight. (That the heart of bulls is of such a nature is shown by the fact that a bone is actually found in some of them, and bones seek the nature of sinew.)

All animals when castrated change to the female character, and utter a voice like that of the females because the sinewy strength in the principle of the voice is relaxed. This relaxation is just as if one should stretch a string and make it taut by hanging some weight on to it, as women do who weave at the loom, for they stretch the warp by attaching stone weights to it. For in this way are the testes attached to the seminal passages, and these again to the blood-vessel which takes its origin in the heart near the organ which sets the voice in motion. Hence as the seminal passages change towards the age at which they are now able to secrete the semen, this part also changes along with them. As this changes, the voice too changes, more indeed in males, but the same thing happens in females too, only not so plainly, the result being what some call 'bleating' when the voice is uneven. After this it settles into a deep or high voice of the succeeding time of life. If the testes are removed the tension of the passages relaxes, as when the weight is taken off the string or the warp; as this relaxes, the principle which moves the voice is loosened in the same proportion. This, then, is the reason why the voice and the form generally change to the female character in castrated animals; it is because the principle is relaxed upon which depends the tension of the body; not that, as some suppose, the testes are themselves a knot of many principles, but small changes are the causes of great ones, not *per se* but when it happens that a principle changes with them. For the principles, though small in size, are great in potency; this, indeed, is what is meant by a principle, that it is itself the cause of many things without anything else being higher than it.

The heat or cold also of their habitat contributes to make some animals of such a character as to be deep-voiced, and others high-voiced. For hot breath being thick causes depth, cold breath being thin the opposite. This is clear also in pipe-playing, for if the breath of the performer is hotter, that is to say if it is expelled as by a groan, the note is deeper.

The cause of roughness and smoothness in the voice, and of all similar inequality, is that the part or organ through which the voice is conveyed is rough or smooth or generally even or uneven. This is plain when there is any moisture about the trachea or when it is roughened by any affection, for then the voice also becomes uneven.

Flexibility and inflexibility depend on the softness or hardness of the organ, for what is soft can be regulated and assume any form, while what is hard cannot; thus the soft organ can utter a loud or a small note, and accordingly a high or a deep one, since it easily regulates the breath, becoming itself easily great or small. But hardness cannot be regulated.

Let this be enough on all those points concerning the voice which have not been previously discussed in the treatise on sensation and in that on the soul. 788b1

8 · With regard to the teeth it has been stated previously that they do not exist for a single purpose nor for the same purpose in all animals, but in some for nutrition, in others also for fighting and for vocal speech. We must, however, consider it not alien to the discussion of generation to inquire into the reason why the front teeth are formed first and the grinders later, and why the latter are not shed but the former are shed and grow again.

Democritus has spoken of these questions but not well, for he assigns the cause too generally without investigating the facts in all cases. He says that the early teeth are shed because they are formed in animals too early, for it is when animals are practically in their prime that they grow according to nature, and suckling is the cause he assigns for their being found too early. Yet the pig also suckles but does not shed his teeth, and, further, all the saw-toothed animals suckle, but some of them do not shed any teeth except the canines, e.g. lions. This mistake, then, was due to his speaking generally without examining what happens in all cases; but this is what we ought to do, for any one who makes any general statement must speak of all the particular cases.

Now we assume, basing our assumption upon what we see, that nature never fails nor does anything in vain so far as is possible in each case. And it is necessary, if an animal is to obtain food after the time of taking milk is over, that it should have instruments for the treatment of the food. If, then, as Democritus says, this happened about the time of reaching maturity, nature would fail in something possible for her to do. And, besides, the operation of nature would be contrary to nature, for what is done by violence is contrary to nature, and it is by violence that he says the formation of the first teeth is brought about. That this view then is not true is plain from these and other similar considerations.

Now these teeth are developed before the flat teeth, in the first place because their function is earlier (for dividing comes before crushing, and the flat teeth are for crushing, the others for dividing), in the second place because the smaller is naturally developed quicker than the larger, even if both start together, and these teeth are smaller in size than the grinders, because the bone of the jaw is flat in that part but narrow towards the mouth. From the greater part, therefore, must flow more nutriment to form the teeth, and from the narrower part less.

The act of sucking in itself contributes nothing to the formation of the teeth, but the heat of the milk makes them appear more quickly. A proof of this is that even in suckling animals those young which enjoy hotter milk grow their teeth quicker, heat being conducive to growth.

They are shed, after they have been formed, partly because it is better so (for what is sharp is soon blunted, so that a fresh relay is needed for the work, whereas the flat teeth cannot be blunted but are only smoothed in time by wearing down), partly from necessity because, while the roots of the grinders are fixed where the jaw is flat and the bone strong, those of the front teeth are in a thin part, so that they are weak and easily moved. They grow again because they are shed while the bone is still growing and the animal is still young enough to grow teeth. A proof of this is that even the flat teeth grow for a long time, the last of them cutting the gum at about twenty years of age; indeed in some cases the last teeth have been grown in quite old age. This is because there is much nutriment in the broad part of the bones, whereas the front part being thin soon reaches perfection and no residual matter is found in it, the nutriment being consumed in its own growth.

Democritus, however, neglecting the final cause, reduces to necessity all the operations of nature. Now they are necessary, it is true, but yet they are for a final cause and for the sake of what is best in each case. Thus nothing prevents the teeth from being formed and being shed in this way; but it is not on account of these causes but on account of the end; these are causes in the sense of being the moving and efficient instruments and the material. So it is reasonable that nature should perform most of her operations using breath as an instrument, for as some instruments serve many uses in the arts, e.g. the hammer and anvil in the smith's art, so does breath in things formed by nature. But to say that necessity is the cause is much as if we should think that the water has been drawn off from a dropsical patient on account of the lancet alone, not on account of health, for the sake of which the lancet made the incision.

We have thus spoken of teeth, saying why some are shed and grow again, and others not, and generally for what cause they are formed. And we have spoken of the other affections of the parts which are found to occur not for any final end but of necessity and on account of the motive cause.

ON COLOURS**

T. Loveday and E. S. Forster

1 · Simple colours are those which belong to the elements, i.e. to fire, air, 791a1
water, and earth. Air and water in themselves are by nature white, fire (and the sun) yellow, and earth is naturally white. The variety of hues which earth assumes is due to dying, as is shown by the fact that ashes turn white when the moisture that tinged them is burnt out. It is true they do not turn a pure white, but that is because they are tinged by the smoke, which is black. And this is the reason why lye-mixture turns yellow, the water being coloured by hues of flame and black.

Black is the proper colour of elements in process of transmutation. The remaining colours, it may easily be seen, arise from blending by mixture of these.

Darkness is due to privation of light. For we see black under three different conditions. Either the object of vision[1] is naturally black (for black light is always reflected from black objects); or no light at all passes to the eyes from the object (for an invisible object surrounded by a visible patch looks black); and objects always appear black to us when the light reflected from them is rare and scanty. This last condition is the reason why shadows appear black. It also explains the blackness of ruffled water, e.g. of the sea when a ripple passes over it: owing to the roughness of the surface few rays of light fall on the water and the light is dissipated, and so the part which is in shadow appears black. The same principle applies to very dense cloud, and to masses of water and of air which light fails to penetrate; for water and air look black when present in very deep masses, because of the extreme rarity of the rays reflected, the parts of the mass between the illuminated surfaces being in 791b1
darkness and therefore looking black. There are many arguments to prove that darkness is not a colour, but merely privation of light, the best being that darkness, unlike all other objects of vision, is never perceived as having any definite magnitude or any definite shape.

Light is clearly the colour of fire; for it is never found with any other hue than this, and it alone is visible in its own right whilst all other things are rendered visible by it. But there is this point to be considered, that some things, though they are not in their nature fire nor any species of fire, yet seem to produce light. So we cannot say that the colour of fire is identical with light, and yet light is the colour of other things besides fire, but we can say that this colour is to be found in other things

TEXT: C. Prantl, Teubner, Leipzig, 1881

[1] Omitting μή.

besides fire, and yet light is the colour of fire. Anyhow, it is only by aid of light that fire is rendered visible, just as all other objects are made visible by the appearance of their colour.[2]

The colour black occurs when air and water are thoroughly burnt by fire, and this is the reason why burning objects turn black, as e.g. wood and charcoal when the fire is put out, and smoke from clay as the moisture in the clay is all secreted and burnt. This is also why the blackest smoke is given off by fat and greasy substances like oil and pitch and resinous wood, because these objects burn most completely, and the process of combustion is most continuous in them.

Again, things turn black through which water percolates if they first become coated with lichen and then the moisture dries off. The stucco on walls is an
792a1 example of this, and much the same applies to stones under water, which get covered with lichen and turn black when dried.

This then is the list of simple colours.

2 · From these the rest are derived in all their variety of chromatic effects by blending of them and by their presence in varying strengths. The different shades of crimson and violet depend on differences in the strength of their constituents, whilst blending is exemplified by mixture of white with black, which gives grey. So a dusky black mixed with light gives crimson. For observation teaches us that black mixed with sunlight or firelight always turns crimson, and that black objects heated in the fire all change to a crimson colour, as e.g. smoky tongues of flame, or charcoal when subjected to intense heat, are seen to have a crimson colour. But a vivid bright violet is obtained from a blend of feeble sunlight with a thin dusky white. That is why the air sometimes looks purple at sunrise and sunset, for then the air is especially dusky and the impinging rays feeble. So, too, the sea takes a purple hue when the waves rise so that one side of them is in shadow: the rays of the sun strike without force on the slope and so produce a violet colour. The same thing may also be observed in birds' wings, which get a purple colour if extended in a certain way against the light, but if the amount of light falling on them is diminished the result is the dark colour called brown, whilst a great quantity of light blended with primary black gives crimson. Add vividness and lustre, and crimson changes to flame-colour.

For it is after this fashion that we ought to proceed in treating of the blending of colours, starting from an observed colour as our basis and making mixtures with it. (But we must not assign to all colours a similar origin, for there are some colours which, though not simple, bear the same relation to their products that simple colours bear to them, inasmuch as a simple colour has to be mixed with one other
792b1 colour to produce them.) And when the constituents are obscure in the compound product, we must still try to establish our conclusions by reference to observation.[3] For, whether we are considering the blend which gives violet or crimson, or whether we are considering the mixtures of these colours which produce other tints, we must explain their origin on the same kind of principles, even though they look dissimilar.[4] So we must start from a colour previously established, and observe what

[2]Prantl proposes moving this paragraph to follow 792a2.

[3]Reading καὶ τὸ μὴ εὔσημον ἐν τῷ παντὶ δεῖ πρὸς τὸ τεθεωρημένον.

[4]Reading εἰ καὶ μὴ . . . ποιεῖ (and omitting μή in line 2).

happens when it is blent. Thus we find that wine colour results from blending airy rays with pure lustrous black, as may be seen in grapes on the bunch, which grow wine-coloured as they ripen; for, as they blacken, their crimson turns to a violet. After the manner indicated we must treat all differences of colours, getting comparisons by moving coloured objects,[5] keeping our eye on actual phenomena, assimilating different cases of mixture on the strength of the particular known instances in which a given origin and blending produce a certain chromatic effect, and verifying our results. But we must not proceed in this inquiry by blending pigments as painters do, but rather by comparing the rays reflected from the aforesaid known colours, this being the best way of investigating the true nature of colour-blends. Verification from experience and observation of similarities are necessary if we are to arrive at clear conclusions about the origin of different colours, and the chief ground of similarities is the common origin of nearly all colours in blends of different strengths of sunlight and firelight, and of air and water. At the same time we ought to draw comparisons from the blends of other colours with rays of light. Thus charcoal and smoke, and rust, and brimstone, and birds' plumage blent, some with firelight and others with sunlight, produce a great variety of chromatic effects. And we must also observe the results of maturation in plants and fruit, and in hair, feathers, and so on.

3 · We must not omit to consider the several conditions which give rise to the manifold tints and infinite variety of colours. It will be found that variations of tint occur either because colours are possessed by varying and irregular strengths of light and shade (for both light and shade may be present in very different strengths, 793a1
and so whether pure or already mixed with colours they alter the tints of the colours); or because the colours blent vary in fullness and in powers; or because they are blent in different proportions. Thus violet and crimson and white and all colours vary very much both in strength and in intermixture and purity.

Difference of hue may also depend on the brightness and lustre or dimness and dullness of the blend. Lustre is simply continuity and density of light; e.g. we have a glistening gold colour when the yellow colour of sunlight is highly concentrated and therefore lustrous. That explains why pigeons' necks and drops of falling water look lustrous when light is reflected from them.

Again, some objects change their colour and assume a variety of hues when polished by rubbing or other means, like silver, gold, copper, and iron, when they are polished; and some kinds of stones give rise to different colours, like . . .[6] which are black but make white marks. This is because the original composition of all such substances is of small dense and black particles, but in the course of their formation they have been tinged, and all the pores through which the tincture passed have taken its colour, so that finally the whole material appears to be of that colour. But the dust that is rubbed off from them loses this golden or copper colour (or whatever the hue may be), and is quite black, because rubbing breaks up the pores through

[5] Retaining κινήσεως.
[6] The name of a stone has dropped out of the text.

which the tincture passed, and black is the original colour of the substance.[7] The other colour is no longer apparent because the dye is dissipated, and so we see the original natural colour of the material, and this is why these substances all appear black. But when rubbed against a smooth and even surface, as e.g. against a
793b1 touchstone, they lose their blackness and get back their other colour, which comes through where the lines of the tincture in the pores are unbroken and continuous.

In the case of objects burning, dissolving, or melting in the fire, we find that those have the greatest variety which are dark in colour and give off a thin hazy smoke, such as the smoke of brimstone or rusty copper vessels, and those which, like silver, are dense and smooth.

Apart from these cases, variety of hue is characteristic of all dark smooth objects, such as water, clouds, and birds' plumage. For these last, owing to their smoothness and the variety of blends into which the impinging rays of light enter, show various colours, as also does darkness.

We never see a colour in absolute purity: it is always blent, if not with another colour, then with rays of light or with shadows, and so it assumes a tint other than its own. That is why objects assume different tints when seen in shade and in light and sunshine, and according as the rays of light are strong or weak, and the objects themselves slope this way or that, and under other differential conditions. Again, they vary when seen by firelight or moonlight or torchlight, because the colours of those lights differ somewhat. They vary also in consequence of mixture with other colours, for they are coloured by passing through one another. For if light falls on a given object and is coloured by it crimson or herb-green, and then the light reflected from that object falls on another colour, it is again modified by this second colour, and so it gets a new chromatic blend. This happening to it continuously, though imperceptibly, light when it reaches the eye may be a blend of many colours, though the sensation produced is not of a blend but of some colour predominant in the blend. This is why objects under water tend to have the colour of water, and why reflections in mirrors resemble the colour of the mirrors, and we must suppose that the same thing happens in the case of air. Thus all hues represent a threefold
794a1 mixture of light, a translucent medium (e.g. water or air), and underlying colours from which the light is reflected. A translucent white medium, when of a very rare consistency, looks hazy in colour; but if it is dense, like water or glass, or air when thick, a sort of mist covers its surface, because the rays of light are inadequate at every point on it owing to its density, and so we cannot see the interior clearly. Air seen close at hand appears to have no colour, for it is so rare that it yields and gives passage to the denser rays of light, which thus shine through it; but when seen in a deep mass it looks practically dark blue. This again is the result of its rarity, for where light fails the air lets darkness through and looks dark blue. When densified, air is, like water, the whitest of things.

4 · All dyed things take their colour from the dye. Common sources of such coloration are the flowers of plants and their roots, bark, wood, leaves, or fruit, and

[7] Reading δὲ τοιοῦτον εἶναι.

again, earth, foam, and inks. Sometimes coloration is due to animal juices (e.g. the juice of the purple-fish, with which clothes are dyed violet), in other cases to wine, or smoke, or lye mixture, or to sea-water, as happens, for instance, to the hair of marine animals, which is always turned red by the sea. In short, anything that has a colour of its own may transfer that colour to other things, and the process is always this, that colour leaving one object passes with moisture and heat into the pores of another, which on drying takes the hue of the object from which the colour came. This explains why colour so often washes out: the dye runs out of the pores again. Furthermore, steeping during the dyeing produces a great variety of hues and mixtures, and these are also affected by the condition of the material itself, as has been said before in the case of blending. Even black fleeces are used for dyeing, but they do not take so bright a colour as white. The reason is that whilst the pores of the wool are tinged by the dye that enters them, the intervals of solid hair between the pores do not take the colour, and if they are white, then in juxtaposition to the colour they make the dye look brighter, but if they are black, they make it look dark and dull. For the same reason a more vivid brown is obtained on black wool than on white, the brown dye blending with the rays of black and so looking purer. For the intervals between the pores are too small to be separately seen, just as tin is invisible when blent with bronze; and there are other parallel cases.

These then are the reasons for the changes in colour produced by dyeing.

5 · As for hair and feathers and flowers and fruit and all plants, it is abundantly clear that all the changes of colour which they undergo coincide with the process of maturation. But what the origins of colour in the various classes of plants are, and what kinds of changes these colours undergo, and from what materials these changes are derived, and the reasons why they are thus affected, and any other difficulties connected with them—in considering all these questions we must start from the following premisses. In all plants the original colour is herb-green; thus shoots and leaves and fruit begin by taking this colour. This can also be seen in the case of rain-water; when water stands for a considerable time and then dries up, it leaves a herb-green behind it. So it is intelligible why herb-green is the first colour to form in all plants. For all water in process of time first turns yellow-green on blending with the rays of the sun; it then gradually turns black, and this further mixture of black and yellow-green produces herb-green. For, as has already been remarked, moisture becoming stale and drying up of itself turns black. This can be seen, for example, on the stucco of reservoirs; here all the part that is always under water turns black, because the moisture, as it cools, dries up of itself, but the part from which the water has been drawn off, and which is exposed to the sun, becomes herb-green, because yellow mingles with the black. Moreover, with the increasing blackness of the moisture, the herb-green tends to become very deep and of a leek-green hue. This is why the old shoots of all plants are much blacker than the young shoots, which are yellower because the moisture in them has not yet begun to turn black. For, the growth being slow and the moisture remaining in them a long time, owing to the fact that the liquid, as it cools, turns very black, a leek-green is produced by blending with pure black. But the colour of shoots in

which the moisture does not mix with the rays of the sun, remains white, unless it has lasted a long time and dried and turned black at an earlier stage. In all plants, therefore, the parts above the ground are at first of a yellow-green, while the parts under the ground, namely the stalks and the roots, are white. The shoots, too, are white as long as they are underground, but if the earth be removed from round them, they turn herb-green; and all fruit, as has been already said, becomes herb-green at first, because the moisture, which passes through the shoots into it, has a natural tendency to assume this colour and is quickly absorbed to promote the growth of the fruit. But when the fruit ceases to grow because the liquid nourishment which flows into it no longer predominates, but the moisture on the contrary is consumed by the heat—then it is that all fruit becomes ripe; and the moisture already present in it being heated by the sun and the warmth of the atmosphere, each species of fruit takes its colour from its juice, just as dyed material takes the hue of the dye. This is why fruits colour gradually, those parts of them which face the sun and heat being most affected; it is also the reason why all fruits change their colour with the changing seasons. This is evident; for all fruits, as soon as they begin to ripen, change from herb-green to their natural colour. They become white and black and grey and yellow and blackish and dusky and crimson and
795b1 wine-coloured and saffron—in fact, assume practically every variety of colour. Since most hues are the result of the blending of several colours, the hues of plants must certainly also be due to the same blends; for the moisture percolating through the plants washes and carries along with it all the ingredients on which their colours depend. When this moisture is heated up by the sun and the warmth of the atmosphere at the time of the ripening of the fruit, each of the colours forms separately, some quickly and some slowly. The same thing happens in the process of dyeing with purple; when, after breaking up the shell and washing all the moisture from it, they pour it into earthenware vessels and boil it, at first no definite colour is noticeable in the dye, because, as the liquid boils more and more and the colours still remaining in the vessels mix together, each of the hues gradually undergoes a great variety of alterations; for black and white and brown and hazy shades appear, and finally the dye all turns purple, when the colours are sufficiently boiled up together; so as a result of the blending no other colour is separately noticeable. This is just what happens with fruit. In many instances, because the maturing of all the colours does not take place simultaneously, but some colours form earlier and others later, changes from one to another take place, as in the case of grapes and dates. Some of these are crimson at first; but when black colour forms in them, they turn to a wine colour, and in the end they become a dark-bluish hue when the crimson is finally mixed with a large quantity of pure black. For the colours which appear late, when they predominate, change the earlier colours. This is best seen in black fruits; for broadly speaking most of them, as has already been remarked, first change from
796a1 herb-green to a pinkish shade and become reddish, but quickly change again from the reddish hue and become dark blue because of the pure black present in them. The presence of crimson is proved by the fact that the twigs and shoots and leaves of all such plants are crimson, because that colour is present in them in large quantities; while that black fruits partake of both colours is clear from the fact that

their juice is always a wine colour. Now the crimson hues come into existence at an earlier stage in growth than the black. This is clear from the fact that pavement upon which there is any dripping, and, generally speaking, any spot where is a slight flow of water in a shady place, always turns first from herb-green to a crimson colour, and the pavement looks as though blood had lately been shed over all the portion of it on which the herb-green colour has matured; then finally this also becomes very black and of a dark-bluish colour. The same thing happens in the case of fruit. That change in the colour of fruit occurs by the formation of a fresh colour, which ousts the earlier one, can easily be seen from the following examples. The fruit of the pomegranate and the petals of roses are white at first, but in the end, when the juices in them are beginning to be tinged as they mature, they alter their colours and change to violet and crimson hues. Other parts of plants have a number of shades, for example the juice of the poppy and the scum of olive oil; for this is white at first, as is the fruit of the pomegranate, but, after being white, it changes to crimson, and finally mingling with a large quantity of black it becomes a dark-bluish hue. So, too, the petals of the poppy are crimson at their ends, because the process of maturation takes place quickly there, but at their base they are black, because this colour is already predominant at the end; just as it predominates in the 796b1
fruit, which also finally becomes black.

In the case of plants which have only one colour—white, for example, or black or crimson or violet—the fruit always keeps a single kind of colour, when once it has changed from herb-green to another colour. Sometimes the blossoms are of the same colour as the fruit—as, for instance, in the pomegranate, the fruit and blossoms of which are both crimson; but sometimes they are of very dissimilar hues—as, for example, in the bay-tree and the ivy, whose blossoms are always yellow, but their fruit respectively black and crimson. The same is true of the apple-tree; its blossom is white with a tinge of pink, while its fruit is yellow. In the poppy the flower is crimson, but the fruit may be black or white, according to the different time at which the juices present in the plant ripen. The truth of the last statement can be seen from many examples; for, as has been said, some fruits come to differ greatly as they ripen. This is why the odours and flavours of flowers and fruits differ so much. This is still more evident in the actual blossoms. For part of the same petal may be black and part crimson, or, in other cases, part white and part purplish. The best example of all is the iris; for its blossom shows a great variety of hues according to the different states of maturation in its different parts, just as grapes do when they are already ripening. Therefore the extremities of blossoms always ripen most completely, whilst the parts near the base have much less colour; for in some cases the moisture is, as it were, burnt out before the blossom undergoes its proper process of maturation. It is for this reason that the blossoms remain the same in colour, while the fruit changes as it grows riper; for the former, owing to the presence of only a small amount of nutriment, soon mature, while the 797a1
fruit, owing to the presence of a large quantity of moisture, changes as it ripens to all the various hues which are natural to it. This can also be seen, as has already been remarked, in the process of colour-dyeing. When in dyeing purple they put in the colouring matter from the vein of the purple-fish, at first it turns brown and

black and hazy; but when the dye has been boiled sufficiently, a vivid, bright violet appears. So it must be from similar reasons that the blossoms of a plant frequently differ in colour from its fruit, and that some pass to a stage beyond, whilst others never attain to their natural colour, according as they do or do not mature thoroughly. For these reasons, then, blossoms and fruit differ from one another in their colouring. The leaves of most trees turn yellow in the end, because, owing to the failure of nutriment, they become dried up before they change to their natural colour; just as some of the fruits also which fall off are yellow in colour, because here too nutriment fails before they mature. Furthermore, corn and in fact all plants turn yellow in the end. This change of colour is due to the fact that the moisture in them no longer turns black owing to the rapidity with which it dries up. As long as it turns black and blends with the yellow-green, it becomes herb-green, as has already been said; but, since the black is continually becoming weaker, the colour gradually reverts to yellow-green and finally becomes yellow. The leaves of the pear-tree and the arbutus and some other trees become crimson when they mature; but the leaves even of these, if they dry up quickly, turn yellow, because the nutriment fails before maturity is reached. It seems very probable then that the differences of colour in plants are due to the above causes.

6 · The hairs, feathers, and hides, whether of horses, cattle, sheep, human beings, or any other class of animals, grow white, grey, reddish, or black for the
797b1 same reason. They are white when the moisture which contains their proper colouring is dried up in the course of maturation. They are black, on the other hand—as was the case in the other form of life—when, during their growth, the moisture present in the skin settles and becomes stale owing to its abundance, and so turns black; in all such cases skin and hide become black. They are grey, reddish, and yellow, and so on, when they have dried up before the moisture in them has completely turned black. Where the process has been irregular, their colours are correspondingly variegated. So in all cases they correspond in colour to the hide and skin; for when men are reddish in colouring, their hair too is of a pale red; when they are black, it is black; and if white leprosy has broken out over some part of the body, the hair on that portion is also always white, like the marking on dappled animals. Thus all hair and feathering follows the colour of the skin, both regional hair and hair which is spread over the whole body. So, too, with hoofs, claws, beaks, and horns; in black animals they are black, in white animals they are white, and always because the nutriment percolates through the skin to the outer surface. A number of facts prove that this is the true cause. For example, the heads of all young children are at first reddish owing to scanty nutriment; that this is so is clear from the fact that the hair of infants is always weak and thin and short at first; but as they grow older, the hair turns black, when the nutriment which flows into them settles owing to its abundance. So, too, with the pubes and beard; when the hair is just beginning to grow on the pubic region and chin, it also is reddish at first, because the moisture in it, being scanty, quickly dries up, but as the nutriment is carried more and more to those regions the hair turns black. But the hair on the rest of the body remains
798a1 reddish for a considerable time owing to lack of nutriment; for as long as it is

growing, it keeps on turning black like the pubes and the hair of the head. This is clear from the fact that hairs which have any length are generally blacker near the body and yellower towards the ends, because the moisture which reaches these parts of them is very scanty and soon dries up. The feathers, too, of black birds are in all cases darker near the body and lighter at the ends. The same is the case with the parts about the neck and, generally speaking, any part which receives scanty nutriment. This can be illustrated by the fact that before turning grey all hair changes colour and becomes reddish, because the nutriment again fails and dries up quickly; finally it becomes white, because the nutriment in it is completely matured before the moisture turns black. This is most evident in the case of beasts of burden; here the hair always turns white, for in those parts because, owing to the feebleness of the heat, they cannot draw up as much nourishment as the rest of the body, the moisture quickly dries up and turns white. So men tend especially to turn grey in the region of the temples, and generally speaking in any part which is weak and ailing. So, too, white is the colour to which more than any other a change tends to take place in instances of deviation from natural colour. For example, a hare has been known before now to be white—while black hares have also been seen—and similarly white deer and bears have sometimes occurred; similarly white quails, partridges, and swallows. For all these creatures, when weak in their growth, come to maturity too soon owing to lack of nutriment, and so turn white. Similarly some infants at birth have white hair and eyelashes and eyebrows, a circumstance which normally occurs when old age is coming on and is then clearly due to weakness and lack of nutriment. Therefore in most classes of animals the white specimens are weaker than the black; for, owing to lack of nutriment, they mature before their 798b1
growth is complete, and so turn white, just as does fruit when it is unhealthy; for fruit is still more apt to get mature through weakness. But when animals grow white and at the same time are far superior to the rest of their species, as is the case with horses and dogs,[8] the change from their natural colour to white is due to generous nutriment. For in such animals the moisture, not settling long, but being absorbed in the process of growth, does not turn black. Such animals are soft and well covered with flesh, because they are well nourished, and white hairs, therefore, never change colour. This is clear from the fact that black hairs, when the nutriment in them fails and matures too completely, turn reddish before they grow grey, but finally turn white. Yet some people hold that hair always turns black because its nutriment is burnt up by heat, just like blood and all other substances; but they are in error, for some animals are black from birth—dogs, for example, and goats, and oxen, and, generally speaking, those creatures whose skin and hair get nutriment from the very first—but they are less black as they get older. If their supposition were correct this ought not to be the case, but it would necessarily follow that the hair of all animals would turn black at their prime, when heat predominates in them, and that they would be more likely to be grey at first. For in the beginning the heat is always much weaker than at the time when the hair begins to turn white. This is clear in the case of white animals also. Some of them are very white in colour at birth, those,

[8]Putting a comma after κύνες.

namely, which at first have an abundance of nutriment, the moisture in which has not been prematurely dried up; but as they grow older their hair turns yellow, because less nutriment afterwards flows into it. Others are yellow at first and are 799a1 whitest at their prime. Similarly birds change colour when the nutriment in them fails. That this is the case can be seen in the fact that in all these animals it is the parts round the neck, and, generally speaking, any parts which are stinted when the nourishment is scanty, which turn yellow; for it is clear that, just as reddish colour turns black and *vice versa,* so white turns yellow and *vice versa.* This happens also in plants, some of which revert from a later stage in the process of maturation back again to an earlier stage. The best illustration of this is to be found in the pomegranate. At first its seeds are crimson, as are also its leaves, owing to the small amount of nourishment which matures completely; afterwards they turn to a herb-green, because a quantity of nutriment flows into them and the process of maturation is less able to predominate than before; but in the end the nutriment does mature and the colour reverts to crimson.

To sum the matter up, in hair and feathers of every kind, changes always occur either—as has already been remarked—when the nutriment in them fails, or when, on the contrary, it is too abundant. Therefore the age at which the hair is at its 799b1 whitest or blackest varies in different cases; for even ravens' feathers turn yellow in the end, when the nutriment in them fails. But hair is never crimson or violet or green or any other colour of that kind, because all such colours arise only by mixture with the rays of the sun, and further because in all hairs which contain moisture the changes take place beneath the skin, and so they admit of no admixture. This is clear from the fact that no feathers have their distinctive colouring at first, but practically all gaily coloured birds start by being black—the peacock, for example, and the dove and the swallow; it is only later that they assume all their varied colours, the process of maturation taking place outside their bodies in their feathers and wattles. Thus in birds, as in plants, the maturation of the colours takes place outside the body. So, too, the other forms of animal life—aquatic creatures, reptiles, and shell-fish—have all sorts and manners of colouring, because in them too the process of maturation is considerable.

From what has been set forth in this treatise one may best understand the theory of colours.

ON THINGS HEARD**

T. Loveday and E. S. Forster

All sounds, whether articulate or inarticulate, are produced by the meeting of bodies or of the air with bodies, not because the air assumes certain shapes, as some people think, but because it is set in motion in the way in which, in other cases, bodies are moved, whether by contraction or expansion or compression, or again when it clashes together by an impact from the breath or from the strings of musical instruments. For, when the nearest portion of it is struck by the breath which comes into contact with it, the air is at once driven forcibly on, thrusting forward in like manner the adjoining air, so that the sound travels unaltered in quality as far as the disturbance of the air manages to reach. For, though the disturbance originates at a particular point, yet its force is dispersed over an extending area, like breezes which blow from rivers or from the land. Sounds which happen for any reason to have been stifled where they arise, are dim and misty; but, if they are clear, they travel far and fill all the space around them.

We all breathe in the same air, but the breath and the sounds which we emit differ owing to the differences among the vessels involved, through which the breath must travel in its passage from within—namely, the windpipe, the lungs, and the mouth. Now the impact of the breath upon the air and the shapes assumed by the mouth make most difference to the voice. This is clearly the case; for indeed all the differences in the kinds of sounds which are produced proceed from this cause, and we find the same people imitating the noise of horses, of frogs, of the nightingale, of cranes, and of practically every other living creature, by means of the same breath and windpipe, merely by expelling the air from the mouth in different ways. Many birds also imitate by these means the cries of other birds which they hear.

As to the lungs, when they are small and thick and hard, they cannot admit the air nor expel it again in large quantities, nor is the impact of the breath strong and vigorous. For, because they are hard and thick and constricted, they do not admit of dilatation to any great extent, nor again can they force out the breath by contracting after wide distension; just as we ourselves cannot produce any effect with bellows, when they have become hard and cannot easily be dilated and closed. For what gives strength to the impact of the breath is that the lungs after wide distension contract and violently force out the air. This can be illustrated from the

TEXT: C. Prantl, Teubner, Leipzig, 1881

other parts of the body, none of which can strike a blow with any effect at a very close distance. It is impossible with either the leg or the hand to smite the object of your blow with any force or to hurl it far, unless you allow the limb a considerable distance in which to strike the blow. If you fail to do so, the blow is hard owing to the energy exerted, but it cannot force its object far. Under similar circumstances stone-throwing engines cannot shoot far, nor a sling, nor a bow, if it is stiff and will not bend, and the string cannot be drawn back far. But if the lung is large and soft and flexible, it can admit the air and expel it again in large quantities, regulating it at will, thanks to its softness and the ease with which it can contract.

As for the windpipe, when it is long and narrow, it is only with difficulty that the voice is emitted, and considerable force is required owing to the distance that the breath has to travel. This is clear from the fact that creatures which have long necks force out their cries—geese, for example, and cranes and domestic fowls. A better illustration may be taken from the pipe; every one, for instance, finds a difficulty in filling the 'silkworm' pipe, and considerable exertion is required owing to the amount of space to be filled. Furthermore, owing to narrowness of the passage, the breath is compressed within, and on escaping immediately expands and disperses, like streams when they pass through narrow straits; so that the voice is not sustained and does not carry far. Moreover, in such cases the breath must necessarily be hard to regulate and not easily controlled. On the other hand, when the windpipe is of considerable width, the breath can pass out easily, but, whilst travelling within, it becomes dispersed owing to the abundance of space, and the voice becomes hollow and lacks solidity; furthermore, creatures which have wide windpipes cannot differentiate clearly with their breath because the windpipe does not hold firmly together. Creatures in whom the windpipe is irregular and has not the same width throughout must suffer from difficulties of every kind; for their breath must be under irregular control, and must be compressed in one part and dispersed again in another part. If the windpipe is short, it necessitates a quick expulsion of the breath, and the impact on the air is more violent; in such cases the voice is higher owing to the quick passage of the breath.

Not only differences among the vessels make a difference to the voice, but also their condition. When the lungs and the windpipe are full of moisture, the breath is dispersed and does not pass out continuously, because it sticks and becomes thick and moist and difficult to move, as happens in the case of a catarrh and in drunkenness. If the breath be absolutely dry, the voice becomes rather hard and dispersed; for moisture, when it is slight, holds the air together and causes, as it were, a unity in the voice. Such, then, are the differences in the voice caused by variations in the vessels and their conditions.

Now though we localize sounds where they severally originate, yet in every case we actually hear them only when they strike upon the ear; for the air struck by the impact is borne along for a certain distance in a mass, and then gradually becomes dispersed, and we hereby distinguish all sounds as near or distant. This can be illustrated by the fact that if a man takes a pot[1] or a pipe or a trumpet and holds it up to another man's ear and speaks through it, all the sounds seem quite close to the

[1] Retaining κέραμον.

ear, because the air passing along the tube is not dispersed and the sound is kept uniform by the instrument which encloses it. Just as in a picture, if an artist represents two objects in colour, one as though it were at a distance and the other as though it were close at hand, the former object appears to us to be sunk into the background of the picture and the latter to stand out in the foreground, though they are really in the same plane; so, too, in the case of sounds, whether articulate or inarticulate, if one sound is already dissolved before it strikes the ear, whilst another still retains its continuity, though both reach the same spot, the former seems distant from the ear and the latter quite near to it, because the one resembles a sound coming from afar, the other a sound[2] close at hand. 801b1

Voices are distinct in proportion to the accuracy of the sounds uttered; for it is impossible for the voice to be distinct if the sounds are not perfectly articulated, just as the sealings of signet-rings cannot be distinct unless they are accurately impressed. For this reason children cannot speak distinctly, nor drunken persons, nor old people, nor those who naturally lisp, nor, speaking generally, those whose tongues and mouths have any defect of movement. For as in instrumental music the sound produced by the combination of brass instruments and horns is less distinct, so too, in the case of speech, great indistinctness is caused by the escape of breath from the mouth if the sounds are irregularly formed. They not only present themselves indistinctly, but they also impede the carefully articulated sounds, because the movement to which they give rise, and which affects the ear, is irregular. Therefore, when we hear one person speaking, we understand better than when we hear a number of persons saying the same thing at the same time. The same is the case with stringed instruments; and we hear still less well when the oboe and lyre are played at the same time, because the sounds confuse one another. This is particularly evident when they are played in harmony, the result being that the two sounds produced drown one another. The conditions under which sounds become indistinct have now been stated.

Clearness in sound resembles clearness in colour. Those colours which most affect the eye are most clearly seen; in like manner we must suppose that those sounds are most clearly heard which are most able to affect the hearing, when they strike upon it, in other words sounds which are distinct and solid and pure, and have most power of penetration; for indeed it is a general truth of sense-perceptions that the most distinct impressions are produced by the strongest, solidest, and purest stimuli. This is borne out by the fact that all sounds finally become dim as the air which carries them becomes dispersed. The point can also be illustrated from the oboe; the sounds produced by oboes which have sloping reeds in their mouthpieces[3] are softer, but not so clear; for the breath being forced down passes immediately into a wide space and is not continuously and consistently sustained, but becomes dispersed. But when the reeds are closely constructed, the sound produced is harder and clearer, the more one presses them against the lips, because the breath is thus emitted with more violence. Such, then, are the conditions of clearness in the voice. So voices which are called 'grey' are generally considered no worse than those which 802a1

[2]Reading τὴν δὲ τῇ πλησίον.
[3]Reading ζευγῶν.

are called 'white'. For voices which are rather harsh and slightly confused and have not any very marked clearness are the fitting accompaniment of outbreaks of passion and of advancing years, and at the same time, owing to their intensity, they are less under control; for what is produced by violent exertion is not easily regulated, for it is difficult to increase or decrease the strength of the sound at will.

In the case of oboes and other instruments of the same class, the sounds produced are clear when the breath emitted from them is concentrated and intense. For the impacts on the external air must be of this kind, and it is in this way that they will best travel to the ear in a solid mass. Similarly, in the case of odours and light and the various forms of heat, the weaker they are, the less definite is the impression which they convey to the sense-perception, just as juices are weaker when mixed with water or with other juices. For that which provides a perception of itself makes the powers in each case obscure.

In contrast to all other musical instruments the notes produced by horns, if they strike the air in a solid and continuous mass, are indistinct. Therefore the horn ought to be one the nature of whose growth is regular and smooth, and which does not shoot up quickly. For such horns as shoot up quickly must necessarily be too soft and spongy, so that the notes are dispersed and do not pass out in a solid mass, nor do they produce a consistent sound owing to the softness and thinness of the pores. On the other hand, the horn must not be of too slowly growing a kind, nor must it be of a thick, hard consistency and lacking in resonance; for, if the sound in its passage strikes against anything, it is arrested at the point and ceases to advance on its outward course, so that the notes which proceed from such horns are dull and irregular. That the direction taken by sound follows a straight line is clear from the way in which carpenters test beams and large timber in general. For when they strike one end, the sound passes along continuously to the other end unless the wood has some flaw in it; if it has a flaw, the sound travels along up to that point and there ceases and is dispersed. It passes round the knots in the wood and cannot continue in a straight course through them. The point can also be illustrated from what happens in bronze-working when they are filing down the loosely hanging folds of drapery or the wings of statues; the cracks close up, so that the metal gives out a rasping sound and causes a considerable noise; but the sound immediately ceases if you tie a band round the folds; for the vibration continues till it strikes the soft material and is there checked.

802b1 The baking of horns contributes greatly to the excellence of their tone; for, when they are well baked, they produce a sound very like that of pottery, owing to the hardness and the baking; whilst, if they are not sufficiently baked, the sound which they make is too gentle owing to the softness of the horn, and they cannot produce such well-defined notes. Men, therefore, choose the ages of their horns; the horns of old animals are dry and callous and porous, while those of young animals are quite soft and contain a considerable amount of moisture. As we have said, a horn should be dry, of uniform thickness, with straight pores and a smooth surface; for if it be so, the notes which pass through it will be full and smooth and even, and the impacts which they make upon the outer air will have the same qualities. For those strings too are best which are smoothest and most even all along, and show the same workmanship throughout, and in which the joining of the gut is not visible; for then the impacts which they make upon the air are most even.

The reeds of oboes, too, must be solid and smooth and even, so that the breath may pass through smoothly and evenly, without being dispersed. Therefore mouthpieces which have been well steeped and soaked in grease give a pleasant sound, while those which are dry produce less agreeable notes. For the air passes softly and evenly through a moist and smooth instrument. This is clear from the fact that the breath itself, when it contains some moisture, is less likely to strike against the mouthpiece and become dispersed; while dry breath is inclined to catch in the oboe, and the impact which it causes is too hard owing to the force necessary to expel it. Differences, then, in sound arise from the above causes.

Hard voices are those which strike forcibly upon the hearing; for which reason they are particularly unpleasing—those, that is to say, which are difficult to start, but which when once started travel with added force—for any quickly yielding body which comes in the way fails to abide the impact and quickly springs aside. To take an illustration of this; heavy missiles travel along with force, as do streams when they pass through narrow channels, for they acquire very considerable force in the actual straits, because they cannot yield to restraint all in a moment, but are driven violently along. The same thing happens in the case of articulate and inarticulate sounds. For clearly all forceful sounds are hard; as, for instance, those caused by the forcible opening of boxes and turning of hinges, and those made by bronze and iron. For the sound made on the anvil is hard when the iron that is being forged is chilled and has become hard. So, too, is the noise from the file, when they are filing iron 803a1 implements and making teeth in saws. The most violent claps of thunder, too, produce very hard sounds, and those showers which from their violence we call 'tearing' showers.

It is quickness of breathing which makes the voice shrill, force which makes it hard. So it happens that the same individuals have not only sometimes a shriller and at other times a deeper voice, but also at times a harder and at times a softer voice. Yet some people hold that it is owing to the hardness of the windpipe that the voice becomes hard. In this they are wrong; for, though this may be quite a slight contributing cause, the real reason is the force of the impact caused by the breath from the lungs. For as some men's bodies are moist and soft, while those of others are hard and closely knit, so do their lungs show variety. Therefore in some cases the breath which comes forth is soft, in others it is hard and violent; for it is easy to see that the windpipe by itself exercises but little influence. For no windpipe is of the hard consistency of an oboe; yet for all that, by passing the breath through the former and through the latter, some people produce soft and others hard tones on the oboe. This is clear from the direct perception; for, if by using greater force one increases the strength of the breathing, the voice immediately becomes harder as a result of the force applied, even if it be a somewhat soft voice. So, too, in the case of the trumpet; when they are revelling, men relax the pressure of breath in the trumpet in order to make the sound as soft as possible. The point can also be illustrated from musical instruments; as has been stated, the sounds produced by tightly stretched strings are hard, as are the notes of horns which have been well baked. If one touches the strings violently instead of softly with the hand, they necessarily respond with more violent sounds. The notes produced by less tightly stretched strings and unbaked horns are softer, as are those produced by the longer musical instruments; for the impacts upon the air are both slower and softer owing to the distance that the sound has to travel, whereas in the shorter instruments they are harder owing to the tension of the strings. That this is so is shown by the fact that the sounds which the instrument itself gives forth are harder when one does not strike the string in the middle, because there is more strain upon the parts of the strings near the crossbar and near the pegs. The notes produced by instruments made of fennel are softer; for the sounds striking on a soft material do not rebound 803b1 with such violence.

Voices are rough when the impact of all the breath upon the air is not single but divided and dispersed. For each portion of the air striking separately upon the hearing—as if each were moved by a different impact—the sense-impression is dispersed, so that one vocal utterance fails to produce any sound, while another strikes with great violence upon the ear, and the contact with the hearing is not evenly sustained; just as when a rough object touches the skin. This can be best illustrated from the file; for the air is set in motion simultaneously at a number of separate minute points, and so the sounds passing from these points to strike the ear seem rough, and especially so when the file is scraped against a hard substance. One may compare the sense of touch; hard, rough objects produce perception more forcefully. The matter can also be illustrated from the pouring of liquids, for the sound made by olive-oil is less noticeable than that made by any other liquid, owing to the continuity of its parts.

Voices are thin, when the breath that is emitted is small in quantity. Children's voices, therefore, are thin, and those of women and eunuchs, and in like manner those of persons who are enfeebled by disease or over-exertion or want of nourishment; for owing to their weakness they cannot expel the breath in large quantities. The same thing may be seen in the case of stringed instruments; the sounds produced from thin strings are thin and narrow and fine as hairs, because the impacts upon the air have only a narrow surface of origin. For the sounds that are produced and strike on the ear are of the same quality as the source of movement which gives rise to the impacts; for example, they are rare or dense, soft or hard, thin or full. For one portion of the air striking upon another portion of the air preserves the quality of the sound, as is the case also in respect of shrillness and depth; for the quick impulsions of the air caused by the impact, quickly succeeding one another, preserve the quality of the voice, as it was in its first origin. Now the impacts upon the air from strings are many and are distinct from one another, but because, owing to the shortness of the intermittence, the ear cannot appreciate the intervals, the sound appears to us to be united and continuous. The same thing is the case with colours; for separate coloured objects appear to join, when they are moved 804a1 rapidly. The same thing happens, too, when notes form a concord; for owing to the fact that the notes overlap and include one another and cease at the same moment, the intermediate sounds escape our notice. For in all concords more frequent impacts upon the air are caused by the shriller note, owing to the quickness of its movement; and the last note strikes upon our hearing simultaneously with an earlier sound produced by the slower impact. Thus, because, as has been said, the ear cannot perceive all the intermediate sounds, we seem to hear both notes together and continuously.

Thick sounds, on the contrary, are produced when the breath is emitted in great quantity and all together. Therefore the voices of men are inclined to be thick, and the notes of the so-called 'perfect' oboes, especially when the latter are well filled with air. This is clear from the fact that if you compress the mouthpiece the sound tends to become shrill and thin, as also if one draws the 'speaker' downwards; but if one stops up the exits, the volume of the sound becomes far greater owing to the amount of breath, like the notes produced from thicker strings. The sounds uttered by those whose voices are breaking and persons suffering from sore-throats, and after vomiting, are thick owing to the roughness of the windpipe and the fact that the voice does not escape, but striking upon it is pent up and acquires volume; and above all, owing to the moist condition of the body.

Piping voices are those which are thin and concentrated, such as those of grasshoppers and locusts and the nightingale's song, and, generally speaking, cries which are thin, and are not followed by a second and different sound. For this piping quality does not depend on volume of sound nor on the tones being without tension and deep, nor yet upon the close sequence of the sounds, but rather upon shrillness and thinness and accuracy. Therefore it is the instruments which are lightly constructed and tightly stretched, and those which have no horn-work about them, that produce piping notes. The sound of running water, and generally speaking, any sound which, whatever its cause keeps up an unbroken continuity, preserve the accuracy of their tone.

Cracked voices which suddenly give way are those which travel along in a solid mass for a certain distance and then become dispersed. The best illustration may be taken from an earthenware vessel; every such vessel when broken as the result of a blow gives forth a cracked sound, for the course of the sound is broken at the point at which the blow was struck, so that the sounds which it gives forth no longer form a solid mass. The same thing happens in the case of broken horns and badly strung strings; in all such cases the sound travels in a solid mass up to a certain point and is then dispersed, wherever the medium which supports it is not continuous, so that the 804b1
impact upon the air is not single but dispersed, and the sound produced seems cracked. Cracked voices closely resemble harsh voices, except that in the latter case the sounds are themselves dispersed into small portions, while cracked voices, for the most part, form a solid mass at first and afterwards become split up into a number of parts.

Aspirated sounds are formed when we emit the breath from within immediately together with the sounds; smooth sounds, on the contrary, are those which are formed without the emission of the breath.

Voices become broken when they have no longer strength enough to expel the air with an impact, but the region about the lungs collapses after distension. For just as the legs and shoulders eventually collapse when they are in a strained position, so too the region about the lungs. The breath comes forth lightly, because the impact which it produces is not forcible enough; at the same time, owing to the fact that the windpipe has become exceedingly rough, the breath cannot pass out in a solid mass, but is dispersed, and so the sounds which it produces are broken. Some people hold that it is owing to the adhesive condition of the lungs that the breath cannot pass out and abroad; but they are wrong, for what really happens is that they make a sound but cannot be heard, because the impact upon the air does not take place with sufficient energy, but they only make a sound such as the breath would make when forced merely from the throat.

When people stammer, it is due not to an affection of the veins or windpipe, but to the movement of the tongue; for they find a difficulty in changing the position of the tongue when they have to utter a second sound. They therefore keep on repeating the same word, for they cannot utter the next word; but the movements of articulation continue and the lungs go on working with an impetus in the same direction as before, owing to the quantity and force of the breath. For just as when one is running fast it is difficult to divert the whole body from its impetus in one direction to some other movement, so likewise is it with the individual parts of the body. So people who stammer are often unable to say the next word, but can easily say the next but one, when they make a fresh start to the movement. This is clear from the fact that people often stammer when angry, because then they force out their breath.

PHYSIOGNOMONICS**

T. Loveday and E. S. Forster

1 · Mental character is not independent of and unaffected by bodily 805a1 processes, but is conditioned by the state of the body; this is well exemplified by drunkenness and sickness, where altered bodily conditions produce obvious mental modifications. And contrariwise the body is evidently influenced by the affections of the soul—by the emotions of love and fear, and by states of pleasure and pain. But still better instances of the fundamental connexion of body and soul and their very extensive interaction may be found in the normal products of nature. There never was an animal with the form of one kind and the mental character of another: the soul and body appropriate to the same kind always go together, and this shows that a specific body involves a specific mental character. Moreover, experts on the animals are always able to judge of character by bodily form: it is thus that a horseman chooses his horse or a sportsman his dogs. Now, supposing all this to be true, physiognomy must be practicable.

Three methods have been essayed in the past, each having had its special adherents.

The first method took as the basis for physiognomic inferences the various genera of animals, positing for each genus a peculiar animal form, and a peculiar mental character appropriate to such a body, and then assuming that if a man resembles such and such a genus in body he will resemble it also in soul.[1]

Those who adopted the second method proceeded in the same way, except that they did not draw their inferences from all kinds of animals but confined themselves to human beings: they distinguished various races of men (e.g. Egyptian, Thracian, Scythian) by differences of appearance and of character, and drew their signs of character from these races.

The third method took as its basis the characteristic facial expressions which are observed to accompany different conditions of mind, such as anger, fear, erotic excitement, and all the other passions.

All these methods are possible, and others as well: the selection of signs may be made in diverse ways. The last mentioned method by itself, however, is defective in 805b1 more than one respect. For one thing, the same facial expression may belong to

TEXT: R. Förster, *Scriptores Physiognomonici*, Teubner, Leipzig, 1893

[1]Reading *διάνοιαν οἵα ἕπεται τῷ τοιούτῳ σώματι, εἶτα τὸν ὅμοιον τούτῳ τὸ σῶμα ἔχοντα.*

different characters: the brave and the impudent, for example, look alike, though their characters are far asunder. Besides, a man may at times wear an expression which is not normally his: for instance, a morose person will now and again spend an enjoyable day and assume a cheerful countenance, whilst a naturally cheerful man, if he be distressed, will change his expression accordingly. And, thirdly, the number of inferences that can be drawn from facial expression alone is small.

As to arguments from beasts, the selection of signs is made on wrong principles. Suppose you have passed in review one by one the forms of all the different kinds of animals, you still have no right to assert that a man who resembles a given kind in body will resemble it in soul also. In the first place, speaking broadly, you will never find this complete likeness, but only a resemblance. Moreover, very few signs are peculiar to individual genera; most of them are common to more than one kind, and of what use is resemblance in a common attribute? A man will resemble a lion, let us say, neither more nor less than a deer. (For we have a right to suppose that common signs indicate common mental characters and peculiar signs peculiar characters.) Thus the physiognomist will not get any clear evidence from common signs. But is he any better off if he takes every genus by itself and selects signs that are peculiar to each? Surely not, for he cannot tell what they are signs of. They ought to be signs of peculiar characteristics, but we have no right to assume that there are any *mental* characteristics peculiar to the different kinds of animals that we examine in physiognomy. Courage is not confined to the lion, but is found in many other creatures; nor timidity to the hare, but it shares this quality with numberless other creatures. Thus it is equally fruitless to select the common and the peculiar features, and we must abandon the attempt to proceed by an examination of every kind of animal singly. Rather, we ought to select our signs from all animals that have some mental affection in common. For instance, when investigating the external marks of courage, we ought to collect all brave animals, and then to inquire what sort of affections are natural to all of them but absent in all other animals. For
806a1 if we were to select this or that as the signs of courage in the animals chosen in such a way as not to exclude the possibility of the presence in all these animals of some other mental affection, we should not be able to tell whether our selected marks were really signs of courage or of this other character. The animals from which we choose our signs must be as numerous as possible, and they must not have any mental affection in common except that one of which we are investigating the signs.

Permanent bodily signs will indicate permanent mental qualities, but what about those that come and go? How can they be true signs if the mental character does not also come and go? No doubt if you took a transitory sign to be permanent, it might be true once in a way, but still it would be worthless because it would not be a constant concomitant of the affection.

Then again there are affections of soul whose occurrence produces no change in the bodily marks on which the physiognomist relies, and they will not provide his art with recognizable signs. Thus as regards opinions or scientific knowledge, you cannot recognize a doctor or a musician, for the fact of having acquired a piece of knowledge will not have produced any alteration in the bodily signs on which physiognomy relies.

2 · We must now determine the special province of physiognomy (for the range of its application is limited), and the sources from which its various kinds of signs are drawn, and then we may proceed to a detailed exposition of the more convincing among its conclusions.

Physiognomy has for its province, as the name implies, all natural affections of mental content, and also such acquired affections as on their occurrence modify the external signs which physiognomists interpret. I will explain later what kinds of acquired characters are meant, but now I will give a list—a complete list—of the sources from which physiognomic signs are drawn. They are these: movements, gestures of the body, colour, characteristic facial expression, the growth of the hair, the smoothness of the skin, the voice, condition of the flesh, the parts of the body, and the build of the body as a whole. Such is the list that physiognomists always give of the sources in which they find their signs. Were this list plain or not obscure, what I have said would suffice; but, as things are, it may be worth while to give a more detailed description of the more convincing of the inferences that they draw from their material, and to state what their various signs are and on what they are supposed to be founded, so far as I have not already done so.

A brilliant *complexion* indicates a hot sanguine temper, whilst a pale pink complexion signifies naturally good parts, when it occurs on a smooth skin.

Soft *hair* indicates cowardice, and coarse hair courage. This inference is based on observation of the whole animal kingdom. The most timid of animals are deer, hares, and sheep, and they have the softest coats; whilst the lion and wild-boar are bravest and have the coarsest coats. Precisely the same holds good of birds, for it is the rule that birds with coarse plumage are brave and those with soft plumage timid, particular instances being the cock and the quail. And again, among the different races of mankind the same combination of qualities may be observed, the inhabitants of the north being brave and coarse-haired, whilst southern peoples are cowardly and have soft hair. A thick growth of hair about the belly signifies loquacity, on the evidence of the whole tribe of birds, for the one is a bodily and the other a mental property peculiar to birds.

When the *flesh* is hard and constitutionally firm, it indicates dullness of sense; when smooth, it indicates naturally good parts combined with instability of character, except when smooth flesh goes with a strong frame and powerful extremities.

Lethargic *movements* are a sign of a soft character, rapid movements of a fervid temper.

As to the *voice*,[2] when deep and full it is a sign of courage; when high-pitched and languid, of cowardice.

Gesture and the varieties of *facial expression* are interpreted by their affinity

[2]Förster thinks that there is a lacuna in the text here.

to different emotions: if, for instance, when disagreeably affected, a man takes on the look which normally characterizes an angry person, irascibility is signified.[3]

Males are bigger and stronger than females of the same kind, and their extremities are stronger and sleeker and firmer and capable of more perfect performance of all functions. But inferences drawn from the parts of the body are less secure than those based on facial expression of character and movements and
807a1 gesture. In general it is silly to rely on a single sign: you will have more reason for confidence in your conclusions when you find several signs all pointing one way.

Here I may mention a possible method of physiognomy which has never yet been tried. Suppose, e.g., that irascibility and morose sulkiness necessarily involve an envious disposition, and that the physiognomist could, without any bodily signs of the last character, deduce its presence from the presence of the other characters, we should then have a method peculiarly appropriate to masters of philosophy, since it is, we suppose, the peculiar mark of philosophy to be able to tell that, when certain premisses are given, something necessarily follows.[4] But this method which considers the interrelations of mental affections and that which proceeds by observation of animals sometimes arrive at contrary conclusions.[5] Take the voice, for example. By the former method you might feel bound to connect a shrill voice with a fierce temper, because in vexation and anger one's voice tends to become loud and shrill, whilst placid people speak in tones at once languid and deep. But as against this, if you observe beasts, you find that a deep voice goes with courage and a shrill voice with timidity, as witness on the one hand the roar of a lion and bull, the hound's bay, and the deep-noted crow of high-spirited cocks, and on the other, the high-pitched tones of deer and hares. Yet perhaps even in these cases it is better not to connect courage and cowardice with the pitch of the voice, but rather with its intensity, so that[6] it is strength of voice that marks the brave and a languid and feeble voice the coward. It is safest, however, to refrain from all positive assertion when you find that your signs are inconsistent and contrary to one another in detail, unless they belong to classes, some of which you have determined to be more trustworthy than others. Above all it is best to base your arguments upon assertions about species and not about entire genera, for the species more nearly resembles what we are concerned with, for in physiognomy we try to infer from bodily signs the character of this or that particular person, and not the characters of the whole human race.

3 · Signs of *Courage* are—coarse hair; an upright carriage of the body; size and strength of bones, sides and extremities; the belly broad and flat; shoulder-blades broad and set well apart, neither too closely nor too loosely knit; a sturdy neck, not very fleshy; a chest well covered with flesh and broad; flat hips; the

[3] Reading *ὅταν γὰρ πάσχῃ τι, εἰ τοιοῦτόν τι γίνεται οἷον ἔχει ὅταν τις ὀργίζηται, ὀργίλου τὸ σημεῖον. τοῦ δ' αὐτοῦ γένους.*

[4] Reading *τὸ γὰρ δύνασθαι ἰδεῖν τινων ὄντων ἀναγκαῖον τοῦτ' εἶναι.*

[5] Reading *ἔστι δ' ὅτε ἐναντιοῦται τῷ κατὰ τὰ πάθη φυσιογνωμονεῖν τὸ κατὰ τὰ ζῷα.*

[6] Förster marks a lacuna here.

807b1 thickness of the calf low down the leg; gleaming eyes, neither wide and staring nor yet mere slits, and not glistening; the body of a brilliant hue; a forehead straight and lean, not large, and neither quite smooth nor yet a mass of wrinkles. Signs of *Cowardice* are—a small growth of soft hair; the figure stooping and lacking in quickness; the thickness of the calf high up the leg; a sallow complexion; weak blinking eyes; weak extremities; little legs,[7] and hands long and delicate; loins small and weak; a rigid gesture of the body; with undecided, deprecating, scared movements, and a shifty downcast look.

Good natural parts are indicated by rather moist and tender flesh, not exactly firm nor yet extremely fat; by leanness of the shoulders, neck, face, and neighbouring regions; by shoulder-blades closely knit and the parts below slack; by supple sides; a somewhat gaunt back; a clear pinkish hue over the body; a thin skin; a small growth of hair, neither very coarse nor very black; and moist, gleaming eyes. *Dullness of sense* is indicated when the region of the neck and the legs are fleshy and stiffly fitted and knitted; the hip-joint round; the shoulder-blades high-set; the forehead big, round, and fleshy; the eyes pale and vacant; the legs thick and fleshy and round at the ankles; the jaws big and fleshy; loins fleshy; legs long; neck thick-set; the face fleshy and rather long. The manner of movement, gesture, and facial expression of the dull man, you may take it, are analogous to his character.

Impudence is signified by small, bright, wide-open eyes, with heavy blood-shot lids slightly bulging;[8] high shoulder-blades; a carriage of the body not erect, but crouched slightly forwards; quickness of movement; a reddish hue over the body; with a sanguine complexion, a round face, and high chest. Signs of *Propriety* are—a slow gait; a slow way of speaking with a breath-like and weak voice; small eyes, black but not lustrous, not open and staring, nor yet mere slits; with a slow, blinking movement of the lids—for rapid blinking signifies either cowardice or a hot 808a1 temperament.

Good Spirits are indicated by a good-sized forehead, fleshy and smooth; the region of the eyes rather low; a rather drowsy-looking countenance, neither keen nor reflective. The gait, we may suppose, will be slow and languid, the gesture and facial expression those of a good but not a quick man. Signs of *Low Spirits* are—lean and wrinkled brows; drooping eyes (but you should notice that drooping eyes may signify softness and effeminacy as well as dejection and low spirits); a meek bearing and weary gait.

The *Effeminate* is drooping-eyed and knock-kneed; his head hangs on his right shoulder; his hands are carried upturned and flabby; and as he walks he either wags his loins or else holds them rigid by an effort; and he casts a furtive gaze around, for all the world like Dionysius the Sophist.

Surliness is indicated by a snarling grin; a black complexion and withered skin; a gaunt, wrinkled face and the neighbouring regions furrowed with lines; and by straight black hair.

Men of *Fierce Temper* bear themselves erect, are broad about the ribs and

[7] Reading *ἀσθενῆ, καὶ μικρὰ σκέλη.*
[8] Reading *μικρὸν ἔγκυρτα.*

move with an easy gait; their bodies are of a reddish hue, their shoulder-blades set well apart, large and broad; there extremities large and powerful; they are smooth about the chest and groin; they have great beards, and the hair of the head starts low down with a vigorous growth.

Those of a *Gentle* disposition are robust-looking, well covered with plenty of moist flesh; well-sized men and well-proportioned; carrying themselves with head thrown back; and their hair starts rather higher up on the head than is usual.

The *Sly* man is fat about the face, with wrinkles round his eyes, and he wears a drowsy expression.

The *Small-Minded* have small limbs and small, delicate, lean bodies, small eyes and small faces, just like a Corinthian or Leucadian.

Men addicted to *Gaming* have short arms, like weasels, and are dancers.

Abusive men have the upper lip updrawn; they tend to lean forwards, and their hue is reddish.

The *Compassionate* are delicate, pale, and lustrous-eyed: the top of their noses is furrowed with lines, and they are always weeping. Such men are fond of women and beget female children, and in character they are erotic and mindful of the past, with good natural parts and a fervid temper. The signs of these qualities have
808b1 already been mentioned. Compassion goes with wisdom, with cowardice, and with propriety, hardness of heart with stupidity and effrontery.

Gluttony is indicated when the distance from navel to chest is greater than that from chest to neck.

Lasciviousness is indicated by a pale complexion, a heavy growth of straight, thick, black hair over the body, a heavy growth of straight hair on the temples, and small, lustrous, lewd eyes.

In the *Somnolent* the upper parts are disproportionately large: such men are vulture-like[9] and hot, and their flesh is firm.

Loquacity is indicated by disproportionate size of the upper parts, with a round delicate build, and a thick growth of hair about the belly.

A *Good Memory* is signified when the upper parts are disproportionately small, and are delicate and tolerably well covered with flesh.

4 · Soul and body, as it seems to me, are affected sympathetically by one another: on the one hand, an alteration of the state of the soul produces an alteration in the form of the body, and contrariwise an alteration in bodily form produces an alteration in the state of soul. Grief and joy, to take an instance, are states of the soul, and every one knows that grief involves a gloomy and joy a cheerful countenance. Now if it were the case that the external expression persisted after the soul had got rid of these emotions, we might still say that soul and body are in sympathy, but their sympathetic changes would not be entirely concomitant. As a matter of fact, however, it is obvious that every modification of the one involves a modification of the other. The best instance of this is to be found in manic insanity. Mania, it is generally allowed, is a condition of the soul, yet doctors cure it partly by administering purgative drugs to the body, partly by prescribing, besides these,

[9]Retaining γυπώδεις.

certain courses of diet. Thus the result of proper treatment of the body is that they succeed, and that too simultaneously, not only in altering the physical condition, but also in curing the soul of mania; and the fact that the changes are simultaneous proves that the sympathetic modifications of body and soul are thoroughly concomitant.

It is equally indisputable that differences in the soul's capacities are represented by corresponding physical traits, so that all the resemblances in animals are indicative of some identity.

Again, if we consider the behaviour of animals, we find that some affections of the soul are peculiar to particular genera, whilst others are common to several, and that the peculiar activities are accompanied by peculiar, the common by common, physical traits. Examples of common characters are insolence, which is found in all animals with bushy tails, and violent sexual excitability, which is found alike in asses and in pigs: whilst on the other hand railing is a character peculiar to dogs, and insensibility to pain is peculiar to the ass. I have already explained how common and peculiar characters are to be distinguished.

At the same time it is only by long and wide experience that one can hope for oneself to attain detailed and expert understanding of these matters. For not only are visible characteristics of the body to be referred for explanation, as we are told, to analogies drawn partly from animals, partly from modes of action, but there are other external traits which depend on the varying proportions of bodily heat and cold; and to add to the difficulty, some of these traits are very much alike and have not got distinctive names, as is the case e.g. with the paleness that results from terror and the paleness due to fatigue—for these have the same name and differ only slightly from one another. Now when the difference is so slight, it can hardly be discerned except by those whom practice has taught to appreciate the congruity of different shades of expression with different conditions of mind, and so the argument from congruity leads to the quickest and soundest conclusions, and enables us to distinguish minute differences. It is a method generally useful, and particularly in the selection of physiognomic signs, for the signs selected must be congruous with what they stand for.

Deduction also should be used in the selection of signs, whenever possible. In the deductive procedure we attach to our data known attributes of them. For instance, if we have it given that a man is an impudent and niggling, we can add that he will be a thief and a miser, the one as a consequence of his effrontery, the other as a consequence of his niggardliness. In all such cases we ought to include the deductive method in our procedure.

5 · I will now first attempt to make a division of animals by the marks in which they are bound to differ if they are respectively brave or timorous, upright or dishonest. We have to divide the whole animal kingdom for this purpose into two physical types, male and female, and to show what mental attributes are congruous with each of these types. In all beasts that we try to breed the female is tamer and gentler in disposition than the male, less powerful, more easily reared and more manageable. One may conclude from this that the female has a less spirited temper,

and I think we find a parallel to this in ourselves, for when we are mastered by a fit of temper we become more obstinate and totally intractable; we grow headstrong and violent and do whatever our temper impels us to do. Further, the female is, in my opinion, more mischievous than the male, and (though feebler) more reckless.
809b1 Every one can see that this is so in women and in domesticated animals, and according to the unanimous evidence of herdsmen and hunters it is no less true of the beasts of the field. Moreover, it is beyond dispute that in every genus the head of the female is smaller than that of the male, her visage narrower, her neck thinner, her chest weaker, her sides of smaller build, and that, whilst her hips and thighs are fuller, she inclines to be knock-kneed, the lower parts of her legs are less stout, and her feet more delicately made: in short, the build of her body is more pleasing to the eye and softer rather than imposing, and she is in comparison feeble and tender, and of moister tissue. The male is the opposite of all this:[10] his is the braver and more upright nature, whilst the female is the more timid and less upright.

This being so, the lion manifestly exhibits the male type in its most perfect form. He has a good-sized mouth: his visage is square and not too bony, the upper jaw level with the lower and not protruding: his nose you would call, if anything, rather thick: his gleaming eyes are deep-set, and neither absolutely round nor unduly long, and of moderate size:[11] his brow is of the right size, his forehead square and slightly hollowed from the centre, and over its lower part towards the eyebrows and nose, there hangs a sort of cloud, and from the top of his forehead down to his nose there runs a ridge of hairs sloping outwards: his head is of moderate size: his neck of due length and broad in proportion with a tawny mane upon it, which is neither stiff and bristly nor yet too closely curled. About the clavicles he is supple and not too tightly articulated: his shoulders are stalwart, his chest powerful, his trunk broad, with sides and back to match: there is no superfluity of flesh on his haunches or thighs: his legs are powerful and sinewy, his gait vigorous, his whole frame well-knit and sinewy and neither too stiff nor too soft: he moves slowly with a large stride, rolling his shoulders as he goes. Such is his bodily appearance, and in soul he is generous and liberal, proud and ambitious, yet gentle and just and affectionate to his comrades.

The leopard, on the other hand, of all animals accounted brave, approximates more closely to the feminine type, save in its legs, which it uses to perform any feat
810a1 of strength. For its face is small, its mouth large, its eyes small and white, set in a hollow, but rather flat in themselves: its forehead is too long and tends to be curved rather than flat near the ears: its neck too long and thin: its chest narrow and its back long: haunches and thighs fleshy: flanks and abdomen rather flat: its colour spotted: and its whole body ill-articulated and ill-proportioned. Such is its bodily aspect, and in soul it is mean and thievish, and in a word, a beast of low cunning.

I have now described the more notable examples of the male and the female types of body to be found among animals accounted brave, and the characterization of the remainder will present no difficulty. I will next proceed to explain in a

[10] Förster marks a lacuna here.
[11] Reading μετρίους.

chapter on selection of signs what marks derived from animals the student of physiognomics should take into consideration.

6 · The selection of signs with regard to men is as follows:

A large and shapely *foot*, well-articulated and sinewy, is held to signify a strong character. For evidence we are referred to the male sex in general. A small, narrow, ill-articulated foot, pretty but weak, signifies a soft character, as in the female sex. Curved toes are a sign of impudence, and so are curved nails, on the evidence of birds with curved claws, whilst toes that are not properly divided indicate timidity, as in web-footed water-birds.

Ankles sinewy and well-articulated mark a strong character, on the evidence of the male sex; fleshy and ill-articulated ankles, a soft character, on the evidence of the female sex.

When the *lower leg* is at once well-articulated and sinewy and stalwart, it signifies a strong character, as in the male sex: when it is thin and sinewy it signifies salaciousness, as in birds. When it is full and almost bursting, it signifies by congruity blatant effrontery.

Knock-knees are a sign of the effeminate, by congruity.

Thighs bony and sinewy indicate a strong character, as in the male sex: but when bony and full, a soft character, as in females.

Buttocks pointed and bony are a mark of a strong character, fat fleshy buttocks of a soft character, whilst lean buttocks which look as if they had been rubbed bare, are indicative of a mischievous disposition, as in apes.

A narrow *waist* marks the hunter, as in the lion and the dog; and you will find that the best hunting dogs also are narrow in the waist.

A loose build round about the *belly* indicates strength of character, as in the male sex, whilst the opposite is by congruity indicative of a soft character.

A well-sized and sturdy *back* marks strength, and a narrow feeble back softness of character, as in males and females respectively.

Strong *sides* indicate strength and weak sides softness, as in males and females respectively, whilst swollen inflated sides signify aimless loquacity, as in frogs. When the distance from navel to the lower end of the breastbone exceeds that from the latter to the neck, it is a mark of gluttony and of dullness of sense, of gluttony because there is so large a receptacle of food, and of dull sense because the seat of the senses is correspondingly confined and compressed by the receptacle of food, so that the senses have become stupefied by repletion of the stomach rather than, as is usual, by inanition.

A large well-articulated *chest* signifies strength of character, as in males.

When the *upper part of the back* is large and well covered with flesh and well-knit, the character is strong, as in males: when it is feeble and gaunt and ill-knit, the character is soft, as in females. When it is very much bent and the shoulders fall in upon the chest, it is argued by congruity to signify a mischievous disposition, since the front parts of the body, which ought to stand clear to view, become invisible. When it is curved backwards, it signifies vanity and lack of intelligence, as in the horse. So it must not be either convex or concave; and something intermediate between these extremes, therefore, should be looked for as marking a man of good natural parts.

When the *shoulders* and the back of the neck are well-articulated, they signify a strong character, whilst weak and ill-articulated shoulders signify a soft character, the reference being to the sexes, as I explained when speaking of feet and thighs.
811a1 Supple shoulders signify liberality of soul, the argument being based on the external appearance, with which liberality seems to be congruous. On the other hand, stiff, clumsy shoulders indicate an illiberal disposition, also by congruity.

Suppleness of the *clavicles* signifies quickness of perception, for when the collar-bone is supple, stimulation of the senses is rendered easy. Contrariwise, a stiff collar-bone indicates dullness of sense, because then it is difficult to apprehend sense-stimuli.

A thick *neck* indicates a strong character, as in males: a thin neck, weakness, as in females: a neck thick and full, fierce temper, as in bulls: a well-sized neck, not too thick, a proud soul, as in lions: a long, thin neck, cowardice, as in deer: an unduly short neck, a treacherous disposition, as in wolves.

Lips thin and pendulous at their points of junction, such that part of the upper lip overhangs the lower at the corners, signify pride of soul. The reference generally given is to the lion, but you may see the same thing as well in large and powerful breeds of dogs. Lips thin and hard with a prominence about the eye-teeth[12] are a sign of base breeding, on the evidence of swine. Thick lips, with the upper overhanging the lower, mean folly, as in the ass and the ape. Projecting upper lip and gums mark the abusive, on the evidence of dogs.

A *nose* thick at the tip means laziness, as witness cattle: but if thick from the tip, it means dullness of sense, as in swine; if the tip is pointed, irascibility, as in dogs; whilst a round, blunt tip indicates pride, as in lions. Men with a nose thin at the tip have the characteristics of birds. When such a nose curves slightly right away from the forehead, it indicates impudence, as in ravens: but when it is strongly aquiline and demarcated from the forehead by a well-defined articulation, it indicates a proud soul, as in the eagle; and when it is hollow, with the part next the forehead rounded and the curve rising upwards, it signifies lasciviousness, as in
811b1 cocks. A snub nose means lasciviousness, as in deer. Open nostrils are a sign of fierce temper, for they enter into the facial expression of temper.

The *face*, when fleshy, indicates laziness, as in cattle: if gaunt, assiduity, and if bony,[13] cowardice, on the analogy of asses and deer. A small face marks a small soul, as in the cat and the ape: a large face means lethargy, as in asses and cattle. So the face must be neither large not little: an intermediate size is therefore best. A mean-looking face signifies by congruity an illiberal spirit.

As to the *eyes*, when the lower lids are pendulous and baggy, you may know a bibulous fellow, for heavy drinking produces bagginess below the eyes; but when the upper lids are baggy and hang over the eyes, that signifies somnolence, for on first waking from sleep our upper lids hang heavily. Small eyes mean a small soul, by

[12]Förster marks a lacuna here.
[13]Reading ὀστώδη.

congruity and on the evidence of the ape: large eyes, lethargy, as in cattle. In a man of good natural parts, therefore, the eyes will be neither large nor small. Hollow eyes mean villainy, as in the ape: protruding eyes, imbecility, by congruity and as in the ass. The eyes, therefore, must neither recede nor protrude: an intermediate position is best. When the eyes are slightly deep-set, they signify a proud soul, as in lions: and when a little deeper still, gentleness, as in cattle.

A small *forehead* means stupidity, as in swine: too large a forehead, lethargy, as in cattle. A round forehead means dullness of sense, as in the ass: a somewhat long and flat forehead, quickness of sense, as in the dog. A square and well-proportioned forehead is a sign of a proud soul, as in the lion. A cloudy brow signifies self-will, as in the lion and the bull: a smooth brow is taken from observation to mark the flatterer, and you may notice how a dog's brow smooths out
when he fawns upon you. So, a cloudy brow indicating self-will and a smooth brow 812a1
obsequiousness, the proper condition must be intermediate between these extremes. A scowling brow means a morose disposition, for we observe that vexation is thus expressed: a downcast brow means querulousness, as may also be verified by observation.

A large *head* means quickness and a small head dullness of sense, on the evidence of the dog and the ass respectively. A peaked head means impudence, as in those birds which have curved claws.

Men with small *ears* have the disposition of monkeys, those with large ears the disposition of asses, and you may notice that the best breeds of dogs have ears of moderate size.

Too black a *hue* marks the coward, as witness Egyptians and Ethiopians, and so does also too white a complexion, as you may see from women. So the hue that makes for courage must be intermediate between these extremes. A tawny colour indicates a bold spirit, as in lions: but too ruddy a hue marks a rogue, as in the case of the fox. A pale mottled hue signifies cowardice, for that is the colour one turns in terror. The honey-pale are cold, and coldness means immobility, and an immobile body means slowness. A red hue indicates hastiness, for all parts of the body on being heated by movement turn red. A flaming skin, however, indicates mania, for it results from an overheated body, and extreme bodily heat is likely to mean mania.

A fiery colour on the chest signifies irascibility, for it is part of the expression of the onset of anger. Swollen veins on the neck and temples also signify irascibility, being part of the expression of anger. A face that reddens easily marks a bashful man, for blushing is an expression of bashfulness. But when the jowl goes red, you have a drunkard, for a red jowl is an expression of heavy drinking: whilst eyes that flush red indicate uncontrollable temper, for in a wild outburst of temper the eyes
flush red. If the eyes are too black, they signify cowardice, for we saw above that 812b1
this is the signification of too black a hue: if they are not too black, but inclining to chestnut, they indicate a bold spirit. Grey or white eyes indicate cowardice, for we saw above that this is the signification of a white hue: but if they are gleaming rather than grey, they mean a bold spirit, as in lions and eagles. Goatish eyes mean lustfulness, as in goats: fiery eyes, impudence, as in dogs: eyes pale and mottled,

cowardice, for in terror the eyes go pale with splotches of colour: glistening eyes, lasciviousness, on the analogy of the cock and the raven.

Hairy legs mean lasciviousness, as in goats. Too much hair on breast and belly mean lack of persistence, as argued from birds, in which this bodily characteristic is most developed; but breasts too devoid of hair indicate impudence, as in women. So both extremes are bad, and an intermediate condition must be best. Hairy shoulders mean lack of persistence, on the analogy of birds: too much hair on the back, impudence, as in wild beasts. Hair on the nape of the neck indicates liberality, as in lions: hair on the point of the chin, a bold spirit, on the evidence of dogs. Eyebrows that meet signify moroseness, by congruity: eyebrows that droop on the nasal and rise on the temporal side, silliness, as is seen in swine. When the hair of the head stands up stiff, it signifies cowardice, by congruity, for fright makes the hair stand on end: and very woolly hair also signifies cowardice, as may be seen in Ethiopians. Thus extremely bristly and extremely woolly hair alike signify cowardice, and so hair gently curling at the end will make for boldness of spirit, as is to be seen in lions. A ridge of hair[14] on the upper part of the forehead indicates a liberal disposition, as in the lion: but a growth of hair on the forehead down by the nose indicates illiberality, the argument being from congruity, because such a growth presents a servile appearance.

A long and slow *step* indicates a mind slow to begin, but persistent when started, for the length of the stride shows determination, but its slowness procrastination. A short slow step means tardiness without persistence, for shortness and slowness indicate lack of determination. A long quick step means enterprise and persistence, for its speed indicates enterprise and its length determination. A short quick step signifies enterprise without persistence.

Identical references are made about *gesture* of hand, elbow, and arm. To hold one's shoulders straight and stiff and roll them as one walks and to have weasel-arms. . .[15] on the analogy of the horse: but to roll the shoulders if one stoops a little forwards means a proud soul, as in the lion. To walk with feet and legs bent out means femininity,[16] as being a characteristic of women. To keep turning and bending the body is a sign of obsequiousness, for that is the gesture of the flatterer. To walk with a stoop to the right is by congruity of appearance held to argue effeminacy.

Mobile *eyes* signify keenness and rapacity, as in hawks: blinking eyes, cowardice, for flight begins with the eyes. Sidelong leering glances are held to be characteristic of a fop, and so are drooping movements of one lid half over a motionless eye, and an upward roll of the eyes under the upper lids with a tender gaze and drooping eyelids, and in general all tender melting glances; we argue partly from congruity, partly from the fact that these looks are common in women. A slow movement of the eyes which allows a tinge of white to show all the time, so that they look stationary, indicates a reflective character; for when the mind is absorbed in reflection, our eyes also are motionless.

[14]Reading ἀνάσιλλον.
[15]There is a lacuna here, or else the text is corrupt.
[16]Reading θήλεις.

A big, deep *voice* indicates insolence, as in the ass: a voice which, starting low, rises to a high pitch, indicates despondency and querulousness, the argument being partly from cattle and partly from congruity. Shrill, soft, broken tones mark the speech of the effeminate; for such a voice is found in women and is congruous. A 813b1
deep, hollow, simple voice. . .[17]as in the stronger breeds of dogs, and also by the argument from congruity. A soft, languid voice means gentleness, as in sheep: a shrill, shrieking voice, lewdness, as in goats.

Men of abnormally small *stature* are hasty, for the flow of their blood having but a small area to cover, its movements are too rapidly propagated to the organ of intelligence. Men of abnormally large stature, on the other hand, are slow, for the flow of the blood has to cover a large area, and its movements are therefore propagated to the organ of intelligence slowly. Small men with dry flesh, or of the hue that heat produces in the body, have not persistence enough to effect their purposes; for their blood flowing in a confined space, and at the same time, in consequence of the fiery condition of the body, flowing rapidly, their thought never keeps to a single topic, but is always passing to something new before being done with the old. Again, big men with moist flesh or of the hue that results from cold, also lack persistence; for their blood flowing over a large area, and slowly, on account of the cold condition of the body, its movement does not manage to reach the organ of intelligence entire. On the other hand, small men with moist flesh and of the hue that results from cold, do effect their purposes; for their blood moving in a confined area, the less mobile constituent in its composition produces a proportion which conduces to effectiveness. And again, big men with dry flesh, and of the hue that results from heat, are also persistent, and are keen of sense; for the warmth of flesh and complexion counteracts the excessive size, so that a proportion conducive to effectiveness is attained. Such, then, are the conditions under which opposite extremes of stature tend now to effective activity, and now to ineffectiveness. But a stature intermediate between these extremes confers upon its possessors the greatest acuity of sense and the greatest general effectiveness, for on the one hand, movements of the blood, not having a long distance to travel, easily reach the reason, while on the other hand, not being confined in too small a space, they do not withdraw. Thus the greatest tenacity of purpose and the greatest acuity of sense will be found in persons of moderate stature.

An ill-proportioned body indicates a rogue, the argument being partly from congruity and partly from the female sex. But[18] if bad proportions mean villainy, a 814a1
well-proportioned frame must be characteristic of upright men and brave: only, the standard of the right proportions must be sought in the good training and good breeding of the body, and not in the male type, as we said at the beginning.

It is advisable, in elucidating all the signs I have mentioned, to take into consideration both their congruity with various characters and the distinction of the sexes; for this is the most complete distinction, and, as was shown, the male is more upright and courageous and, in short, altogether better than the female. It will be

[17]Förster marks a lacuna.
[18]Reading εἰ δέ.

814b1 found, moreover, in every selection of signs that some signs are better adapted than others to indicate the mental character behind them. The clearest indications are given by signs in certain particularly suitable parts of the body. The most suitable part of all is the region of the eyes and forehead, head and face; next to it comes the region of the chest and shoulders, and next again, that of the legs and feet; whilst the belly and neighbouring parts are of least service. In a word, the clearest signs are derived from those parts in which intelligence is most manifest.

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