ON THE GENERATION OF ANIMALS

by Aristotle

Table of Contents

Table of Contents

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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 final cause.

There are four causes underlying everything: first, the final cause, that for the sake of which a thing exists; secondly, the formal cause, the definition of its essence (and these two we may regard pretty much as one and the same); thirdly, the material; and fourthly, the moving principle or efficient cause.

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 all matter. 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 or efficient 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, 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 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 to 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 unending or imperfect, and Nature ever 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 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 conclusive proof of this is drawn from considering how and whence comes the semen; for there is no doubt that 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; wherefore men apply these terms to the macrocosm also, naming Earth mother as being female, but addressing Heaven and the Sun and other like entities as fathers, as causing generation.

Male and female differ in their essence by each having a separate ability or faculty, and anatomically by certain

parts; essentially 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 parent. And since they are differentiated by an ability or faculty and by their function, and since instruments or organs are needed for all functioning, and since the bodily parts are the instruments or organs to serve the faculties, it follows that certain parts must exist for union of parents 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 the part used for 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. But if in the sanguinea it is the parts concerned in copulation that differ primarily in their forms, we must observe that a small change in a first principle is often attended by changes in other 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 than an animal is not male or female in virtue of an isolated part or an isolated 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; others outside, either pendent as in man or towards the fundament as in swine. They have been discriminated more accurately in the Enquiries about Animals.

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 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 hard to distinguish in the case of the poulps, 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 the question is uncertain 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; else had it 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 Enquiries about Animals.) 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 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 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 than when they are external, for even in the latter case 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. (Wherefore also the legs are strained in intercourse, both the penis and the legs being sinewy.) So that, 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 vivipira 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 before 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 reflected 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 reflected 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 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. Wherefore also 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 alike in this part; women and all the vivipara with feet have the uterus low down by the pudendum, but the cartilaginous viviparous fish 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 for 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 profitable 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 cartilaginous fish 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, and because the eggs are soft they do not produce them externally; for that would have caused their destruction.

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 cartilaginous fishes. But the facts about this and the other kinds of uterus must be gathered from inspection of the drawings of dissections and from the Enquiries. 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 egg or foetus, which needs guarding, shelter, and maturation by 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 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', as with the scaly integument of fish and reptiles, then the testes must needs 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.

[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. Wherefore 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. 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 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, not only in the ovipara, 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.

We have now discussed the situation of the parts contributing to generation, and the causes thereof.

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 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 flaps 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 arms. 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 the parts of animals. 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 indivisible to the eye 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 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 poulps, of the arm of the male into the funnel of the female, by which arm 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 in the male and indeed outside the body of the male altogether.

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 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 scolex, 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 other; such are gnats, 'conopes', 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), 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 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 to be observed in this respect.

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 so−called catamenia 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. Wherefore 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 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 alleged fact that mutilations are inherited, 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 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 or seed 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 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, for it is not hard to refute the above arguments and 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 the Aethiop; her daughter was not an Aethiop but the son of that daughter was. The same thing applies also to plants, for it is clear that if this theory were 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 resemblance exists rather in the heterogeneous parts, such as face and hands and feet; 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, necessarily, in flesh and nails. If the semen comes from both, what would be the manner of generation? For the heteroeneous parts are composed of the homogneous, so that to come from the former would be to come from the latter and from their composition. To make this clearer by an illustration, 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 than anything else, 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 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. Wherefore 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. What he says agrees with it when 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...' For why does not the female generate from herself if the semen comes from all parts alike and she has a receptacle ready in the uterus? 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', says he, 'many heads sprang up without necks,' 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 states or conditions; the heterogeneous, as tongue and hand, by the faculty of doing something, the homogeneous by hardness and softness and the other similar states. 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 flesh, will not be identical with that part. But if it is something different from which the blood of the offspring 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 other parts of the offspring as well as blood be formed from one part of the parent? 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 the universe.

Then, again, how will these parts that came from all the body of the parent be increased or grow? It is true that Anaxagoras plausibly says that particles of flesh out of the food are added to the flesh. But if 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 is there any other alternative, for surely we cannot 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 of the mixture 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'). 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 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 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 others? For if semen does not come from this part, 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 scolex. 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 of the semen scattered throughout the body must needs follow only a single secretion. Nor is it possible for it to be separated in the uterus, for this would no longer be a mere separation of semen, but, as it were, a severance from a new plant or animal.

Again, the cuttings from a plant bear seed; clearly, therefore, even before they were cut from the parent plant, 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, 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. Conversely, 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 simply because this is the semen. 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 A follows B; 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 preexisting which is only 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. 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 offspring comes from the semen, and it is plainly in one of the two following senses that it does so− either the semen is the material from which it is made, or it is the first efficient cause. For assuredly it is not in the sense of A being after B, as the voyage comes from, i.e. after, 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 the first mixture which arises from the union of male and female, be it a foetus or an ovum, for these already have in them that which comes from both. (Semen, or seed, and grain differ only in the one being earlier and the other later, grain in that it comes from something else, i.e. the seed, and seed in that something else, the grain, 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. Needs must everything which we find in the body either be (1) one of the natural parts, whether homogeneous or heterogeneous, or (2) an unnatural part such as a growth, or (3) a secretion or excretion, or (4) waste−product, or (5) nutriment. (By secretion or excretion I mean the residue of the nutriment, by waste−product that which is given off from the tissues by an unnatural decomposition.)

Now that semen cannot be a part of the body is plain, for it is homogeneous, and from the homogeneous nothing is composed, e.g. from only sinew or only 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 development of the young animal comes from it. Nutriment, again, is obviously introduced from without.

It remains, then, that it must be either a waste−product or a secretion or excretion. 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 of the body in copulation, 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 secretion or excretion.

But, to go further into it, every secretion or excretion 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 none at all or it is not fertile, because a useless and morbid secretion is mingled with it.

Semen, then, is part of a useful secretion. But the most useful is the last and that from which finally is formed each of the parts of the body. For secretions are either earlier or later; of the nutriment in the first stage the secretion is phlegm and the like, for phlegm also is a secretion 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 secretion 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 be added continually to the same thing 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 secretion. For it is more reasonable to suppose that the last extract of the nutriment which goes to all parts resembles that which is left over from 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 or decay and to a departure from Nature.

A further proof that it is not a waste−product, but rather a secretion, is the fact that the large animals have few young, the small many. For the large must have more waste and less secretion, since the great size of the body causes most of the nutriment to be used up, so that the residue or secretion is small.

Again, no place has been set apart by Nature for waste−products but they flow wherever they can find an easy passage in the body, but a place has been set apart for all the natural secretions; 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 secretion. 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 secretions 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, and these are morbid. Wherefore, 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 they do not sufficiently concoct their food, 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 wantonly 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 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 secretion when in process of concoction turns to fat with those who are too well−nourished. For fat also is a healthy secretion 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 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 secretion 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 corrupt humours collect here as in the urine, which also has been known to cause disease.

[Further the same passage serves for urine 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 secretion 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 secretion 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.]

From what has been said, it is clear that semen is a secretion 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 secretion, and must discuss the catamenia which occur in certain of the vivipara. For thus we shall make it clear (1) whether the female also produces semen like the male and the foetus is a single mixture of two semens, or whether no semen is secreted by the female, and, (2) if not, whether she contributes nothing else either to generation but only provides a receptacle, or whether she does contribute something, and, if so, how and 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 secretion of the nutriment, and that in its final stage, it follows that it will be either (1) blood or that which is analogous to blood, or (2) 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 secretion 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. I mention these alternatives here because we have not yet made it clear from the distincti;1H the vivipara. For thus we shall make it clear (1) ons 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 as the living hand.

On this subject, then, so much may be laid down. But since it is necessary (1) that the weaker animal also should have a secretion greater in quantity and less concocted, and (2) that being of such a nature it should be a mass of sanguineous liquid, and (3) since that which Nature endows with a smaller portion of heat is weaker, and (4) since it has already been stated that such is the character of the female− putting all these considerations together we see that the sanguineous matter discharged by the female is also a secretion. And such is the discharge of the so−called catamenia.

It is plain, then, that the catamenia are a secretion, and that they are 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 catamenia begin to flow in females, and that they change their voice and their breasts begin to develop. So, too, in the decline of life the generative power fails in the one sex and the catamenia in the other.

The following signs also indicate that this discharge in females is a secretion. Generally speaking women suffer neither from haemorrhoids nor bleeding at the nose nor anything else of the sort except when the catamenia 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 secretion which in men goes to these vessels is drained away with the catamenia. 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 the catamenia 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. Wherefore her pallor and the absence of prominent blood−vessels is 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 such 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 catamenia; but, as it is, because she has the latter she has not the former.

It has been stated then that the catamenia are a secretion 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 secretion, is in fact concocted blood, only not concocted in the same way as the semen. Thus, if the secretion 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 spermatic secretion.

And a proof 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 experience 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 so−called catamenia is present in a right proportion. Hence the female does not produce young if the catamenia are absent altogether, nor often when, they 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 catamenia because of their abundance. But when after their occurrence the greater part has been evacuated, the remainder is formed into a foetus. Cases of conception when the catamenia do not occur at all, or of conception during their 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 catamenia 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, wherefore it is found only in a few cases and then 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 catamenia, and that they are a secretion.

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 spiritus, 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 attrition. And those who have been injured in the generative organs sometimes suffer from diarrhoea because the secretion, 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 their 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 that of the catamenia, 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 catamenia are semen not in a pure state but in need of working up, 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 catamenia cause generation 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) 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 outwards, for all these are viviparous without producing eggs)− all these have the catamenia, 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 Enquiries concerning animals.

The catamenia are 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 catamenia, for, as said before, this secretion appears in the male at the same time of life as the catamenia in the female; this indicates that the parts destined to receive each of these secretions are differentiated at the same time in both sexes; and as the neighboring 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 spiritus; 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 catamenia generally begin.

Now, in all living things in which the male and female are not separated the semen (or seed) is a sort of embryo; by embryo I mean the first mixture of male and female; hence, from one semen comes one bodys− 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 proof of this is that animals which can bear more than one young one at a time do so in consequence of only one coition. Whereby, too, it is plain that the semen does not come from the whole of the body; for neither would on to their size. The reason is that the composition of thei2J 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 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 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 this does not matter, but what does matter is only that each part should correspond to the material, being neither too little to concoct it and fix it into form, nor too much so as to dry it up; it then generates a number of offspring. But 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 catamenia, or that which is analogous to it in bloodless animals, is clear from what has been said, and also from a general and abstract 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, considered as 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 catamenia have in their 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 considerations, 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; the moving thing does not exist in that which 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 (in the case of those animals whose males do insert a part) 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 secretion. 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 scoleces.

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 conclusion is to be drawn from the generation of oviparous fishes. When the female has laid her eggs, the male spinkles 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 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 moves 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 herself watches over them. Thus here she resembles a modeller in clay rather than a carpenter, for she does not touch the work she is forming by means of tools, but, as it were, 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 man and horse. But in plants these powers are mingled, female not being separated from male. Wherefore 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 oviposit; first olives...' 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.

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 literally to be 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 absolute insensibility 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.

Book II

1

THAT the male and the 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 (1) that the sexes arise from Necessity and the first efficient cause, (2) from what sort of material they are formed. That (3) they exist because it is better and on account of the final cause, takes us back to a principle still further remote.

Now (1) some existing things are eternal and divine whilst others admit of both existence and non−existence. But (2) 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 (3) soul is better than body, and 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 (though of course the real essence of things is in the individual)− were it 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 essences are the first principles of these, they will exist in the existing individuals 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, or efficient cause, whereby that which comes into being is male, is better and more divine than the material whereby it is female. 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, wherefore 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 of 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 either lay an egg or give birth to a scolex. The difference between egg and scolex 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 scolex 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 cartilaginous fishes). 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 are sanguineous, and the sanguinea are either viviparous or oviparous, except those which are altogether infertile. Among bloodless animals the insects produce a scolex, alike 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 cartilaginous fishes, 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 have feet, as man, and some which have not, 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 receive and breathe 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 scolex are imperfect, so the perfect is naturally produced from the more 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 cartilaginous fishes 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 scolex. Now all the insects are bloodless, wherefore all creatures that produce a scolex from themselves are so. But we cannot say simply that all bloodless animals produce a scolex, for the classes overlap one another, (1) the insects, (2) the animals that produce a scolex, (3) those that lay their egg imperfect, as the scaly fishes, the crustacea, and the cephalopoda. I say that these form a gradation, for the eggs of these latter resemble a scolex, in that they increase after oviposition, and the scolex 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 scolex first; the scolex after developing becomes egg−like (for the so−called chrysalis or pupa 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 second 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.

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 (1) be made out of something, (2) be made by the agency of something, and (3) 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 scolex 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 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.

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 another if it 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 and does not perish. 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 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 machines shown as curiosities. For the parts of such machines 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 machines 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 life or soul in it; it is only equivocally 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 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 in an equivocal sense (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, as e.g. a mathematician when asleep is further from his realization in actuality as engaged in mathematics than when he is awake, and when awake again but not studying mathematics he is further removed than when he is so 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 and turn to water.

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, 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, as..., by the cold, the oil becomes thicker. 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.

Semen, then, is a compound of spirit (pneuma) and water, and the former is hot air (aerh); 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 spirit, 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 Aethiopians 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 shaken together, 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.)

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 unfertilized embryo or not, and if it does whence does it come? For nobody would put down the unfertilized 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 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 which an animal is an animal. 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 unfertilized embryo, while still separate from each other, must be assumed to have the nutritive soul potentially, but not actually, except that (like those unfertilized 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 (1) that they should all come into being in the embryo without existing previously outside it, or (2) that they should all exist previously, or (3), that some should so exist and others not. Again, it is necessary that they should either (1) come into being in the material supplied by the female without entering with the semen of the male, or (2) 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 preexist 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 secretion 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 spiritus included in the semen and the foam−like, and the natural principle in the spiritus, being analogous to the element of the stars. Hence, whereas fire generates 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 residuum of the animal nature there may be, this also has still a vital principle in 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 comes away from the male the spiritus conveying 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 secretion 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 secretion of the female and moves it with the same movement wherewith it is moved itself. For the female's contribution also is a secretion, and has all the arts 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 catamenia 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 ben imparted to the secretion of the female it becomes an embryo.

Liquid but corporeal substances become surrounded by some kind of covering on heating, like the solid scum 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.

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 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 connection with the uterus, and therefore the egg is not set free from the uterus. This character marks the cartilaginous fish, of which we must speak later by themselves.

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 secretion or the residue 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. Why, even without this force the secretions or excretions 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 secretions, alike the useless (as the residues of the liquid and solid 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 catamenia tend to occur at the above−mentioned period, but when it is not concocted a little matter at a 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 secretions are moderate, the body remains in good health, for they act as a purification of the secretions 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 secretion 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 in the blood−vessels, and this filling the channels of the finest vessels must overflow. Then Nature, aiming at the best 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 secretion, 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 secretion, 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 whence 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 secretion, while all females do, is that the animal is a body with Soul or life; 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 is meant by calling them 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 the work of art or the embryo 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 reality 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 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 considerable width, whereas the males that emit semen have only passages for this purpose, and these are bloodless.

Each of the secretions 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 secretions 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 secretion (for the greater part of the catamenia also is useless and 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 and superfluous matter 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 bad 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 secretion of the corresponding female material, 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 os uteri 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 for 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 os uteri 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. Sometimes it remains in this place; at other times, if the uterus chance to be conveniently placed and hot on account of the purgation of the catamenia, 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 catamenia 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 catamenia is the same, milk and the catamenia 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 a final cause, 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 that the plant gets nourishment; for it needs growth. So also in the embryo all the parts exist potentially in a way at the same time, 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 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. (Wherefore 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 or origin 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 or origin. For the animal 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, wherefore the heart is the principle or origin of these also. (This is clear from the Enquiries and the anatomical drawings.)

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 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. These are what is called the umbilicus, for this 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 roots, or as animals themselves when separated from the nutriment within the mother, of which 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 secretion 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), straightway 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 thing

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 which originally generated it; if then this acting power is the nutritive soul, this 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 animals, not in others.] In plants, then, the female is not separated from the male, but in those animals in which it is separated the male needs the female 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 secretion 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. If then, when the sexes are separated, it is the male that has the power of making the sensitive soul, it is impossible for the female to generate an animal from itself alone, for the process in question was seen to involve the male quality. 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 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 without copulation. 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 are neither male nor female, as eels and a kind of mullets 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 without it. 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 the wheels are moved one by another in the automatic machines. 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 into 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 scolex 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 mother and produced from an egg, within which the differentiation takes place; other animals do not breathe at all, but are produced as a scolex 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−philosolphers 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 reality. Again, that which exists for the sake of the end admits of division into two classes, (1) the origin of the movement, (2) that which is used by the end; I mean, for instance, (1) that which can generate, (2) 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; 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 (or first principle) 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 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 anatomical diagrams which are represented on the wall, 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 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 secretion, 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 it 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 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 invertebrates is testaceous or crustaceous, in the vertebrates 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 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 spiritus; 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; this applies both to the brain and 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 'bregma' 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 children 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 never so little 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, those most honourable and 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 in the outside world 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 secretion or residue. As the animal grows the bones grow from the natural nourishment, being the same as that of the sovereign parts, 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 gives its essence both to the whole and to 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, their growth not being in proportion to their detrition. 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 must have been very large indeed, and many sets of them must have been produced, for even if they had grown 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 growth 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 connate with 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 that part of the blood which 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 animals with no front teeth in the upper jaw, and all those which have them in both jaws and 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 between embryo and uterus and split up into smaller vessels 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 she sends milk into the 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 fall in together.

But most of the animals which have front teeth in both jaws and no horns 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 Anatomy and the Enquiries.) For the young, if numerous, are attached each to its umbilical cord, and this to the blood−vessel of the mother; 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. Thirdly, it is plain that all creatures developed in eggs grow when separated from the uterus.

Natural intercourse takes place 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; the Indian dogs also spring from the union of a dog with some wild dog−like animal. A similar thing has been seen to take place in those birds that are amative, 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 'rhini' and '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, 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 men who are in too good condition and women who are too fat the seminal secretion is taken up into the body, and the former have no semen, the latter no catamenia); 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 secretions. Often, too, in both sexes this state is caused by injuries 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 women of a masculine and men of a feminine appearance, and in the former the catamenia do 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 thereof 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 catamenia are secreted, are clogged and closed. For the region about the eyes is, of all the head, that most nearly connected with the generative secretions; 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 purgations 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 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 their demonstration in the case of all these animals alike 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, all others that unite in this manner ought to be barren. 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 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. 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 in two ways according as the parents are stallion and she−ass or jackass and mare, 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 barren, 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 argument is intended to apply to both male and female mules alike, but the male does generate at seven years of age, it is said; it is the female alone that 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 special principles involved. 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 (1) mules are produced of both sexes and are not different in species from one another, and (2) 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 (1) another kind cannot be, because the product of male and female of the same species is also of the same species, and (2) 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 special principles involved 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 of different species are fertile with one another, 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 (wherefore breeders put the horse to the mare again at intervals). Indeed, both the mare is deficient in catamenia, discharging less than any other quadruped, and the she−ass does not admit the impregnation, but ejects the semen with her urine, wherefore 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 of the male and the material contributed by the female are cold, and those of the horse, in both sexes, 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, (when too even in the other case when united with their own species they with difficulty produce a single young one), 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 female mules grow large because the matter which is secreted in other animals to form the catamenia is diverted to growth. But since the period of gestation in such animals is a year, the mule must not only conceive, if she is to be fertile, but must also nourish the embryo till birth, and this is impossible if there are no catamenia. But there are 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 smell to the pudenda of the females, as do the other solid−hoofed ungulates, but only to the evacuation 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 dwarf 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 injured 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 injured 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 (1) birds produce a perfect hard−shelled egg, unless it be injured by disease, and the eggs of birds are all two−coloured. (2) The cartilaginous 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 'frog'; the reason of which must be stated later. (3) 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 of these classes of animals, 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 cartilaginous fishes, 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 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 all such secretion is diverted to the wings and wing−feathers, while the body is small and dry and hot. (The secretion corresponding in hen−birds to catamenia, and the semen of the cock, 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, wherefore 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 turn 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 other birds are more fertile than game−fowl, for their bodies are more fluid and bulkier, whereas those of game−fowl are leaner and drier, since a passionate spirit is found rather in such bodies as the latter. Moreover the thinness and weakness of the legs contribute to making the 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 this number lies 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 the plants become exhausted, 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 generative secretion is failing along with the advance of years.

We have now stated in which birds wind−eggs are found, and also what sort of birds lay many eggs or few, and for what reasons. And wind−eggs, as said before, come into being because while it is the material for generation that exists in the female of all animals, birds have no discharge of catamenia 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 as in birds is found an embryonic formation without impregnation, but it is less obvious because their nature is colder. The secretion corresponding to the catamenia of vivipara is formed in birds at the appropriate season for the discharge of superfluous matter, 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 Enquiries

concerning them. And generally 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 this is that just as with women intercourse with men draws down the secretion of the catamenia (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 catamenia 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,] and that the blood is the 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 'lecithus' or yolk in the eggs of such birds is large and 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 puts them into form; 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 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 the shape of two−coloured eggs is 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 a scolex, 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 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 to the uterus 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 Crotona. 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 are sufficiently concocted without incubation, 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 than of incubation.

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 special sense of care for their young: in the inferior animals this lasts only to the moment of giving birth to the incompletely developed animal; 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 sunshiny weather, the season aiding in the work, for concoction is a kind of heat. For the earth aids in the concoction by its heat, and the brooding hen does the same, for she applies 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' or rotten eggs are produced; for just as wines turn sour in the heats from the sediment rising (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, wherefore 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 natural 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 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]. 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 Enquiries; 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 on the inside of 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 becomes more liquid by heating. This is because the nourishment, being of a material character in its first form, must become liquid before it can be absorbed, 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, the chick has 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). So also the relation of the chick to the outermost membrane, the sanguineous one, is like that of the mammalian embryo to the uterus. At the same time the egg−shell surrounds both the yolk and the membrane analogous to the uterus, just as if it should be put round both the embryo itself and the whole of the mother, in the vivipara. 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 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 the egg 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 'selache' or cartilaginous fishes produce a perfect egg within themselves but are externally viviparous except one which they call the '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 cartilaginous fishes is soft−shelled (for they cannot harden and dry its circumference, being colder than birds), the egg of the frog−fish 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 frog−fishes) 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 eggs against external injury between laying and hatching out. Secondly, the process in these also begins on the surface of the egg but not where it is attached to the uterus, as in birds, for the chick is 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 before it is perfected, but in most though not all cartilaginous fishes 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 asked why the development of birds and cartilaginous 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 cartilaginous fish 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 hound'.

In these respects and for the reasons given the development of cartilaginous 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 frog−fish; the reason of 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 cartilaginous 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 scolex, for those animals which produce a scolex 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 superfluous yeasty matter), but also for the sake of a final cause, for it is impossible for them to attain their whole growth in the uterus because these animals have so many eggs. Therefore are they 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 before hatching. 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 'belone', 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.

5

A proof that these fish also are oviparous is the fact that even viviparous fish, such as the cartilaginous, are first internally oviparous, for hence 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 cartilaginous 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 cartilaginous, for they do not dispute the sexes in these. And yet there is no difference in the males of cartilaginous fishes and those belonging to the oviparous class in respect of the organs for the milt, and it is manifest that semen can be squeezed 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 (as with mules in the class of bushy−tailed animals), 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 cartilaginous fish 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 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, speculating on a small induction, 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 of the male 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 roe 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 they come into being by 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 helps in the deception 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] 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 Herodotus the storyteller, 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 other physicists, 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 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 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 the Heracleot 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 cartilaginous fish 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 cartilaginous class do not produce much semen, and further the females have their uterus near 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 cartilaginous 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 scolex, for the product discharged by them is still more imperfect than a fish's egg. 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.

In birds the wind−eggs become fertile, and those previously impregnated by one kind of cock change their nature to that of the later cock. And if the eggs be behindhand in growth, then, if the same cock treads the hen again after leaving off treading for a time, he causes them to increase quickly, not, however, at any period whatever of their development, 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 birds egg already contains the principle that comes from the male parent.... for the male contributes to 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, wherefore 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, 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 cock; for they already contain both principles, which is why they do not change again after the second impregnation.

8

The young are produced in the same way also by the cephalopoda, e.g. sepias and the like, and by the crustacea, e.g. carabi 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 sepias and calamaries or squids the eggs appear to be two, because the uterus is divided and appears double, but that of the poulps appears to be single. The reason is that the shape of the uterus in the poulp is round in form and spherical, the cleavage being obscure when it is filled with eggs. The uterus of the carabi is also bifid. All these animals also lay an imperfect egg for the same reason as fishes. In the carabi and their like the females produce their eggs so as to keep them 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 sticky and glutinous mass, but in the carabi 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 sepia 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 pointing in the same direction. For the position and attitude of the young while developing you must look at the Enquiries.

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 scolex, and why this is so. For pretty much all creatures seem in a certain way to produce a scolex 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 scolex. After this stage some of the ovipara produce the egg in a perfect 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, wherefore they call the abortion of an embryo at that stage an 'efflux'.

Those insects which generate at all generate a scolex, and those which come into being spontaneously and not from copulation do so at first from a formation this nature. I say that the former generate a scolex, for we must put down caterpillars also and the product of spiders as a sort of scolex. 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 scolex, 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 scolex 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 scolex, 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 scolex stage become immovable and their integument dries round them, and after this the latter bursts and there comes forth as from an egg an animal perfected in its second metamorphosis, most of those which are not aquatic being winged.

Another point is quite natural, which may 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 scolex

of wasps and bees, but after this comes into being the so−called nymph.... and have 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 scolex contains in itself the material from which it is nourished and obtains such an addition to its size, e.g. in bees and wasps; sometimes it gets its nourishment from outside itself, as caterpillars and some others.

It has thus been stated why such animals go through a double 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 (1) 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 (2) they must generate them themselves, or (3) 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 (1) each kind must generate its own kind, or (2) some one kind must generate the others, or (3) one kind must unite with another for the purpose (I mean for instance (1) that bees may be generated from the union of bees, drones from that of drones, and kings from that of kings, or (2) that all the others may be generated from one, as from what are called kings and leaders, or (3) 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 germs. For why, if new bees come into existence when the germs are transported, should they not do so if the germs are left there? They ought to do so just as much, whether the germs are spontaneously generated in the flowers or whether some animal generates them. And if the germs were of some other animal, then that animal ought to be produced from them instead of bees. 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.

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 (1) of bee with bee or drone with drone or (2) 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 if it prevails with one.) 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 of offence, 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 as 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 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 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 has been solved, for the leaders are like both kinds at once, like the bees in possessing a sting, like the drones in size.

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 grubs 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, but 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 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 reasons 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 the food and because of the slowness of their bodies. But the bees are intermediate in size 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 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 generated by copulation, the parents remain united for a long time but produce quickly something of the nature of a scolex and of a considerable size.

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 kind from one another and from bees, they must be investigated with the aid of the illustrations to the Enquiries.

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 quickening 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−oysters, oysters 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 water, though sweet and nutritious, is cold and less material. Wherefore 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 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. 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 produced mussels, for smaller ones are always growing off alongside the original, but the whelks, the purple−fish, and those which are said to 'spawn' 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 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 'spawn' 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 'spawn' 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, 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 psychical 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 matter (or 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 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 the more complicated combinations of these, so that what the heat in animals produces from their nutriment, this does the heat of the warm season in the environment put together and combine by concoction out of the sea−water on the earth. And the portion of the psychical 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 scolex, 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 scolex.

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 scolex 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 scolex) 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 to have been one of these two, scolex or egg. 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 scolex. For the scolex 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 scolex, 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 scolex 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 turbinata, 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 limnostrea, a kind of oyster, 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 to generation but are only a condition, like fat in the sanguinea, and therefore the oysters are savoury 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, whelks, and purple−fish; only they are sometimes larger and sometimes smaller; in others as pectens, mussels, and the so−called limnostrea, 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 Enquiry.)

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 germs or seeds; for the germ, they say, comes from the male while the female only provides the place in which it is to be developed, and the male is from the right, the female from the left testis, 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 or cold what enters it becomes male or female, the cause of the heat or cold being the flow of the catamenia, according as it is colder or hotter, more 'antique' 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 light−hearted 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 origin of this difference 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 sexual parts like the rest should be separated from one another, already existing as masses of a certain size, and that they should come into being in the embryo on account of uniting with one another, not on account of cooling or heating of the semen. But perhaps it would take too long to discuss thoroughly such a cause as this which is stated by Empedocles, 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 embryo 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...'; nor yet that a whole embryo 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 the embryo 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 varies along with the uterus from that of the father, 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 part where the struggle is not yet decided; thus the offspring would be not only female or male but also like its mother or father respectively in all other details.

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 framework. 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 needs 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 only a concomitant result; not this but something else must be held to be the first principle and the cause of the development of an embryo as male or female; this is so even if no semen is secreted by either male or female, but the embryo is formed in any way you please.

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 to the embryo, 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 have come from the left but has not acquired this part, it will be a female without a uterus, and so too there is nothing to stop another from being a male with a uterus! 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.

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 immediate 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 (1) the male and female are distinguished by a certain capacity and incapacity. (For the male is that which can concoct the blood into semen and which can form and secrete 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, indeed, but cannot form it for itself or secrete or discharge it.) And (2) 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 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 the catamenia. It is true that blood is hot, and that which has more of it is hotter than that which has less. But they assume that this discharge occurs through excess of blood and of heat, as if it could be taken for granted that all blood is 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 (1) the one sex is able and the other is unable to reduce the residual secretion to a pure form, and (2) every capacity or power in an organism has a certain corresponding organ, whether the faculty produces the desired results in a lower degree or in a higher degree, and 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 excreta. 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 needs the material which it works on 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 or affected needs must many of the parts that go along with it change with it.

If then (1) the male quality or essence is a principle and a cause, and (2) the male is such in virtue of a certain capacity and the female is such in virtue of an incapacity, and (3) the essence or 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 (4) 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, which is the foundation of the embryo, is the ultimate secretion 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 from the corresponding secretion of the female 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 secretions the part fitted to receive it. But the semen is a secretion, and this in the hotter animals with blood, i.e. the males, is moderate in quantity, wherefore the recipient parts of this secretion 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 vital 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 in the latter case the animals produce more secretion, and too much secretion is harder to concoct; hence the semen of the males is more liquid, and so is the discharge of the catamenia.

Also the fact that the catamenia occur 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 to produce at all, 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 artistic or natural 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 medical 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 following groups of facts. (1) 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, male and female offspring resembling father and mother respectively rather than the other way about. (2) They resemble their parents more than remoter ancestors, and resemble those ancestors more than any chance individual. (3) 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 in the mixture of the two elements, 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 secretion in the catamenia 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 particular 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 than the more general and wider characteristics. Coriscus is both a man and an animal, but his manhood is nearer to his individual existence than is his animalhood. In generation both the individual and the class are operative, but the individual is the more so of the two, for this is the only true existence. And the offspring is produced indeed of a certain quality, but also as an individual, and this latter is the true existence. Therefore it is from the forces of all such existences that the efficient movements come which exist in the semen; potentially from remoter ancestors but in a higher degree and more nearly from the individual (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 paternal and efficient or 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 as general terms, 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 than the more remote, both in the paternal and in the maternal line.

Some of the movements exist in the semen 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. Thus the male and efficient principle, if it lose its own nature, changes to its opposites, but the movements which form the embryo change into those nearly connected with them; for instance, if the movement of the male parent be resolved, 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 not only in the male but also in the female line 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 individual 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 characters. Hence for the most part the male offspring resemble the father, and the female the mother. For in the latter case the loss of both characters takes place at once, and the change is into the two opposites; now is opposed to male, and the individual mother to the individual father.

But if the movement coming from the male principle prevails while that coming from the individual 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 be resolved, if the male character remain but the movement coming from the individual Socrates be resolved 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 be resolved, 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 in the semen actually and others potentially. We must grasp certain fundamental 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 be resolved, 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 the race, i.e. it is a human being. The reason of this is that this is closely knit up with the individual characteristics; 'human being' is the general term, while Socrates, the father, and the mother, whoever she may be, are individuals.

The reason why the movements are resolved 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 or efficient 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 is the thing on which it acts, 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 by the semen, 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 all, so as to increase and arrange their form symmetrically; 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 satyrism, in which the face appears like that of a satyr owing to a quantity of unconcocted humour or wind being diverted into parts of the face.

We have thus discussed the cause of all these phenomena, (1) female and male offspring are produced, (2) 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, however, have been given of these phenomena by some of the nature−philosophers; I mean 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 each part of both parents; 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 of the parents, 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 (1) those who assign the same cause of sex as Empedocles or Democritus say what is on other grounds impossible, and (2) those who say that it is determined by the greater or smaller amount of semen coming 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 common mixture (panspermia) 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 'panspermia' exists potentially, not actually; it cannot exist actually, but it can do so potentially. Also, if we assign only one sort of cause, it is not easy to explain all the phenomena, (1) the distinction of sex, (2) why the female is often like the father and the male like the mother, and again (3) the resemblance to remoter ancestors, and further (4) the reason why the offspring is sometimes unlike any of these but still a human being, but sometimes, (5) 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 imparted by the semen are resolved and the material contributed by the mother is not controlled by them, at last there remains the most general substratum, 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 some one 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 cause of animals being born defective in any part, for monstrosity is also a kind of deficiency.

4

Democritus said that monstrosities arose because two emissions of seminal fluid met together, the one succeeding the other at an interval of time; that the later entering into the uterus reinforced the earlier so that the parts of the embryo grow together and get confused with one another. But in birds, he says, since copulation takes place quickly, both the eggs and their colour always 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 we must rather by all means suppose that the cause lies in the material contributed by the female 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, 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 in her usual operations; nothing can happen contrary to Nature considered as eternal and necessary, but we speak of things being contrary to her 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 'capneos'; 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 violent one nor, so to say, contrary to Nature; at least, is it not a change into another nature. But in animals producing many young not only

do the same phenomena occur, but also the numerous embryos hinder one another from becoming perfect and interfere with the generative motions imparted by the semen.

A difficulty may be raised concerning (1) the production of many young and the multiplication of the parts in a single young one, and (2) 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 absent. 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 are found also in the internal parts, animals either not possessing some at all, or possessing them in a rudimentary 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 deficiency 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 another but still a single cause 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. This certainly seems surprising, for we should expect the large animals to be able to generate more young and to secrete 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 so gained to the seminal secretion. Moreover, more semen must needs 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, and speaking generally, with regard to the number of young produced, the solid−hoofed produce one, the cloven−footed few, the many−toed 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 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 female secretion than is needed for beginning the existence of 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 of the female 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 on the material 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 then 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 to be more portentous, 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 cause 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 it aggregates more material at any point of itself 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 such part, as eddies do in rivers; as the water in these is carried along with a certain motion, if it dash against anything two systems or eddies come into being out of one, each retaining the same motion; the same

thing happens also with the embryos. The abnormal parts generally are attached near those they resemble, 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]. 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 growth (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 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 members, we must assume the same cause as when the embryo is altogether aborted (abortion of embryos happens frequently).

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 which form the embryo 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 the catamenia 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 or of their deficiency, 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 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 of the female 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 catamenia is in females a sort of 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 spermatic, 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 spermatic the generative discharge is copious, and because the body is not large but the discharge is excessive and 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 during gestation 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 are spermatic. 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 of 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 scolex, 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, that is to say blind; this applies to all small birds which lay many eggs, as crows and rooks, 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 man (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 or end, 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 no work; therefore their travail is painful. But work exercises them so that they can hold their breath, upon which depends the ease or 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 corresponding to the catamenia is but 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 catamenia 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 catamenia 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 mola uteri, which occurs rarely in women but still is found sometimes during pregnancy. For they produce what is called a mola; 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 mola. 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 maternal heat. (For their nature seems to be incapable, and unable to perfect or to put the last touches to the process of generation. Hence it is that the mola 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, as with half−cooked meat, for this half−dressing of meat 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 does occur and 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 catamenia and is unable to concoct them; when, then, the embryo has been formed of a liquid hard to concoct, then comes the so−called mola 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 may neither fail at this time at all nor yet be 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 this 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, it being now fixed because it has reached perfection (for in a sense there is a perfection even of an embryo). 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 sovereign part of the animal, 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 catamenia 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 not only in women but also in those animals which have the mammae low down.

This change in the voice and the parts about the mammae 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 that of the catamenia in women and the emission of semen in men. 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 the residual matter should collect in all those empty parts which are set upon the same passages. And such is the position of the mammae 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 thoroughly 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 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 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 composed the line: 'On the tenth day of the eighth month the milk comes into being, a white pus', for putrefaction and concoction are opposite things, and pus is a kind of putrefaction but milk is concocted). While women are suckling children the catamenia do 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 catamenia 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 nourishment of the newly−born animal, 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. This we should expect, 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 periods only correspond accidentally for the most part; for though the larger and 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 development and the length of life aims at being measured by naturally complete periods. By a natural period I mean, e.g. a day and night, a month, a year, and the greater 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 her connexion with the sun and her participation in his 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 needs follow suit. For it is reasonable that the periods of the 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 measure the coming into being and the end of animals by the measure of these higher periods, but she 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 in the eyes, height and depth of pitch in the voice, and differences in colour whether of the skin or of hair and 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 working upon the animal kingdom as a whole, nor yet characteristic of each separate kind, then none of these things is such as it is or is so developed for any final cause. 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 essence of the animal's being, but we must refer the causes to the material and the motive principle or efficient cause, 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, but rather that they become so and so because they are so and so, for the process of Becoming or development attends upon Being and is for the sake of Being, not vice versa.

The ancient Nature−philosophers however took the opposite view. The reason of 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 means to an 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 course 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 the fundamental idea of the animal is of such a kind), 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 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 embryo animal to sleep most of the time because the growth takes place in the upper part of the body, which is consequently heavier (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 anything like 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 of this is that the eyes of other animals are more apt to have only one colour for each kind of animal; 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 (goat−eyed), 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 are actually heteroglaucous; this phenomenon is not to be seen in any of the other animals, but man is sometimes heteroglaucous.

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− 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 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. And so they see less well in the dusk, 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 'nyctalopia' 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 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 shade the liquid behind it 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 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 are heteroglaucous 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 an incapacity to concoct properly, 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 heteroglaucia.

The cause of some animals being keen−sighted and others not so is not simple but double. For the word 'keen' has pretty much a double sense (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 are not necessarily combined in the same individual. For the same person, if he shades 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) 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 in the transparent medium coming to the eyes from distant objects. A proof of this is that 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 judging well the distinctions, if both that 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 spiritus causes in some animals the pulsation of the heart and in others respiration; wherefore also it is that we are able to understand what is said and repeat what we have heard, for as 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 atmosphere.... And the ears seemed to be filled with air because their starting−point is near the region of breathing.

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. Perception and non−perception at a distance also depend on the same things with hearing and smell 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 the movements which cause sight do 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 of quality in the objects he is the best of all. The reason is that the sense−organ in man 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 land hedgehog and any other such animal among the vivipara. 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 coarser 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 first on these or on the back

of the head. Some such affections occur in a corresponding manner also in all 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 in general 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 substratum of 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 or their analogue are not formed out of the flesh but out of the skin moisture evaporating and exhaling in them, and therefore thick hairs arise from a thick skin and thin from 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 for the causes mentioned; however, the thickest−skinned are not more so than other thick−skinned ones, 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 porous.

The cause of the hairs being long or short 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 only 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, not deeply rooted in it, 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 the Sauromatic sheep is hard. The reason of this is the same as it is also 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 the exposure to the cold is the cause of hardness in the hair, in the

others the nature of the climate is the cause. 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 denotes, 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 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 unctuous, and hence unctuous plants are more evergreen. (However we must elsewhere state the cause of this phenomena in plants, 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 the latter 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 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, rather than their age, 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 of the change of condition is similar in man to what it is in the animals and plants in question.

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 uni−coloured or vari−coloured); 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 the whiteness does not invade 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 cold at every time of life, and especially in old age, 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 loses its efficiency, and destruction 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 but external 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 of 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 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 in illness, wherefore 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 'bregma' 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 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 to this spot is fatal to them, wherefore Homer also has said: 'where the first hairs grow on the skull of horses, and a wound is most fatal.' 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, however, that cranes become darker as they grow old. The reason of this would be, if it should prove true, that their feathers are naturally moister 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. (1) A proof of the former statement 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. (2) 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 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, therefore 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 both 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 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 of the colour, 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 colour 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 which cause the development and so 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 meant by 'voice' and by '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 of the air 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 the quantity of the air 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 not loud−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 (or loud) 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 surpass the strength of that which moves it, the air that is sent forth 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, wherefore 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 are naturally connected with 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 to it what are called 'laiai'. 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 again 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 the 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 organ which moves the voice is loosened in the same proportion. This, then, is the reason why the voice and the form generally changes 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 ganglion 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 for it to depend upon.

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 depends 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.

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 only, in others also for fighting and for vocal speech. We must, however, consider it not alien to the discussion of generation and development 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 its teeth, and, further, all the animals with carnivorous dentition 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 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 (or final cause); these are causes only 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 the living things formed by Nature. But to say that necessity is the only cause is much as if we should think that the water has been drawn off from a dropsical patient on account of the lancet, not on account of health, for the sake of which the lancet made the incision.

We have thus spoken of the 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 or efficient cause.

−THE END−