Book IV

1

THE account which has now been given of the viscera, the stomach, and the other several parts holds equally good not only for the oviparous quadrupeds, but also for such apodous animals as the Serpents. These two classes of animals are indeed nearly akin, a serpent resembling a lizard which has been lengthened out and deprived of its feet. Fishes, again, resemble these two groups in all their parts, excepting that, while these, being land animals, have a lung, fishes have no lung, but gills in its place. None of these animals, excepting the tortoise, as also no fish, has a urinary bladder. For owing to the bloodlessness of their lung, they drink but sparingly; and such fluid as they have is diverted to the scaly plates, as in birds it is diverted to the feathers, and thus they come to have the same white matter on the surface of their excrement as we see on that of birds. For in animals that have a bladder, its excretion when voided throws down a deposit of earthy brine in the containing vessel. For the sweet and fresh elements, being light, are expended on the flesh.

Among the Serpents, the same peculiarity attaches to vipers, as among fishes attaches to Selachia. For both these and vipers are externally viviparous, but previously produce ova internally.

The stomach in all these animals is single, just as it is single in all other animals that have teeth in front of both jaws; and their viscera are excessively small, as always happens when there is no bladder. In

serpents these viscera are, moreover, differently shaped from those of other animals. For, a serpent's body being long and narrow, its contents are as it were moulded into a similar form, and thus come to be themselves elongated.

All animals that have blood possess an omentum, a mesentery, intestines with their appendages, and, moreover, a diaphragm and a heart; and all, excepting fishes, a lung and a windpipe. The relative positions, moreover, of the windpipe and the oesophagus are precisely similar in them all; and the reason is the same as has already been given.

2

Almost all sanguineous animals have a gall-bladder. In some this is attached to the liver, in others separated from that organ and attached to the intestines, being apparently in the latter case no less than in the former an appendage of the lower stomach. It is in fishes that this is most clearly seen. For all fishes have a gall-bladder; and in most of them it is attached to the intestine, being in some, as in the Amia, united with this, like a border, along its whole length. It is similarly placed in most serpents There are therefore no good grounds for the view entertained by some writers, that the gall exists for the sake of some sensory action. For they say that its use is to affect that part of the soul which is lodged in the neighbourhood of the liver, vexing this part when it is congealed, and restoring it to cheerfulness when it again flows free. But this cannot be. For in some animals there is absolutely no gall-bladder at all--in the horse, for instance, the mule, the ass, the deer, and the roe; and in others, as the camel, there is no distinct bladder, but merely small vessels of a biliary character. Again, there is no such organ in the seal, nor, of purely sea-animals, in the dolphin. Even within the limits of the same genus, some animals appear to have and others to be without it. Such, for instance, is the case with mice; such also with man. For in some individuals there is a distinct gall-bladder attached to the liver, while in others there is no gall-bladder at all. This explains

how the existence of this part in the whole genus has been a matter of dispute. For each observer, according as he has found it present or absent in the individual cases he has examined, has supposed it to be present or absent in the whole genus. The same has occurred in the case of sheep and of goats. For these animals usually have a gall-bladder; but, while in some localities it is so enormously big as to appear a monstrosity, as is the case in Naxos, in others it is altogether wanting, as is the case in a certain district belonging to the inhabitants of Chalcis in Euboea. Moreover, the gall-bladder in fishes is separated, as already mentioned, by a considerable interval from the liver. No less mistaken seems to be the opinion of Anaxagoras and his followers, that the gall-bladder is the cause of acute diseases, inasmuch as it becomes over-full, and spirts out its excess on to the lung, the blood-vessels, and the ribs. For, almost invariably, those who suffer from these forms of disease are persons who have no gall-bladder at all, as would be quite evident were they to be dissected. Moreover, there is no kind of correspondence between the amount of bile which is present in these diseases and the amount which is exuded. The most probable opinion is that, as the bile when it is present in any other part of the body is a mere residuum or a product of decay, so also when it is present in the region of the liver it is equally excremental and has no further use; just as is the case with the dejections of the stomach and intestines. For though even the residua are occasionally used by nature for some useful purpose, yet we must not in all cases expect to find such a final cause; for granted the existence in the body of this or that constituent, with such and such properties, many results must ensue merely as necessary consequences of these properties. All animals, then, whose is healthy in composition and supplied with none but sweet blood, are either entirely without a gall-bladder on this organ, or have merely small bile-containing vessels; or are some with and some without such parts. Thus it is that the liver in animals that have no gall-bladder is, as a rule, of good colour and sweet; and that, when there is a gall-bladder, that part of the liver is sweetest which lies immediately underneath it. But, when animals are formed of blood less pure in

composition, the bile serves for the excretion of its impure residue. For the very meaning of excrement is that it is the opposite of nutriment, and of bitter that it is the opposite of sweet; and healthy blood is sweet. So that it is evident that the bile, which is bitter, cannot have any use, but must simply be a purifying excretion. It was therefore no bad saying of old writers that the absence of a gall-bladder gave long life. In so saying they had in mind deer and animals with solid hoofs. For such have no gall-bladder and live long. But besides these there are other animals that have no gall-bladder, though those old writers had not noticed the fact, such as the camel and the dolphin; and these also are, as it happens, long-lived. Seeing, indeed, that the liver is not only useful, but a necessary and vital part in all animals that have blood, it is but reasonable that on its character should depend the length or the shortness of life. Nor less reasonable is it that this organ and none other should have such an excretion as the bile. For the heart, unable as it is to stand any violent affection, would be utterly intolerant of the proximity of such a fluid; and, as to the rest of the viscera, none excepting the liver are necessary parts of an animal. It is the liver therefore that alone has this provision. In conclusion, wherever we see bile we must take it to be excremental. For to suppose that it has one character in this part, another in that, would be as great an absurdity as to suppose mucus or the dejections of the stomach to vary in character according to locality and not to be excremental wherever found.

3

So much then of the gall-bladder, and of the reasons why some animals have one, while others have not. We have still to speak of the mesentery and the omentum; for these are associated with the parts already described and contained in the same cavity. The omentum, then, is a membrane containing fat; the fat being suet or lard, according as the fat of the animal generally is of the former or latter description. What kinds of animals are so distinguished has been already set forth in an earlier part of this treatise. This membrane, alike in animals that have a single and in those that have a multiple

stomach, grows from the middle of that organ, along a line which is marked on it like a seam. Thus attached, it covers the rest of the stomach and the greater part of the bowels, and this alike in all sanguineous animals, whether they live on land or in water. Now the development of this part into such a form as has been described is the result of necessity. For, whenever solid and fluid are mixed together and heated, the surface invariably becomes membranous and skin-like. But the region in which the omentum lies is full of nutriment of such a mixed character. Moreover, in consequence of the close texture of the membrane, that portion of the sanguineous nutriment will alone filter into it which is of a greasy character; for this portion is composed of the finest particles; and when it has so filtered in, it will be concocted by the heat of the part, and will be converted into suet or lard, and will not acquire a flesh-like or sanguineous constitution. The development, then, of the omentum is simply the result of necessity. But when once formed, it is used by nature for an end, namely, to facilitate and to hasten the concoction of food. For all that is hot aids concoction; and fat is hot, and the omentum is fat. This too explains why it hangs from the middle of the stomach; for the upper part of the stomach has no need of it, being assisted in concoction by the adjacent liver. Thus much as concerns the omentum.

4

The so-called mesentery is also a membrane; and extends continuously from the long stretch of intestine to the great vessel and the aorta. In it are numerous and close-packed vessels, which run from the intestines to the great vessel and to the aorta. The formation of this membrane we shall find to be the result of necessity, as is that of the other [similar] parts. What, however, is the final cause of its existence in sanguineous animals is manifest on reflection. For it is necessary that animals shall get nutriment from without; and, again, that this shall be converted into the ultimate nutriment, which is then distributed as sustenance to the various parts; this ultimate nutriment being, in sanguineous animals, what we call blood,

and having, in bloodless animals, no definite name. This being so, there must be channels through which the nutriment shall pass, as it were through roots, from the stomach into the blood-vessels. Now the roots of plants are in the ground; for thence their nutriment is derived. But in animals the stomach and intestines represent the ground from which the nutriment is to be taken. The mesentery, then, is an organ to contain the roots; and these roots are the vessels that traverse it. This then is the final cause of its existence. But how it absorbs nutriment, and how that portion of the food which enters into the vessels is distributed by them to the various parts of the body, are questions which will be considered when we come to deal with the generation and nutrition of animals.

The constitution of sanguineous animals, so far as the parts as yet mentioned are concerned, and the reasons for such constitution, have now been set forth. In natural sequence we should next go on to the organs of generation, as yet undescribed, on which depend the distinctions of male and female. But, inasmuch as we shall have to deal specially with generation hereafter, it will be more convenient to defer the consideration of these parts to that occasion.

5

Very different from the animals we have as yet considered are the Cephalopoda and the Crustacea. For these have absolutely no viscera whatsoever; as is indeed the case with all bloodless animals, in which are included two other genera, namely the Testacea and the Insects. For in none of them does the material out of which viscera are formed exist. None of them, that is, have blood. The cause of this lies in their essential constitution. For the presence of blood in some animals, its absence from others, must be included in the conception which determines their respective essences. Moreover, in the animals we are now considering, none of those final causes will be found to exist which in sanguineous animals determine the presence of viscera. For they have no blood vessels nor urinary bladder, nor do they breathe; the only part that it is necessary for them to have

being that which is analogous to a heart. For in all animals there must be some central and commanding part of the body, to lodge the sensory portion of the soul and the source of life. The organs of nutrition are also of necessity present in them all. They differ, however, in character because of differences of the habitats in which they get their subsistence.

In the Cephalopoda there are two teeth, enclosing what is called the mouth; and inside this mouth is a flesh-like substance which represents a tongue and serves for the discrimination of pleasant and unpleasant food. The Crustacea have teeth corresponding to those of the Cephalopoda, namely their anterior teeth, and also have the fleshy representative of a tongue. This latter part is found, moreover, in all Testacea, and serves, as in sanguineous animals, for gustatory sensations. Similarly provided also are the Insects. For some of these, such as the Bees and the Flies, have, as already described, their proboscis protruding from the mouth; while those others that have no such instrument in front have a part which acts as a tongue inside the mouth. Such, for instance, is the case in the Ants and the like. As for teeth, some insects have them, the Bees and the Ants for instance, though in a somewhat modified form, while others that live on fluid nutriment are without them. For in many insects the teeth are not meant to deal with the food, but to serve as weapons.

In some Testacea, as was said in the first treatise, the organ which is called the tongue is of considerable strength; and in the Cochli (Sea-snails) there are also two teeth, just as in the Crustacea. The mouth in the Cephalopoda is succeeded by a long gullet. This leads to a crop, like that of a bird, and directly continuous with this is the stomach, from which a gut runs without windings to the vent. The Sepias and the Poulps resemble each other completely, so far as regards the shape and consistency of these parts. But not so the Teuthides (Calamaries). Here, as in the other groups there are the two stomach-like receptacles; but the first of these cavities has less resemblance to a crop, and in neither is the form [or the consistency]

the same as in the other kinds, the whole body indeed being made of a softer kind of flesh.

The object of this arrangement of the parts in question is the same in the Cephalopoda as in Birds; for these also are all unable to masticate their food; and therefore it is that a crop precedes their stomach.

For purposes of defence, and to enable them to escape from their foes, the Cephalopoda have what is called their ink. This is contained in a membranous pouch, which is attached to the body and provided with a terminal outlet just at the point where what is termed the funnel gives issue to the residua of the stomach. This funnel is placed on the ventral surface of the animal. All Cephalopoda alike have this characteristic ink, but chief of all the Sepia, where it is more abundant than in the rest. When the animal is disturbed and frightened it uses this ink to make the surrounding water black and turbid, and so, as it were, puts a shield in front of its body.

In the Calamaries and the Poulps the ink-bag is placed in the upper part of the body, in close proximity to the mytis, whereas in the Sepia it is lower down, against the stomach. For the Sepia has a more plentiful supply of ink than the rest, inasmuch as it makes more use of it. The reasons for this are, firstly, that it lives near the shore, and, secondly, that it has no other means of protection; whereas the Poulp has its long twining feet to use in its defence, and is, moreover, endowed with the power of changing colour. This changing of colour, like the discharge of ink, occurs as the result of fright. As to the Calamary, it lives far out at sea, being the only one of the Cephalopoda that does so; and this gives it protection. These then are the reasons why the ink is more abundant in the Sepia than in the Calamary, and this greater abundance explains the lower position; for it allows the ink to be ejected with ease even from a distance. The ink itself is of an earthy character, in this resembling the white deposit on the surface of a bird's excrement and the explanation in both cases is the same, namely, the absence of a urinary bladder. For, in default of this, it is the ink that serves for the excretion of the earthiest matter. And this is more especially the case in the Sepia, because

there is a greater proportion of earth in its composition than in that of the other Cephalopoda. The earthy character of its bone is a clear indication of this. For in the Poulp there is no bone at all, and in the Calamary it is thin and cartilaginous. Why this bone should be present in some Cephalopoda, and wanting in others, and how its character varies in those that have it, has now been set forth.

These animals, having no blood, are in consequence cold and of a timid character. Now, in some animals, fear causes a disturbance of the bowels, and, in others, a flow of urine from the bladder. Similarly in these it produces a discharge of ink, and, though the ejection of this ink in fright, like that of the urine, is the result of necessity, and, though it is of excremental character, yet it is used by nature for a purpose, namely, the protection and safety of the animal that excretes it.

The Crustacea also, both the Caraboid forms and the Crabs, are provided with teeth, namely their two anterior teeth; and between these they also present the tongue-like piece of flesh, as has indeed been already mentioned. Directly after their mouth comes a gullet, which, if we compare relative sizes, is but small in proportion to the body: and then a stomach, which in the Carabi and some of the Crabs is furnished with a second set of teeth, the anterior teeth being insufficient for adequate mastication. From the stomach a uniform gut runs in a direct line to the excremental vent.

The parts described are to be found also in all the various Testacea. The degree of distinctness, however, with which they are formed varies in the different kinds, and the larger the size of the animal the more easily distinguishable are all these parts severally. In the Sea-snails, for example, we find teeth, hard and sharp, as before mentioned, and between them the flesh-like substance, just as in the Crustacea and Cephalopoda, and again the proboscis, which, as has been stated, is something between a sting and a tongue. Directly after the mouth comes a kind of bird-like crop, then a gullet, succeeded by a stomach, in which is the mecon, as it is styled; and continuous with this mecon is an intestine, starting directly from it. It is

this residual substance which appears in all the Testacea to form the most palatable morsel. Purpuras and Whelks, and all other Testacea that have turbinate shells, in structure resemble the Sea-snail. The genera and species of Testacea are very numerous. For there are those with turbinate shells, of which some have just been mentioned; and, besides these, there are bivalves and univalves. Those with turbinate shells may, indeed, after a certain fashion be said to resemble bivalves. For they all from their very birth have an operculum to protect that part of their body which is exposed to view. This is the case with the Purpuras, with Whelks, with the Nerites, and the like. Were it not for this, the part which is undefended by the shell would be very liable to injury by collision with external objects. The univalves also are not without protection. For on their dorsal surface they have a shell, and by the under surface they attach themselves to the rocks, and so after a manner become bivalved, the rock representing the second valve. Of these the animals known as Limpets are an example. The bivalves, scallops and mussels, for instance, are protected by the power they have of closing their valves; and the Turbinata by the operculum just mentioned, which transforms them, as it were, crom univalves into bivalves. But of all there is none so perfectly protected as the sea-urchin. For here there is a globular shell which encloses the body completely, and which is, moreover, set with sharp spines. This peculiarity distinguishes the sea-urchin from all other Testacea, as has already been mentioned.

The structure of the Testacea and of the Crustacea is exactly the reverse of that of the Cephalopoda. For in the latter the fleshy substance is on the outside and the earthy substance within, whereas in the former the soft parts are inside and the hard part without. In the sea-urchin, however, there is no fleshy part whatsoever.

All the Testacea then, those that have not been mentioned as well as those that have, agree as stated in possessing a mouth with the tongue-like body, a stomach, and a vent for excrement, but they differ from each other in the positions and proportions of these parts. The details, however, of these differences must be looked for in the

Researches concerning Animals and the treatises on Anatomy. For while there are some points which can be made clear by verbal description, there are others which are more suited for ocular demonstration.

Peculiar among the Testacea are the sea-urchins and the animals known as Tethya (Ascidians). The sea-urchins have five teeth, and in the centre of these the fleshy body which is common to all the animals we have been discussing. Immediately after this comes a gullet, and then the stomach, divided into a number of separate compartments, which look like so many distinct stomachs; for the cavities are separate and all contain abundant residual matter. They are all, however, connected with one and the same oesophagus, and they all end in one and the same excremental vent. There is nothing besides the stomach of a fleshy character, as has already been stated. All that can be seen are the so-called ova, of which there are several, contained each in a separate membrane, and certain black bodies which have no name, and which, beginning at the animal's mouth, are scattered round its body here and there promiscuously. These sea-urchins are not all of one species, but there are several different kinds, and in all of them the parts mentioned are to be found. It is not, however, in every kind that the so-called ova are edible. Neither do these attain to any size in any other species than that with which we are all familiar. A similar distinction may be made generally in the case of all Testacea. For there is a great difference in the edible qualities of the flesh of different kinds; and in some, moreover, the residual substance known as the mecon is good for food, while in others it is uneatable. This mecon in the turbinated genera is lodged in the spiral part of the shell, while in univalves, such as limpets, it occupies the fundus, and in bivalves is placed near the hinge, the so-called ovum lying on the right; while on the opposite side is the vent. The former is incorrectly termed ovum, for it merely corresponds to what in well-fed sanguineous animals is fat; and thus it is that it makes its appearance in Testacea at those seasons of the year when they are in good condition, namely, spring and autumn. For no Testacea can abide extremes of temperature, and they are

therefore in evil plight in seasons of great cold or heat. This is clearly shown by what occurs in the case of the sea-urchins. For though the ova are to be found in these animals even directly they are born, yet they acquire a greater size than usual at the time of full moon; not, as some think, because sea-urchins eat more at that season, but because the nights are then warmer, owing to the moonlight. For these creatures are bloodless, and so are unable to stand cold and require warmth. Therefore it is that they are found in better condition in summer than at any other season; and this all over the world excepting in the Pyrrhean tidal strait. There the sea-urchins flourish as well in winter as in summer. But the reason for this is that they have a greater abundance of food in the winter, because the fish desert the strait at that season.

The number of the ova is the same in all sea-urchins, and is an odd one. For there are five ova, just as there are also five teeth and five stomachs; and the explanation of this is to be found in the fact that the so-called ova are not really ova, but merely, as was said before, the result of the animal's well-fed condition. Oysters also have a so-called ovum, corresponding in character to that of the sea-urchins, but existing only on one side of their body. Now inasmuch as the sea-urchin is of a spherical form, and not merely a single disk like the oyster, and in virtue of its spherical shape is the same from whatever side it be examined, its ovum must necessarily be of a corresponding symmetry. For the spherical shape has not the asymmetry of the disk-shaped body of the oysters. For in all these animals the head is central, but in the sea-urchin the so-called ovum is above [and symmetrical, while in the oyster it is only one side]. Now the necessary symmetry would be observed were the ovum to form a continuous ring. But this may not be. For it would be in opposition to what prevails in the whole tribe of Testacea; for in all the ovum is discontinuous, and in all excepting the sea-urchins asymmetrical, being placed only on one side of the body. Owing then to this necessary discontinuity of the ovum, which belongs to the sea-urchin as a member of the class, and owing to the spherical shape of its body, which is its individual peculiarity, this animal cannot possibly

have an even number of ova. For were they an even number, they would have to be arranged exactly opposite to each other, in pairs, so as to keep the necessary symmetry; one ovum of each pair being placed at one end, the other ovum at the other end of a transverse diameter. This again would violate the universal provision in Testacea. For both in the oysters and in the scallops we find the ovum only on one side of the circumference. The number then of the ova must be uneven, three for instance, or five. But if there were only three they would be much too far apart; while, if there were more than five, they would come to form a continuous mass. The former arrangement would be disadvantageous to the animal, the latter an impossibility. There can therefore be neither more nor less than five. For the same reason the stomach is divided into five parts, and there is a corresponding number of teeth. For seeing that the ova represent each of them a kind of body for the animal, their disposition must conform to that of the stomach, seeing that it is from this that they derive the material for their growth. Now if there were only one stomach, either the ova would be too far off from it, or it would be so big as to fill up the whole cavity, and the sea-urchin would have great difficulty in moving about and finding due nourishment for its repletion. As then there are five intervals between the five ova, so are there of necessity five divisions of the stomach, one for each interval. So also, and on like grounds, there are five teeth. For nature is thus enabled to allot to each stomachal compartment and ovum its separate and similar tooth. These, then, are the reasons why the number of ova in the sea-urchin is an odd one, and why that odd number is five. In some sea-urchins the ova are excessively small, in others of considerable size, the explanation being that the latter are of a warmer constitution, and so are able to concoct their food more thoroughly; while in the former concoction is less perfect, so that the stomach is found full of residual matter, while the ova are small and uneatable. Those of a warmer constitution are, moreover, in virtue of their warmth more given to motion, so that they make expeditions in search of food, instead of remaining stationary like the rest. As evidence of this, it will be found that they always have

something or other sticking to their spines, as though they moved much about; for they use their spines as feet.

The Ascidians differ but slightly from plants, and yet have more of an animal nature than the sponges, which are virtually plants and nothing more. For nature passes from lifeless objects to animals in such unbroken sequence, interposing between them beings which live and yet are not animals, that scarcely any difference seems to exist between two neighbouring groups owing to their close proximity.

A sponge, then, as already said, in these respects completely resembles a plant, that throughout its life it is attached to a rock, and that when separated from this it dies. Slightly different from the sponges are the so-called Holothurias and the sea-lungs, as also sundry other sea-animals that resemble them. For these are free and unattached. Yet they have no feeling, and their life is simply that of a plant separated from the ground. For even among land-plants there are some that are independent of the soil, and that spring up and grow, either upon other plants, or even entirely free. Such, for example, is the plant which is found on Parnassus, and which some call the Epipetrum. This you may hang up on a peg and it will yet live for a considerable time. Sometimes it is a matter of doubt whether a given organism should be classed with plants or with animals. The Ascidians, for instance, and the like so far resemble plants as that they never live free and unattached, but, on the other hand, inasmuch as they have a certain flesh-like substance, they must be supposed to possess some degree of sensibility.

An Ascidian has a body divided by a single septum and with two orifices, one where it takes in the fluid matter that ministers to its nutrition, the other where it discharges the surplus of unused juice, for it has no visible residual substance, such as have the other Testacea. This is itself a very strong justification for considering an Ascidian, and anything else there may be among animals that resembles it, to be of a vegetable character; for plants also never have any residuum. Across the middle of the body of these Ascidians there runs a thin

transverse partition, and here it is that we may reasonably suppose the part on which life depends to be situated.

The Acalephae, or Sea-nettles, as they are variously called, are not Testacea at all, but lie outside the recognized groups. Their constitution, like that of the Ascidians, approximates them on one side to plants, on the other to animals. For seeing that some of them can detach themselves and can fasten upon their food, and that they are sensible of objects which come in contact with them, they must be considered to have an animal nature. The like conclusion follows from their using the asperity of their bodies as a protection against their enemies. But, on the other hand, they are closely allied to plants, firstly by the imperfection of their structure, secondly by their being able to attach themselves to the rocks, which they do with great rapidity, and lastly by their having no visible residuum notwithstanding that they possess a mouth.

Very similar again to the Acalephae are the Starfishes. For these also fasten on their prey, and suck out its juices, and thus destroy a vast number of oysters. At the same time they present a certain resemblance to such of the animals we have described as the Cephalopoda and Crustacea, inasmuch as they are free and unattached. The same may also be said of the Testacea.

Such, then, is the structure of the parts that minister to nutrition and which every animal must possess. But besides these organs it is quite plain that in every animal there must be some part or other which shall be analogous to what in sanguineous animals is the presiding seat of sensation. Whether an animal has or has not blood, it cannot possibly be without this. In the Cephalopoda this part consists of a fluid substance contained in a membrane, through which runs the gullet on its way to the stomach. It is attached to the body rather towards its dorsal surface, and by some is called the mytis. Just such another organ is found also in the Crustacea and there too is known by the same name. This part is at once fluid and corporeal and, as before said, is traversed by the gullet. For had the gullet been placed between the mytis and the dorsal surface of the animal, the

hardness of the back would have interfered with its due dilatation in the act of deglutition. On the outer surface of the mytis runs the intestine; and in contact with this latter is placed the ink-bag, so that it may be removed as far as possible from the mouth and its obnoxious fluid be kept at a distance from the nobler and sovereign part. The position of the mytis shows that it corresponds to the heart of sanguineous animals; for it occupies the self-same place. The same is shown by the sweetness of its fluid, which has the character of concocted matter and resembles blood.

In the Testacea the presiding seat of sensation is in a corresponding position, but is less easily made out. It should, however, always be looked for in some midway position; namely, in such Testacea as are stationary, midway between the part by which food is taken in and the channel through which either the excrement or the spermatic fluid is voided, and, in those species which are capable of locomotion, invariably midway between the right and left sides.

In Insects this organ, which is the seat of sensation, lies, as was stated in the first treatise, between the head and the cavity which contains the stomach. In most of them it consists of a single part; but in others, for instance in such as have long bodies and resemble the Juli (Millipedes), it is made up of several parts, so that such insects continue to live after they have been cut in pieces. For the aim of nature is to give to each animal only one such dominant part; and when she is unable to carry out this intention she causes the parts, though potentially many, to work together actually as one. This is much more clearly marked in some insects than in others.

The parts concerned in nutrition are not alike in all insects, but show considerable diversity. Thus some have what is called a sting in the mouth, which is a kind of compound instrument that combines in itself the character of a tongue and of lips. In others that have no such instrument in front there is a part inside the mouth that answers the same sensory purposes. Immediately after the mouth comes the intestine, which is never wanting in any insect. This runs in a straight line and without further complication to the vent; oc-

casionally, however, it has a spiral coil. There are, moreover, some insects in which a stomach succeeds to the mouth, and is itself succeeded by a convoluted intestine, so that the larger and more voracious insects may be enabled to take in a more abundant supply of food. More curious than any are the Cicadae. For here the mouth and the tongue are united so as to form a single part, through which, as through a root, the insect sucks up the fluids on which it lives. Insects are always small eaters, not so much because of their diminutive size as because of their cold temperament. For it is heat which requires sustenance; just as it is heat which speedily concocts it. But cold requires no sustenance. In no insects is this so conspicuous as in these Cicadae. For they find enough to live on in the moisture which is deposited from the air. So also do the Ephemera that are found about the Black sea. But while these latter only live for a single day, the Cicadae subsist on such food for several days, though still not many.

We have now done with the internal parts of animals, and must therefore return to the consideration of the external parts which have not yet been described. It will be better to change our order of exposition and begin with the animals we have just been describing, so that proceeding from these, which require less discussion, our account may have more time to spend on the perfect kinds of animals, those namely that have blood.

6

We will begin with Insects. These animals, though they present no great multiplicity of parts, are not without diversities when compared with each other. They are all manyfooted; the object of this being to compensate their natural slowness and frigidity, and give greater activity to their motions. Accordingly we find that those which, as the (Millipedes), have long bodies, and are therefore the most liable to refrigeration, have also the greatest number of feet. Again, the body in these animals is insected-the reason for this being

that they have not got one vital centre but many-and the number of their feet corresponds to that of the insections.

Should the feet fall short of this, their deficiency is compensated by the power of flight. Of such flying insects some live a wandering life, and are forced to make long expeditions in search of food. These have a body of light weight, and four feathers, two on either side, to support it. Such are bees and the insects akin to them. When, however, such insects are of very small bulk, their feathers are reduced to two, as is the case with flies. Insects with heavy bodies and of stationary habits, though not polypterous in the same way as bees, yet have sheaths to their feathers to maintain their efficiency. Such are the Melolonthae and the like. For their stationary habits expose their feathers to much greater risks than are run by those of insects that are more constantly in flight, and on this account they are provided with this protecting shield. The feather of an insect has neither barbs nor shaft. For, though it is called a feather, it is no feather at all, but merely a skin-like membrane that, owing to its dryness, necessarily becomes detached from the surface of the body, as the fleshy substance grows cold.

These animals then have their bodies insected, not only for the reasons already assigned, but also to enable them to curl round in such a manner as may protect them from injury; for such insects as have long bodies can roll themselves up, which would be impossible were it not for the insections; and those that cannot do this can yet draw their segments up into the insected spaces, and so increase the hardness of their bodies. This can be felt quite plainly by putting the finger on one of the insects, for instance, known as Canthari. The touch frightens the insect, and it remains motionless, while its body becomes hard. The division of the body into segments is also a necessary result of there being several supreme organs in place of one; and this again is a part of the essential constitution of insects, and is a character which approximates them to plants. For as plants, though cut into pieces, can still live, so also can insects. There is, however, this difference between the two cases, that the portions of

the divided insect live only for a limited time, whereas the portions of the plant live on and attain the perfect form of the whole, so that from one single plant you may obtain two or more.

Some insects are also provided with another means of protection against their enemies, namely a sting. In some this is in front, connected with the tongue, in others behind at the posterior end. For just as the organ of smell in elephants answers several uses, serving alike as a weapon and for purposes of nutrition, so does also the sting, when placed in connexion with the tongue, as in some insects, answer more than one end. For it is the instrument through which they derive their sensations of food, as well as that with which they suck it up and bring it to the mouth. Such of these insects as have no anterior sting are provided with teeth, which serve in some of them for biting the food, and in others for its prehension and conveyance to the mouth. Such are their uses, for instance, in ants and all the various kinds of bees. As for the insects that have a sting behind, this weapon is given them because they are of a fierce disposition. In some of them the sting is lodged inside the body, in bees, for example, and wasps. For these insects are made for flight, and were their sting external and of delicate make it would soon get spoiled; and if, on the other hand, it were of thicker build, as in scorpions, its weight would be an incumbrance. As for scorpions that live on the ground and have a tail, their sting must be set upon this, as otherwise it would be of no use as a weapon. Dipterous insects never have a posterior sting. For the very reason of their being dipterous is that they are small and weak, and therefore require no more than two feathers to support their light weight; and the same reason which reduces their feathers to two causes their sting to be in front; for their strength is not sufficient to allow them to strike efficiently with the hinder part of the body. Polypterous insects, on the other hand, are of greater bulk-indeed it is this which causes them to have so many feathers; and their greater size makes them stronger in their hinder parts. The sting of such insects is therefore placed behind. Now it is better, when possible, that one and the same instrument shall not be made to serve several dissimilar uses; but that there shall be one

organ to serve as a weapon, which can then be very sharp, and a distinct one to serve as a tongue, which can then be of spongy texture and fit to absorb nutriment. Whenever, therefore, nature is able to provide two separate instruments for two separate uses, without the one hampering the other, she does so, instead of acting like a coppersmith who for cheapness makes a spit and lampholder in one. It is only when this is impossible that she uses one organ for several functions.

The anterior legs are in some cases longer than the others, that they may serve to wipe away any foreign matter that may lodge on the insect's eyes and obstruct its sight, which already is not very distinct owing to the eyes being made of a hard substance. Flies and bees and the like may be constantly seen thus dressing themselves with crossed forelegs. Of the other legs, the hinder are bigger than the middle pair, both to aid in running and also that the insect, when it takes flight, may spring more easily from the ground. This difference is still more marked in such insects as leap, in locusts for instance, and in the various kinds of fleas. For these first bend and then extend the legs, and, by doing so, are necessarily shot up from the ground. It is only the. hind legs of locusts, and not the front ones, that resemble the steering oars of a ship. For this requires that the joint shall be deflected inwards, and such is never the case with the anterior limbs. The whole number of legs, including those used in leaping, is six in all these insects.

7

In the Testacea the body consists of but few parts, the reason being that these animals live a stationary life. For such animals as move much about must of necessity have more numerous parts than such as remain quiet; for their activities are many, and the more diversified the movements the greater the number of organs required to effect them. Some species of Testacea are absolutely motionless, and others not quite but nearly so. Nature, however, has provided them with a protection in the hardness of the shell with which she has in-

vested their body. This shell, as already has been said, may have one valve, or two valves, or be turbinate. In the latter case it may be either spiral, as in whelks, or merely globular, as in sea-urchins. When it has two valves, these may be gaping, as in scallops and mussels, where the valves are united together on one side only, so as to open and shut on the other; or they may be united together on both sides, as in the Solens (razor-fishes). In all cases alike the Testacea have, like plants, the head downwards. The reason for this is, that they take in their nourishment from below, just as do plants with their roots. Thus the under parts come in them to be above, and the upper parts to be below. The body is enclosed in a membrane, and through this the animal filters fluid free from salt and absorbs its nutriment. In all there is a head; but none of the parts, excepting this recipient of food, has any distinctive name.

8

All the Crustacea can crawl as well as swim, and accordingly they are provided with numerous feet. There are four main genera, viz. the Carabi, as they are called, the Astaci, the Carides, and the Carcini. In each of these genera, again, there are numerous species, which differ from each other not only as regards shape, but also very considerably as regards size. For, while in some species the individuals are large, in others they are excessively minute. The Carcinoid and Caraboid Crustacea resemble each other in possessing claws. These claws are not for locomotion, but to serve in place of hands for seizing and holding objects; and they are therefore bent in the opposite direction to the feet, being so twisted as to turn their convexity towards the body, while their feet turn towards it their concavity. For in this position the claws are best suited for laying hold of the food and carrying it to the mouth. The distinction between the Carabi and the Carcini (Crabs) consists in the former having a tail while the latter have none. For the Carabi swim about and a tail is therefore of use to them, serving for their propulsion like the blade of an oar. But it would be of no use to the Crabs; for these animals live habitually close to the shore, and creep into holes and corners. In such of them

as live out at sea, the feet are much less adapted for locomotion than in the rest, because they are little given to moving about but depend for protection on their shell-like covering. The Maiae and the crabs known as Heracleotic are examples of this; the legs in the former being very thin, in the latter very short.

The very minute crabs that are found among the small fry at the bottom of the net have their hindermost feet flattened out into the semblance of fins or oar-blades, so as to help the animal in swimming.

The Carides are distinguished from the Carcinoid species by the presence of a tail; and from the Caraboids by the absence of claws. This is explained by their large number of feet, on which has been expended the material for the growth of claws. Their feet again are numerous to suit their mode of progression, which is mainly by swimming.

Of the parts on the ventral surface, those near the head are in some of these animals formed like gills, for the admission and discharge of water; while the parts lower down differ in the two sexes. For in the female Carabi these are more laminar than in the males, and in the female crabs the flap is furnished with hairier appendages. This gives ampler space for the disposal of the ova, which the females retain in these parts instead of letting them go free, as do fishes and all other oviparous animals. In the Carabi and in the Crabs the right claw is invariably the larger and the stronger. For it is natural to every animal in active operations to use the parts on its right side in preference to those on its left; and nature, in distributing the organs, invariably assigns each, either exclusively or in a more perfect condition, to such animals as can use it. So it is with tusks, and teeth, and horns, and spurs, and all such defensive and offensive weapons.

In the Lobsters alone it is a matter of chance which claw is the larger, and this in either sex. Claws they must have, because they belong to a genus in which this is a constant character; but they have them in this indeterminate way, owing to imperfect formation and

to their not using them for their natural purpose, but for locomotion.

For a detailed account of the several parts of these animals, of their position and their differences, those parts being also included which distinguish the sexes, reference must be made to the treatises on Anatomy and to the Researches concerning Animals.

9

We come now to the Cephalopoda. Their internal organs have already been described with those of other animals. Externally there is the trunk of the body, not distinctly defined, and in front of this the head surrounded by feet, which form a circle about the mouth and teeth, and are set between these and the eyes. Now in all other animals the feet, if there are any, are disposed in one of two ways; either before and behind or along the sides, the latter being the plan in such of them, for instance, as are bloodless and have numerous feet. But in the Cephalopoda there is a peculiar arrangement, different from either of these. For their feet are all placed at what may be called the fore end. The reason for this is that the hind part of their body has been drawn up close to the fore part, as is also the case in the turbinated Testacea. For the Testacea, while in some points they resemble the Crustacea, in others resemble the Cephalopoda. Their earthy matter is on the outside, and their fleshy substance within. So far they are like the Crustacea. But the general plan of their body is that of the Cephalopoda; and, though this is true in a certain degree of all the Testacea, it is more especially true of those turbinated species that have a spiral shell. Of this general plan, common to the two, we will speak presently. But let us first consider the case of quadrupeds and of man, where the arrangement is that of a straight line. Let A at the upper end of such a line be supposed to represent the mouth, then B the gullet, and C the stomach, and the intestine to run from this C to the excremental vent where D is inscribed. Such is the plan in sanguineous animals; and round this straight line as an axis are disposed the head and so-called trunk; the remaining

parts, such as the anterior and posterior limbs, having been superadded by nature, merely to minister to these and for locomotion.

In the Crustacea also and in Insects there is a tendency to a similar arrangement of the internal parts in a straight line; the distinction between these groups and the sanguineous animals depending on differences of the external organs which minister to locomotion. But the Cephalopoda and the turbinated Testacea have in common an arrangement which stands in contrast with this. For here the two extremities are brought together by a curve, as if one were to bend the straight line marked E until D came close to Such, then, is the disposition of the internal parts; and round these, in the Cephalopoda, is placed the sac (in the Poulps alone called a head), and, in the Testacea, the turbinate shell which corresponds to the sac. There is, in fact, only this difference between them, that the investing substance of the Cephalopoda is soft while the shell of the Testacea is hard, nature having surrounded their fleshy part with this hard coating as a protection because of their limited power of locomotion. In both classes, owing to this arrangement of the internal organs, the excrement is voided near the mouth; at a point below this orifice in the Cephalopoda, and in the Turbinata on one side of it.

Such, then, is the explanation of the position of the feet in the Cephalopoda, and of the contrast they present to other animals in this matter. The arrangement, however, in the Sepias and the Calamaries is not precisely the same as in the Poulps, owing to the former having no other mode of progression than by swimming, while the latter not only swim but crawl. For in the former six of the feet are above the teeth and small, the outer one on either side being the biggest; while the remaining two, which make up the total weight, are below the mouth and are the biggest of all, just as the hind limbs in quadrupeds are stronger than the fore limbs. For it is these that have to support the weight, and to take the main part in locomotion. And the outer two of the upper six are bigger than the pair which intervene between them and the uppermost of all, because they have to assist the lowermost pair in their office. In the Poulps, on the other

hand, the four central feet are the biggest. Again, though the number of feet is the same in all the Cephalopoda, namely eight, their length varies in different kinds, being short in the Sepias and the Calamaries, but greater in the Poulps. For in these latter the trunk of the body is of small bulk, while in the former it is of considerable size; and so in the one case nature has used the materials subtracted from the body to give length to the feet, while in the other she has acted in precisely the opposite way, and has given to the growth of the body what she has first taken from the feet. The Poulps, then, owing to the length of their feet, can not only swim but crawl, whereas in the other genera the feet are useless for the latter mode of progression, being small while the bulk of the body is considerable. These short feet would not enable their possessors to cling to the rocks and keep themselves from being torn off by the waves when these run high in times of storm; neither would they serve to lay hold of objects at all remote and bring them in; but, to supply these defects, the animal is furnished with two long proboscises, by which it can moor itself and ride at anchor like a ship in rough weather. These same processes serve also to catch prey at a distance and to bring it to the mouth. They are so used by both the Sepias and the Calamaries. In the Poulps the feet are themselves able to perform these offices, and there are consequently no proboscises. Proboscises and twining tentacles, with acetabula set upon them, act in the same way and have the same structure as those plaited instruments which were used by physicians of old to reduce dislocations of the fingers. Like these they are made by the interlacing of their fibres, and they act by pulling upon pieces of flesh and yielding substances. For the plaited fibres encircle an object in a slackened condition, and when they are put on the stretch they grasp and cling tightly to whatever it may be that is in contact with their inner surface. Since, then, the Cephalopoda have no other instruments with which to convey anything to themselves from without, than either twining tentacles, as in some species, or proboscises as in others, they are provided with these to serve as hands for offence and defence and other necessary uses.

The acetabula are set in double line in all the Cephalopoda excepting in one kind of poulp, where there is but a single row. The length and the slimness which is part of the nature of this kind of poulp explain the exception. For a narrow space cannot possibly admit of more than a single row. This exceptional character, then, belongs to them, not because it is the most advantageous arrangement, but because it is the necessary consequence of their essential specific constitution.

In all these animals there is a fin, encircling the sac. In the Poulps and the Sepias this fin is unbroken and continuous, as is also the case in the larger calamaries known as Teuthi. But in the smaller kind, called Teuthides, the fin is not only broader than in the Sepias and the Poulps, where it is very narrow, but, moreover, does not encircle the entire sac, but only begins in the middle of the side. The use of this fin is to enable the animal to swim, and also to direct its course. It acts, that is, like the rump-feathers in birds, or the tail-fin in fishes. In none is it so small or so indistinct as in the Poulps. For in these the body is of small bulk and can be steered by the feet sufficiently well without other assistance.

The Insects, the Crustacea, the Testacea, and the Cephalopoda, have now been dealt with in turn; and their parts have been described, whether internal or external.

10

We must now go back to the animals that have blood, and consider such of their parts, already enumerated, as were before passed over. We will take the viviparous animals first, and, we have done with these, will pass on to the oviparous, and treat of them in like manner.

The parts that border on the head, and on what is known as the neck and throat, have already been taken into consideration. All animals that have blood have a head; whereas in some bloodless animals, such as crabs, the part which represents a head is not clearly defined. As to the neck, it is present in all the Vivipara, but only

in some of the Ovipara; for while those that have a lung also have a neck, those that do not inhale the outer air have none. The head exists mainly for the sake of the brain. For every animal that has blood must of necessity have a brain; and must, moreover, for reasons already given, have it placed in an opposite region to the heart. But the head has also been chosen by nature as the part in which to set some of the senses; because its blood is mixed in such suitable proportions as to ensure their tranquillity and precision, while at the same time it can supply the brain with such warmth as it requires. There is yet a third constituent superadded to the head, namely the part which ministers to the ingestion of food. This has been placed here by nature, because such a situation accords best with the general configuration of the body. For the stomach could not possibly be placed above the heart, seeing that this is the sovereign organ; and if placed below, as in fact it is, then the mouth could not possibly be placed there also. For this would have necessitated a great increase in the length of the body; and the stomach, moreover, would have been removed too far from the source of motion and of concoction.

The head, then, exists for the sake of these three parts; while the neck, again, exists for the sake of the windpipe. For it acts as a defence to this and to the oesophagus, encircling them and keeping them from injury. In all other animals this neck is flexible and contains several vertebrae; but in wolves and lions it contains only a single bone. For the object of nature was to give these animals an organ which should be serviceable in the way of strength, rather than one that should be useful for any of the other purposes to which necks are subservient.

Continuous with the head and neck is the trunk with the anterior limbs. In man the forelegs and forefeet are replaced by arms and by what we call hands. For of all animals man alone stands erect, in accordance with his godlike nature and essence. For it is the function of the god-like to think and to be wise; and no easy task were this under the burden of a heavy body, pressing down from above and obstructing by its weight the motions of the intellect and of the

general sense. When, moreover, the weight and corporeal substance become excessive, the body must of necessity incline towards the ground. In such cases therefore nature, in order to give support to the body, has replaced the arms and hands by forefeet, and has thus converted the animal into a quadruped. For, as every animal that walks must of necessity have the two hinder feet, such an animal becomes a quadruped, its body inclining downwards in front from the weight which its soul cannot sustain. For all animals, man alone excepted, are dwarf-like in form. For the dwarf-like is that in which the upper part is large, while that which bears the weight and is used in progression is small. This upper part is what we call the trunk, which reaches from the mouth to the vent. In man it is duly proportionate to the part below, and diminishes much in its comparative size as the man attains to full growth. But in his infancy the contrary obtains, and the upper parts are large, while the lower part is small; so that the infant can only crawl, and is unable to walk; nay, at first cannot even crawl, but remains without motion. For all children are dwarfs in shape, but cease to be so as they become men, from the growth of their lower part; whereas in quadrupeds the reverse occurs, their lower parts being largest in youth, and advance of years bringing increased growth above, that is in the trunk, which extends from the rump to the head. Thus it is that colts are scarcely, if at all, below full-grown horses in height; and that while still young they can touch their heads with the hind legs, though this is no longer possible when they are older. Such, then, is the form of animals that have either a solid or a cloven hoof. But such as are polydactylous and without horns, though they too are of dwarf-like shape, are so in a less degree; and therefore the greater growth of the lower parts as compared with the upper is also small, being proportionate to this smaller deficiency.

Dwarf-like again is the race of birds and fishes; and so in fact, as already has been said, is every animal that has blood. This is the reason why no other animal is so intelligent as man. For even among men themselves if we compare children with adults, or such adults as are of dwarf-like shape with such as are not, we find that, whatever

other superiority the former may possess, they are at any rate deficient as compared with the latter in intelligence. The explanation, as already stated, is that their psychical principle is corporeal, and much impeded in its motions. Let now a further decrease occur in the elevating heat, and a further increase in the earthy matter, and the animals become smaller in bulk, and their feet more numerous, until at a later stage they become apodous, and extended full length on the ground. Then, by further small successions of change, they come to have their principal organ below; and at last their cephalic part becomes motionless and destitute of sensation. Thus the animal becomes a plant, that has its upper parts downwards and its lower parts above. For in plants the roots are the equivalents of mouth and head, while the seed has an opposite significance, for it is produced above it the extremities of the twigs.

The reasons have now been stated why some animals have many feet, some only two, and others none; why, also, some living things are plants and others animals; and, lastly, why man alone of all animals stands erect. Standing thus erect, man has no need of legs in front, and in their stead has been endowed by nature with arms and hands. Now it is the opinion of Anaxagoras that the possession of these hands is the cause of man being of all animals the most intelligent. But it is more rational to suppose that his endowment with hands is the consequence rather than the cause of his superior intelligence. For the hands are instruments or organs, and the invariable plan of nature in distributing the organs is to give each to such animal as can make use of it; nature acting in this matter as any prudent man would do. For it is a better plan to take a person who is already a flute-player and give him a flute, than to take one who possesses a flute and teach him the art of flute-playing. For nature adds that which is less to that which is greater and more important, and not that which is more valuable and greater to that which is less. Seeing then that such is the better course, and seeing also that of what is possible nature invariably brings about the best, we must conclude that man does not owe his superior intelligence to his hands, but his hands to his superior intelligence. For the most intelligent of

animals is the one who would put the most organs to use; and the hand is not to be looked on as one organ but as many; for it is, as it were, an instrument for further instruments. This instrument, therefore,-the hand-of all instruments the most variously serviceable, has been given by nature to man, the animal of all animals the most capable of acquiring the most varied handicrafts.

Much in error, then, are they who say that the construction of man is not only faulty, but inferior to that of all other animals; seeing that he is, as they point out, bare-footed, naked, and without weapon of which to avail himself. For other animals have each but one mode of defence, and this they can never change; so that they must perform all the offices of life and even, so to speak, sleep with sandals on, never laying aside whatever serves as a protection to their bodies, nor changing such single weapon as they may chance to possess. But to man numerous modes of defence are open, and these, moreover, he may change at will; as also he may adopt such weapon as he pleases, and at such times as suit him. For the hand is talon, hoof, and horn, at will. So too it is spear, and sword, and whatsoever other weapon or instrument you please; for all these can it be from its power of grasping and holding them all. In harmony with this varied office is the form which nature has contrived for it. For it is split into several divisions, and these are capable of divergence. Such capacity of divergence does not prevent their again converging so as to form a single compact body, whereas had the hand been an undivided mass, divergence would have been impossible. The divisions also may be used singly or two together and in various combinations. The joints, moreover, of the fingers are well constructed for prehension and for pressure. One of these also, and this not long like the rest but short and thick, is placed laterally. For were it not so placed all prehension would be as impossible, as were there no hand at all. For the pressure of this digit is applied from below upwards, while the rest act from above downwards; an arrangement which is essential, if the grasp is to be firm and hold like a tight clamp. As for the shortness of this digit, the object is to increase its strength, so that it may be able, though but one, to counterbalance its more numerous opponents.

Moreover, were it long it would be of no use. This is the explanation of its being sometimes called the great digit, in spite of its small size; for without it all the rest would be practically useless. The finger which stands at the other end of the row is small, while the central one of all is long, like a centre oar in a ship. This is rightly so; for it is mainly by the central part of the encircling grasp that a tool must be held when put to use.

No less skilfully contrived are the nails. For, while in man these serve simply as coverings to protect the tips of the fingers, in other animals they are also used for active purposes; and their form in each case is suited to their office.

The arms in man and the fore limbs in quadrupeds bend in contrary directions, this difference having reference to the ingestion of food and to the other offices which belong to these parts. For quadrupeds must of necessity bend their anterior limbs inwards that they may serve in locomotion, for they use them as feet. Not but what even among quadrupeds there is at any rate a tendency for such as are polydactylous to use their forefeet not only for locomotion but as hands. And they are in fact so used, as any one may see. For these animals seize hold of objects, and also repel assailants with their anterior limbs; whereas quadrupeds with solid hoofs use their hind legs for this latter purpose. For their fore limbs are not analogous to the arms and hands of man.

It is this hand-like office of the anterior limbs which explains why in some of the polydactylous quadrupeds, such as wolves, lions, dogs, and leopards, there are actually five digits on each forefoot, though there are only four on each hind one. For the fifth digit of the foot corresponds to the fifth digit of the hand, and like it is called the big one. It is true that in the smaller polydactylous quadrupeds the hind feet also have each five toes. But this is because these animals are creepers; and the increased number of nails serves to give them a tighter grip, and so enables them to creep up steep places with greater facility, or even to run head downwards.

In man between the arms, and in other animals between the forelegs, lies what is called the breast. This in man is broad, as one might expect; for as the arms are set laterally on the body, they offer no impediment to such expansion in this part. But in quadrupeds the breast is narrow, owing to the legs having to be extended in a forward direction in progression and locomotion.

Owing to this narrowness the mammae of quadrupeds are never placed on the breast. But in the human body there is ample space in this part; moreover, the heart and neighbouring organs require protection, and for these reasons this part is fleshy and the mammae are placed upon it separately, side by side, being themselves of a fleshy substance in the male and therefore of use in the way just stated; while in the female, nature, in accordance with what we say is her frequent practice, makes them minister to an additional function, employing them as a store-place of nutriment for the offspring. The human mammae are two in number, in accordance with the division of the body into two halves, a right and a left. They are somewhat firmer than they would otherwise be, because the ribs in this region are joined together; while they form two separate masses, because their presence is in no wise burdensome. In other animals than man, it is impossible for the mammae to be placed on the breast between the forelegs, for they would interfere with locomotion; they are therefore disposed of otherwise, and in a variety of ways. Thus in such animals as produce but few at a birth, whether horned quadrupeds or those with solid hoofs, the mammae are placed in the region of the thighs, and are two in number, while in such as produce litters, or such as are polydactylous, the dugs are either numerous and placed laterally on the belly, as in swine and dogs, or are only two in number, being set, however, in the centre of the abdomen, as is the case in the lion. The explanation of this latter condition is not that the lion produces few at a birth, for sometimes it has more than two cubs at a time, but is to be found in the fact that this animal has no plentiful supply of milk. For, being a flesheater, it gets food at but rare intervals, and such nourishment as it obtains is all expended on the growth of its body.

In the elephant also there are but two mammae, which are placed under the axillae of the fore limbs. The mammae are not more than two, because this animal has only a single young one at a birth; and they are not placed in the region of the thighs, because they never occupy that position in any polydactylous animal such as this. Lastly, they are placed above, close to the axillae, because this is the position of the foremost dugs in all animals whose dugs are numerous, and the dugs so placed give the most milk. Evidence of this is furnished by the sow. For she always presents these foremost dugs to the first-born of her litter. A single young one is of course a first-born, and so such animals as only produce a single young one must have these anterior dugs to present to it; that is they must have the dugs which are under the axillae. This, then, is the reason why the elephant has but two mammae, and why they are so placed. But, in such animals as have litters of young, the dugs are disposed about the belly; the reason being that more dugs are required by those that will have more young to nourish. Now it is impossible that these dugs should be set transversely in rows of more than two, one, that is, for each side of the body, the right and the left; they must therefore be placed lengthways, and the only place where there is sufficient length for this is the region between the front and hind legs. As to the animals that are not polydactylous but produce few at a birth, or have horns, their dugs are placed in the region of the thighs. The horse, the ass, the camel are examples; all of which bear but a single young one at a time, and of which the two former have solid hoofs, while in the last the hoof is cloven. As still further examples may be mentioned the deer, the ox, the goat, and all other similar animals.

The explanation is that in these animals growth takes place in an upward direction; so that there must be an abundant collection of residual matter and of blood in the lower region, that is to say in the neighbourhood of the orifices for efflux, and here therefore nature has placed the mammae. For the place in which the nutriment is set in motion must also be the place whence nutriment can be derived by them. In man there are mammae in the male as well as in the female; but some of the males of other animals are without them.

Such, for instance, is the case with horses, some stallions being destitute of these parts, while others that resemble their dams have them. Thus much then concerning the mammae.

Next after the breast comes the region of the belly, which is left unenclosed by the ribs for a reason which has already been given; namely that there may be no impediment to the swelling which necessarily occurs in the food as it gets heated, nor to the expansion of the womb in pregnancy.

At the extreme end of what is called the trunk are the parts concerned in the evacuation of the solid and also of the fluid residue. In all sanguineous animals with some few exceptions, and in all Vivipara without any exception at all, the same part which serves for the evacuation of the fluid residue is also made by nature to serve in sexual congress, and this alike in male and female. For the semen is a kind of fluid and residual matter. The proof of this will be given hereafter, but for the present let it taken for granted. (The like holds good of the menstrual fluid in women, and of the part where they emit semen. This also, however, is a matter of which a more accurate account will be given hereafter. For the present let it be simply stated as a fact, that the catamenia of the female like the semen of the male are residual matter. Both of them, moreover, being fluid, it is only natural that the parts which serve for voidance of the urine should give issue to residues which resemble it in character.) Of the internal structure of these parts, and of the differences which exist between the parts concerned with semen and the parts concerned with conception, a clear account is given in the book of Researches concerning Animals and in the treatises on Anatomy. Moreover, I shall have to speak of them again when I come to deal with Generation. As regards, however, the external shape of these parts, it is plain enough that they are adapted to their operations, as indeed of necessity they must be. There are, however, differences in the male organ corresponding to differences in the body generally. For all animals are not of an equally sinewy nature. This organ, again, is the only one that, independently of any morbid change, admits of augmenta-

tion and of diminution of bulk. The former condition is of service in copulation, while the other is required for the advantage of the body at large. For, were the organ constantly in the former condition, it would be an incumbrance. The organ therefore has been formed of such constituents as will admit of either state. For it is partly sinewy, partly cartilaginous, and thus is enabled either to contract or to become extended, and is capable of admitting air.

All female quadrupeds void their urine backwards, because the position of the parts which this implies is useful to them in the act of copulation. This is the case with only some few males, such as the lynx, the lion, the camel, and the hare. No quadruped with a solid hoof is retromingent.

The posterior portion of the body and the parts about the legs are peculiar in man as compared with quadrupeds. Nearly all these latter have a tail, and this whether they are viviparous or oviparous. For, even if the tail be of no great size, yet they have a kind of scut, as at any rate a small representative of it. But man is tail-less. He has, however, buttocks, which exist in none of the quadrupeds. His legs also are fleshy (as too are his thighs and feet); while the legs in all other animals that have any, whether viviparous or not, are flesh-less, being made of sinew and bone and spinous substance. For all these differences there is, so to say, one common explanation, and this is that of all animals man alone stands erect. It was to facilitate the maintenance of this position that Nature made his upper parts light, taking away some of their corporeal substance, and using it to increase the weight of lithe parts below, so that the buttocks, the thighs, and the calves of the legs were all made fleshy. The character which she thus gave to the buttocks renders them at the same time useful in resting the body. For standing causes no fatigue to quadrupeds, and even the long continuance of this posture produces in them no weariness; for they are supported the whole time by four props, which is much as though they were lying down. But to man it is no task to remain for any length of time on his feet, his body demanding rest in a sitting position. This, then, is the reason why

man has buttocks and fleshy legs; and the presence of these fleshy parts explains why he has no tail. For the nutriment which would otherwise go to the tail is used up in the production of these parts, while at the same time the existence of buttocks does away with the necessity of a tail. But in quadrupeds and other animals the reverse obtains. For they are of dwarf-like form, so that all the pressure of their weight and corporeal substance is on their upper part, and is withdrawn from the parts below. On this account they are without buttocks and have hard legs. In order, however, to cover and protect that part which serves for the evacuation of excrement, nature has given them a tail of some kind or other, subtracting for the purpose some of the nutriment which would otherwise go to the legs. Intermediate in shape between man and quadrupeds is the ape, belonging therefore to neither or to both, and having on this account neither tail nor buttocks; no tail in its character of biped, no buttocks in its character of quadruped. There is great diversity of so-called tails; and this organ like others is sometimes used by nature for by-purposes, being made to serve not only as a covering and protection to the fundament, but also for other uses and advantages of its possessor.

There are differences in the feet of quadrupeds. For in some of these animals there is a solid hoof, and in others a hoof cloven into two, and again in others a foot divided into many parts.

The hoof is solid when the body is large and the earthy matter present in great abundance; in which case the earth, instead of forming teeth and horns, is separated in the character of a nail, and being very abundant forms one continuous nail, that is a hoof, in place of several. This consumption of the earthy matter on the hoof explains why these animals, as a rule, have no huckle-bones; a second reason being that the presence of such a bone in the joint of the hind leg somewhat impedes its free motion. For extension and flexion can be made more rapidly in parts that have but one angle than in parts that have several. But the presence of a huckle-bone, as a connecting bolt, is the introduction as it were of a new limb-segment between the two ordinary ones. Such an addition adds to the weight of the

foot, but renders the act of progression more secure. Thus it is that in such animals as have a hucklebone, it is only in the posterior and not in the anterior limbs that this bone is found. For the anterior limbs, moving as they do in advance of the others, require to be light and capable of ready flexion, whereas firmness and extensibility are what are wanted in the hind limbs. Moreover, a huckle-bone adds weight to the blow of a limb, and so renders it a suitable weapon of defence; and these animals all use their hind legs to protect themselves, kicking out with their heels against anything which annoys them. In the cloven-hoofed quadrupeds the lighter character of the hind legs admits of there being a huckle-bone; and the presence of the huckle-bone prevents them from having a solid hoof, the bony substance remaining in the joint, and therefore being deficient in the foot. As to the polydactylous quadrupeds, none of them have huckle-bones. For if they had they would not be polydactylous, but the divisions of the foot would only extend to that amount of its breadth which was covered by the huckle-bone. Thus it is that most of the animals that have huckle-bones are cloven-hoofed.

Of all animals man has the largest foot in proportion to the size of the body. This is only what might be expected. For seeing that he is the only animal that stands erect, the two feet which are intended to bear all the weight of the body must be both long and broad. Equally intelligible is it that the proportion between the size of the fingers and that of the whole hand should be inverted in the case of the toes and feet. For the function of the hands is to take hold of objects and retain them by pressure; so that the fingers require to be long. For it is by its flexed portion that the hand grasps an object. But the function of the feet is to enable us to stand securely, and for this the undivided part of the foot requires to be of larger size than the toes. However, it is better for the extremity to be divided than to be undivided. For in an undivided foot disease of any one part would extend to the whole organ; whereas, if the foot be divided into separate digits, there is not an equal liability to such an occurrence. The digits, again, by being short would be less liable to injury. For these reasons the feet in man are many-toed, while the separate digits are

of no great length. The toes, finally, are furnished with nails for the same reason as are the fingers, namely because such projecting parts are weak and therefore require special protection.

11

We have now done with such sanguineous animals as live on land and bring forth their young alive; and, having dealt with all their main kinds, we may pass on to such sanguineous animals as are oviparous. Of these some have four feet, while others have none. The latter form a single genus, namely the Serpents; and why these are apodous has been already explained in the dissertation on Animal Progression. Irrespective of this absence of feet, serpents resemble the oviparous quadrupeds in their conformation.

In all these animals there is a head with its component parts; its presence being determined by the same causes as obtain in the case of other sanguineous animals; and in all, with the single exception of the river crocodile, there is a tongue inside the mouth. In this one exception there would seem to be no actual tongue, but merely a space left vacant for it. The reason is that a crocodile is in a way a land-animal and a water-animal combined. In its character of land-animal it has a space for a tongue; but in its character of water-animal it is without the tongue itself. For in some fishes, as has already been mentioned, there is no appearance whatsoever of a tongue, unless the mouth be stretched open very widely indeed; while in others it is indistinctly separated from the rest of the mouth. The reason for this is that a tongue would be of but little service to such animals, seeing that they are unable to chew their food or to taste it before swallowing, the pleasurable sensations they derive from it being limited to the act of deglutition. For it is in their passage down the gullet that solid edibles cause enjoyment, while it is by the tongue that the savour of fluids is perceived. Thus it is during deglutition that the oiliness, the heat, and other such qualities of food are recognized; and, in fact, the satisfaction from most solid edibles and dainties is derived almost entirely from the dilatation of the oesophagus during

deglutition. This sensation, then, belongs even to animals that have no tongue, but while other animals have in addition the sensations of taste, tongueless animals have, we may say, no other satisfaction than it. What has now been said explains why intemperance as regards drinks and savoury fluids does not go hand in hand with intemperance as regards eating and solid relishes.

In some oviparous quadrupeds, namely in lizards, the tongue is bifid, as also it is in serpents, and its terminal divisions are of hair-like fineness, as has already been described. (Seals also have a forked tongue.) This it is which accounts for all these animals being so fond of dainty food. The teeth in the four-footed Ovipara are of the sharp interfitting kind, like the teeth of fishes. The organs of all the senses are present and resemble those of other animals. Thus there are nostrils for smell, eves for vision, and ears for hearing. The latter organs, however, do not project from the sides of the head, but consist simply of the duct, as also is the case in birds. This is due in both cases to the hardness of the integument; birds having their bodies covered with feathers, and these oviparous quadrupeds with horny plates. These plates are equivalent to scales, but of a harder character. This is manifest in tortoises and river crocodiles, and also in the large serpents. For here the plates become stronger than the bones, being seemingly of the same substance as these.

These animals have no upper eyelid, but close the eye with the lower lid In this they resemble birds, and the reason is the same as was assigned in their case. Among birds there are some that can not only thus close the eye, but can also blink by means of a membrane which comes from its corner. But none of the oviparous quadrupeds blink; for their eyes are harder than those of birds. The reason for this is that keen vision and far-sightedness are of very considerable service to birds, flying as they do in the air, whereas they would be of comparatively small use to the oviparous quadrupeds, seeing that they are all of troglodytic habits.

Of the two separate portions which constitute the head, namely the upper part and the lower jaw, the latter in man and in the vi-

viparous quadrupeds moves not only upwards and downwards, but also from side to side; while in fishes, and birds and oviparous quadrupeds, the only movement is up and down. The reason is that this latter movement is the one required in biting and dividing food, while the lateral movement serve to reduce substances to a pulp. To such animals, therefore, as have grinder-teeth this lateral motion is of service; but to those animals that have no grinders it would be quite useless, and they are therefore invariably without it. For nature never makes anything that is superfluous. While in all other animals it is the lower jaw that is movable, in the river crocodile it is exceptionally the upper. This is because the feet in this creature are so excessively small as to be useless for seizing and holding prey; on which account nature has given it a mouth that can serve for these purposes in their stead. For that direction of motion which will give the greater force to a blow will be the more serviceable one in holding or in seizing prey; and a blow from above is always more forcible than one from below. Seeing, then, that both the prehension and the mastication of food are offices of the mouth, and that the former of these two is the more essential in an animal that has neither hands nor suitably formed feet, these crocodiles will derive greater benefit from a motion of the upper jaw downwards than from a motion of the lower jaw upwards. The same considerations explain why crabs also move the upper division of each claw and not the lower. For their claws are substitutes for hands, and so require to be suitable for the prehension of food, and not for its comminution; for such comminution and biting is the office of teeth. In crabs, then, and in such other animals as are able to seize their food in a leisurely manner, inasmuch as their mouth is not called on to perform its office while they are still in the water, the two functions are assigned to different parts, prehension to the hands or feet, biting and comminution of food to the mouth. But in crocodiles the mouth has been so framed by nature as to serve both purposes, the jaws being made to move in the manner just described.

Another part present in these animals is a neck, this being the necessary consequence of their having a lung. For the windpipe by

which the air is admitted to the lung is of some length. If, however, the definition of a neck be correct, which calls it the portion between the head and the shoulders, a serpent can scarcely be said with the same right as the rest of these animals to have a neck, but only to have something analogous to that part of the body. It is a peculiarity of serpents, as compared with other animals allied to them, that they are able to turn their head backwards without stirring the rest of the body. The reason of this is that a serpent, like an insect, has a body that admits of being curled up, its vertebrae being cartilaginous and easily bent. The faculty in question belongs then to serpents simply as a necessary consequence of this character of their vertebrae; but at the same time it has a final cause, for it enables them to guard against attacks from behind. For their body, owing to its length and the absence of feet, is ill-suited for turning round and protecting the hinder parts; and merely to lift the head, without the power of turning it round, would be of no use whatsoever.

The animals with which we are dealing have, moreover, a part which corresponds to the breast; but neither here nor elsewhere in their body have they any mammae, as neither has any bird or fish. This is a consequence of their having no milk; for a mamma is a receptacle for milk and, as it were, a vessel to contain it. This absence of milk is not peculiar to these animals, but is common to all such as are not internally viviparous. For all such produce eggs, and the nutriment which in Vivipara has the character of milk is in them engendered in the egg. Of all this, however, a clearer account will be given in the treatise on Generation. As to the mode in which the legs bend, a general account, in which all animals are considered, has already been given in the dissertation on Progression. These animals also have a tail, larger in some of them, smaller in others, and the reason for this has been stated in general terms in an earlier passage.

Of all oviparous animals that live on land there is none so lean as the Chamaeleon. For there is none that has so little blood. The explanation of this is to be found in the psychical temperament of the creature. For it is of a timid nature, as the frequent changes it

undergoes in its outward aspect testify. But fear is a refrigeration, and results from deficiency of natural heat and scantiness of blood. We have now done with such sanguineous animals as are quadrupedous and also such as are apodous, and have stated with sufficient completeness what external parts they possess, and for what reason they have them.

12

The differences of birds compared one with another are differences of magnitude, and of the greater or smaller development of parts. Thus some have long legs, others short legs; some have a broad tongue, others a narrow tongue; and so on with the other parts. There are few of their parts that differ save in size, taking birds by themselves. But when birds are compared with other animals the parts present differences of form also. For in some animals these are hairy, in others scaly, and in others have scale-like plates, while birds are feathered.

Birds, then, are feathered, and this is a character common to them all and peculiar to them. Their feathers, too, are split and distinct in kind from the undivided feathers of insects; for the bird's feather is barbed, these are not; the bird's feather has a shaft, these have none. A second strange peculiarity which distinguishes birds from all other animals is their beak. For as in elephants the nostril serves in place of hands, and as in some insects the tongue serves in place of mouth, so in birds there is a beak, which, being bony, serves in place of teeth and lips. Their organs of sense have already been considered.

All birds have a neck extending from the body; and the purpose of this neck is the same as in such other animals as have one. This neck in some birds is long, in others short; its length, as a general rule, being pretty nearly determined by that of the legs. For long-legged birds have a long neck, short-legged birds a short one, to which rule, however, the web-footed birds form an exception. For to a bird perched up on long legs a short neck would be of no use whatsoever in collecting food from the ground; and equally useless

would be a long neck, if the legs were short. Such birds, again, as are carnivorous would find length in this part interfere greatly with their habits of life. For a long neck is weak, and it is on their superior strength that carnivorous birds depend for their subsistence. No bird, therefore, that has talons ever has an elongated neck. In web-footed birds, however, and in those other birds belonging to the same class, whose toes though actually separate have flat marginal lobes, the neck is elongated, so as to be suitable for collecting food from the water; while the legs are short, so as to serve in swimming. The beaks of birds, as their feet, vary with their modes of life. For in some the beak is straight, in others crooked; straight, in those who use it merely for eating; crooked, in those that live on raw flesh. For a crooked beak is an advantage in fighting; and these birds must, of course, get their food from the bodies of other animals, and in most cases by violence. In such birds, again, as live in marshes and are herbivorous the beak is broad and flat, this form being best suited for digging and cropping, and for pulling up plants. In some of these marsh birds, however, the beak is elongated, as too is the neck, the reason for this being that the bird get its food from some depth below the surface. For most birds of this kind, and most of those whose feet are webbed, either in their entirety or each part separately, live by preying on some of the smaller animals that are to be found in water, and use these parts for their capture, the neck acting as a fishing-rod, and the beak representing the line and hook.

The upper and under sides of the body, that is of what in quadrupeds is called the trunk, present in birds one unbroken surface, and they have no arms or forelegs attached to it, but in their stead wings, which are a distinctive peculiarity of these animals; and, as these wings are substitutes for arms, their terminal segments lie on the back in the place of a shoulder-blade.

The legs are two in number, as in man; not however, as in man, bent outwards, but bent inwards like the legs of a quadruped. The wings are bent like the forelegs of a quadruped, having their convexity turned outwards. That the feet should be two in number is a mat-

ter of necessity. For a bird is essentially a sanguineous animal, and at the same time essentially a winged animal; and no sanguineous animal has more than four points for motion In birds, then, as in those other sanguineous animals that live and move upon the ground, the limbs attached to the trunk are four in number. But, while in all the rest these four limbs consist of a pair of arms and a pair of legs, or of four legs as in quadrupeds, in birds the arms or forelegs are replaced by a pair of wings, and this is their distinctive character. For it is of the essence of a bird that it shall be able to fly; and it is by the extension of wings that this is made possible. Of all arrangements, then, the only possible, and so the necessary, one is that birds shall have two feet; for this with the wings will give them four points for motion. The breast in all birds is sharp-edged, and fleshy. The sharp edge is to minister to flight, for broad surfaces move with considerable difficulty, owing to the large quantity of air which they have to displace; while the fleshy character acts as a protection, for the breast, owing to its form, would be weak, were it not amply covered.

Below the breast lies the belly, extending, as in quadrupeds and in man, to the vent and to the place where the legs are jointed to the trunk.

Such, then, are the parts which lie between the wings and the legs. Birds like all other animals, whether produced viviparously or from eggs, have an umbilicus during their development, but, when the bird has attained to fuller growth, no signs of this remain visible. The cause of this is plainly to be seen during the process of development; for in birds the umbilical cord unites with the intestine, and is not a portion of the vascular system, as is the case in viviparous animals.

Some birds, again, are well adapted for flight, their wings being large and strong. Such, for instance, are those that have talons and live on flesh. For their mode of life renders the power of flight a necessity, and it is on this account that their feathers are so abundant and their wings so large. Besides these, however, there are also other genera of birds that can fly well; all those, namely, that depend on

speed for security, or that are of migratory habits. On the other hand, some kinds of birds have heavy bodies and are not constructed for flight. These are birds that are frugivorous and live on the ground, or that are able to swim and get their living in watery places. In those that have talons the body, without the wings, is small; for the nutriment is consumed in the production of these wings, and of the weapons and defensive appliances; whereas in birds that are not made for flight the contrary obtains, and the body is bulky and so of heavy weight. In some of these heavy-bodied birds the legs are furnished with what are called spurs, which replace the wings as a means of defence. Spurs and talons never co-exist in the same bird. For nature never makes anything superfluous; and if a bird can fly, and has talons, it has no use for spurs; for these are weapons for fighting on the ground, and on this account are an appanage of certain heavy-bodied birds. These latter, again, would find the possession of talons not only useless but actually injurious; for the claws would stick into the ground and interfere with progression. This is the reason why all birds with talons walk so badly, and why they never settle upon rocks. For the character of their claws is ill-suited for either action.

All this is the necessary consequence of the process of development. For the earthy matter in the body issuing from it is converted into parts that are useful as weapons. That which flows upwards gives hardness or size to the beak; and, should any flow downwards, it either forms spurs upon the legs or gives size and strength to the claws upon the feet. But it does not at one and the same time produce both these results, one in the legs, the other in the claws; for such a dispersion of this residual matter would destroy all its efficiency. In other birds this earthy residue furnishes the legs with the material for their elongation; or sometimes, in place of this, fills up the interspaces between the toes. Thus it is simply a matter of necessity, that such birds as swim shall either be actually web-footed, or shall have a kind of broad blade-like margin running along the whole length of each distinct toe. The forms, then, of these feet are simply the necessary results of the causes that have been mentioned. Yet at the

same time they are intended for the animal's advantage. For they are in harmony with the mode of life of these birds, who, living on the water, where their wings are useless, require that their feet shall be such as to serve in swimming. For these feet are so developed as to resemble the oars of a boat, or the fins of a fish; and the destruction of the foot-web has the same effect as the destruction of the fins; that is to say, it puts an end to all power of swimming.

In some birds the legs are very long, the cause of this being that they inhabit marshes. I say the cause, because nature makes the organs for the function, and not the function for the organs. It is, then, because these birds are not meant for swimming that their feet are without webs, and it is because they live on ground that gives way under the foot that their legs and toes are elongated, and that these latter in most of them have an extra number of joints. Again, though all birds have the same material composition, they are not all made for flight; and in these, therefore, the nutriment that should go to their tail-feathers is spent on the legs and used to increase their size. This is the reason why these birds when they fly make use of their legs as a tail, stretching them out behind, and so rendering them serviceable, whereas in any other position they would be simply an impediment.

In other birds, where the legs are short, these are held close against the belly during flight. In some cases this is merely to keep the feet out of the way, but in birds that have talons the position has a further purpose, being the one best suited for rapine. Birds that have a long and a thick neck keep it stretched out during flight; but those whose neck though long is slender fly with it coiled up. For in this position it is protected, and less likely to get broken, should the bird fly against any obstacle.

In all birds there is an ischium, but so placed and of such length that it would scarcely be taken for an ischium, but rather for a second thigh-bone; for it extends as far as to the middle of the belly. The reason for this is that the bird is a biped, and yet is unable to stand erect. For if its ischium extended but a short way from the

fundament, and then immediately came the leg, as is the case in man and in quadrupeds, the bird would be unable to stand up at all. For while man stands erect, and while quadrupeds have their heavy bodies propped up in front by the forelegs, birds can neither stand erect owing to their dwarf-like shape, nor have anterior legs to prop them up, these legs being replaced by wings. As a remedy for this Nature has given them a long ischium, and brought it to the centre of the body, fixing it firmly; and she has placed the legs under this central point, that the weight on either side may be equally balanced, and standing or progression rendered possible. Such then is the reason why a bird, though it is a biped, does not stand erect. Why its legs are destitute of flesh has also already been stated; for the reasons are the same as in the case of quadrupeds.

In all birds alike, whether web-footed or not, the number of toes in each foot is four. For the Libyan ostrich may be disregarded for the present, and its cloven hoof and other discrepancies of structure as compared with the tribe of birds will be considered further on. Of these four toes three are in front, while the fourth points backward, serving, as a heel, to give steadiness. In the long-legged birds this fourth toe is much shorter than the others, as is the case with the Crex, but the number of their toes is not increased. The arrangement of the toes is such as has been described in all birds with the exception of the wryneck. Here only two of the toes are in front, the other two behind; and the reason for this is that the body of the wryneck is not inclined forward so much as that of other birds. All birds have testicles; but they are inside the body. The reason for this will be given in the treatise On the Generation of Animals.

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Thus then are fashioned the parts of birds. But in fishes a still further stunting has occurred in the external parts. For here, for reasons already given, there are neither legs nor hands nor wings, the whole body from head to tail presenting one unbroken surface. This tail differs in different fishes, in some approximating in character to the

fins, while in others, namely in some of the flat kinds, it is spinous and elongated, because the material which should have gone to the tail has been diverted thence and used to increase the breadth of the body. Such, for instance, is the case with the Torpedos, the Trygons, and whatever other Selachia there may be of like nature. In such fishes, then, the tail is spinous and long; while in some others it is short and fleshy, for the same reason which makes it spinous and long in the Torpedo. For to be short and fleshy comes to the same thing as to be long and less amply furnished with flesh.

What has occurred in the Fishing-frog is the reverse of what has occurred in the other instances just given. For here the anterior and broad part of the body is not of a fleshy character, and so all the fleshy substance which has been thence diverted has been placed by nature in the tail and hinder portion of the body.

In fishes there are no limbs attached to the body. For in accordance with their essential constitution they are swimming animals; and nature never makes anything superfluous or void of use. Now inasmuch as fishes are made swimming they have fins, and as they are not made for walking they are without feet; for feet are attached to the body that they may be of use in progression on land. Moreover, fishes cannot have feet, or any other similar limbs, as well as four fins; for they are essentially sanguineous animals. The Cordylus, though it has gills, has feet, for it has no fins but merely has its tail flattened out and loose in texture.

Fishes, unless, like the Batos and the Trygon, they are broad and flat, have four fins, two on the upper and two on the under side of the body; and no fish ever has more than these. For, if it had, it would be a bloodless animal.

The upper pair of fins is present in nearly all fishes, but not so the under pair; for these are wanting in some of those fishes that have long thick bodies, such as the eel, the conger, and a certain kind of Cestreus that is found in the lake at Siphae. When the body is still more elongated, and resembles that of a serpent rather than that of a fish, as is the case in the Smuraena, there are absolutely no fins

at all; and locomotion is effected by the flexures of the body, the water being put to the same use by these fishes as is the ground by serpents. For serpents swim in water exactly in the same way as they glide on the ground. The reason for these serpent-like fishes being without fins is the same as that which causes serpents to be without feet; and what this is has been already stated in the dissertations on the Progression and the Motion of Animals. The reason was this. If the points of motion were four, motion would be effected under difficulties; for either the two pairs of fins would be close to each other, in which case motion would scarcely be possible, or they would be at a very considerable distance apart, in which case the long interval between them would be just as great an evil. On the other hand, to have more than four such motor points would convert the fishes into bloodless animals. A similar explanation applies to the case of those fishes that have only two fins. For here again the body is of great length and like that of a serpent, and its undulations do the office of the two missing fins. It is owing to this that such fishes can even crawl on dry ground, and can live there for a considerable time; and do not begin to gasp until they have been for a considerable time out of the water, while others, whose nature is akin to that of land-animals, do not even do as much as that. In such fishes as have but two fins it is the upper pair (pectorals) that is present, excepting when the flat broad shape of the body prevents this. The fins in such cases are placed at the head, because in this region there is no elongation, which might serve in the absence of fins as a means of locomotion; whereas in the direction of the tail there is a considerable lengthening out in fishes of this conformation. As for the Bati and the like, they use the marginal part of their flattened bodies in place of fins for swimming.

In the Torpedo and the Fishing-frog the breadth of the anterior part of the body is not so great as to render locomotion by fins impossible, but in consequence of it the upper pair (pectorals) are placed further back and the under pair (ventrals) are placed close to the head, while to compensate for this advancement they are reduced in size so as to be smaller than the upper ones. In the Torpedo

the two upper fins (pectorals) are placed on the tail, and the fish uses the broad expansion of its body to supply their place, each lateral half of its circumference serving the office of a fin.

The head, with its several parts, as also the organs of sense, have already come under consideration.

There is one peculiarity which distinguishes fishes from all other sanguineous animals, namely, the possession of gills. Why they have these organs has been set forth in the treatise on Respiration. These gills are in most fishes covered by opercula, but in the Selachia, owing to the skeleton being cartilaginous, there are no such coverings. For an operculum requires fish-spine for its formation, and in other fishes the skeleton is made of this substance, whereas in the Selachia it is invariably formed of cartilage. Again, while the motions of spinous fishes are rapid, those of the Selachia are sluggish, inasmuch as they have neither fish-spine nor sinew; but an operculum requires rapidity of motion, seeing that the office of the gills is to minister as it were to expiration. For this reason in Selachia the branchial orifices themselves effect their own closure, and thus there is no need for an operculum to ensure its taking place with due rapidity. In some fishes the gills are numerous, in others few in number; in some again they are double, in others single. The last gill in most cases is single. For a detailed account of all this, reference must be made to the treatises on Anatomy, and to the book of Researches concerning Animals.

It is the abundance or the deficiency of the cardiac heat which determines the numerical abundance or deficiency of the gills. For, the greater an animal's heat, the more rapid and the more forcible does it require the branchial movement to be; and numerous and double gills act with more force and rapidity than such as are few and single. Thus, too, it is that some fishes that have but few gills, and those of comparatively small efficacy, can live out of water for a considerable time; for in them there is no great demand for refrigeration. Such, for example, are the eel and all other fishes of serpent-like form.

Fishes also present diversities as regards the mouth. For in some this is placed in front, at the very extremity of the body, while in others, as the dolphin and the Selachia, it is placed on the under surface; so that these fishes turn on the back in order to take their food. The purpose of Nature in this was apparently not merely to provide a means of salvation for other animals, by allowing them opportunity of escape during the time lost in the act of turning-for all the fishes with this kind of mouth prey on living animals-but also to prevent these fishes from giving way too much to their gluttonous ravening after food. For had they been able to seize their prey more easily than they do, they would soon have perished from over-repletion. An additional reason is that the projecting extremity of the head in these fishes is round and small, and therefore cannot admit of a wide opening.

Again, even when the mouth is not placed on the under surface, there are differences in the extent to which it can open. For in some cases it can gape widely, while in others it is set at the point of a small tapering snout; the former being the case in carnivorous fishes, such as those with sharp interfitting teeth, whose strength lies in their mouth, while the latter is its form in all such as are not carnivorous.

The skin is in some fishes covered with scales (the scale of a fish is a thin and shiny film, and therefore easily becomes detached from the surface of the body). In others it is rough, as for instance in the Rhine, the Batos, and the like. Fewest of all are those whose skin is smooth. The Selachia have no scales, but a rough skin. This is explained by their cartilaginous skeleton. For the earthy material which has been thence diverted is expended by nature upon the skin.

No fish has testicles either externally or internally; as indeed have no apodous animals, among which of course are included the serpents. One and the same orifice serves both for the excrement and for the generative secretions, as is the case also in all other oviparous animals, whether two-footed or four-footed, inasmuch as they have no urinary bladder and form no fluid excretion.

Such then are the characters which distinguish fishes from all other animals. But dolphins and whales and all such Cetacea are without gills; and, having a lung, are provided with a blow-hole; for this serves them to discharge the sea-water which has been taken into the mouth. For, feeding as they do in the water, they cannot but let this fluid enter into their mouth, and, having let it in, they must of necessity let it out again. The use of gills, however, as has been explained in the treatise on Respiration, is limited to such animals as do not breathe; for no animal can possibly possess gills and at the same time be a respiratory animal. In order, therefore, that these Cetacea may discharge the water, they are provided with a blow-hole. This is placed in front of the brain; for otherwise it would have cut off the brain from the spine. The reason for these animals having a lung and breathing, is that animals of large size require an excess of heat, to facilitate their motion. A lung, therefore, is placed within their body, and is fully supplied with blood-heat. These creatures are after a fashion land and water animals in one. For so far as they are inhalers of air they resemble land-animals, while they resemble water-animals in having no feet and in deriving their food from the sea. So also seals lie halfway between land and water animals, and bats half-way between animals that live on the ground and animals that fly; and so belong to both kinds or to neither. For seals, if looked on as water-animals, are yet found to have feet; and, if looked on as land-animals, are yet found to have fins. For their hind feet are exactly like the fins of fishes; and their teeth also are sharp and interfitting as in fishes. Bats again, if regarded as winged animals, have feet; and, if regarded as quadrupeds, are without them. So also they have neither the tail of a quadruped nor the tail of a bird; no quadruped's tail, because they are winted animals; no bird's tail, because they are terrestrial. This absence of tail is the result of necessity. For bats fly by means of a membrane, but no animal, unless it has barbed feathers, has the tail of a bird; for a bird's tail is composed of such feathers. As for a quadruped's tail, it would be an actual impediment, if present among the feathers.

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Much the same may be said also of the Libyan ostrich. For it has some of the characters of a bird, some of the characters of a quadruped. It differs from a quadruped in being feathered; and from a bird in being unable to soar aloft and in having feathers that resemble hair and are useless for flight. Again, it agrees with quadrupeds in having upper eyelashes, which are the more richly supplied with hairs because the parts about the head and the upper portion of the neck are bare; and it agrees with birds in being feathered in all the parts posterior to these. Further, it resembles a bird in being a biped, and a quadruped in having a cloven hoof; for it has hoofs and not toes. The explanation of these peculiarities is to be found in its bulk, which is that of a quadruped rather than that of a bird. For, speaking generally, a bird must necessarily be of very small size. For a body of heavy bulk can with difficulty be raised into the air.

Thus much then as regards the parts of animals. We have discussed them all, and set forth the cause why each exists; and in so doing we have severally considered each group of animals. We must now pass on, and in due sequence must next deal with the question of their generation.