Book IV

1

We have now treated, in regard to blooded animals of the parts they have in common and of the parts peculiar to this genus or that, and of the parts both composite and simple, whether without or within. We now proceed to treat of animals devoid of blood. These animals are divided into several genera.

One genus consists of so-called 'molluscs'; and by the term 'mollusc' we mean an animal that, being devoid of blood, has its flesh-like substance outside, and any hard structure it may happen to have, inside-in this respect resembling the red-blooded animals, such as the genus of the cuttle-fish.

Another genus is that of the malacostraca. These are animals that have their hard structure outside, and their soft or fleshlike substance inside, and the hard substance belonging to them has to be crushed rather than shattered; and to this genus belongs the crawfish and the crab.

A third genus is that of the ostracoderms or 'testaceans'. These are animals that have their hard substance outside and their flesh-like substance within, and their hard substance can be shattered but not crushed; and to this genus belong the snail and the oyster.

The fourth genus is that of insects; and this genus comprehends numerous and dissimilar species. Insects are creatures that, as the name implies, have nicks either on the belly or on the back, or on

both belly and back, and have no one part distinctly osseous and no one part distinctly fleshy, but are throughout a something intermediate between bone and flesh; that is to say, their body is hard all through, inside and outside. Some insects are wingless, such as the iulus and the centipede; some are winged, as the bee, the cockchafer, and the wasp; and the same kind is in some cases both winged and wingless, as the ant and the glow-worm.

In molluscs the external parts are as follows: in the first place, the so-called feet; secondly, and attached to these, the head; thirdly, the mantle-sac, containing the internal parts, and incorrectly designated by some writers the head; and, fourthly, fins round about the sac. (See diagram.) In all molluscs the head is found to be between the feet and the belly. All molluscs are furnished with eight feet, and in all cases these feet are severally furnished with a double row of suckers, with the exception of one single species of poulpe or octopus. The sepia, the small calamary and the large calamary have an exceptional organ in a pair of long arms or tentacles, having at their extremities a portion rendered rough by the presence of two rows of suckers; and with these arms or tentacles they apprehend their food and draw it into their mouths, and in stormy weather they cling by them to a rock and sway about in the rough water like ships lying at anchor. They swim by the aid of the fins that they have about the sac. In all cases their feet are furnished with suckers.

The octopus, by the way, uses his feelers either as feet or hands; with the two which stand over his mouth he draws in food, and the last of his feelers he employs in the act of copulation; and this last one, by the way, is extremely sharp, is exceptional as being of a whitish colour, and at its extremity is bifurcate; that is to say, it has an additional something on the rachis, and by rachis is meant the smooth surface or edge of the arm on the far side from the suckers. (See diagram.)

In front of the sac and over the feelers they have a hollow tube, by means of which they discharge any sea-water that they may have taken into the sac of the body in the act of receiving food by the

mouth. They can shift the tube from side to side, and by means of it they discharge the black liquid peculiar to the animal.

Stretching out its feet, it swims obliquely in the direction of the so-called head, and by this mode of swimming it can see in front, for its eyes are at the top, and in this attitude it has its mouth at the rear. The 'head', while the creature is alive, is hard, and looks as though it were inflated. It apprehends and retains objects by means of the under-surface of its arms, and the membrane in between its feet is kept at full tension; if the animal get on to the sand it can no longer retain its hold.

There is a difference between the octopus and the other molluscs above mentioned: the body of the octopus is small, and his feet are long, whereas in the others the body is large and the feet short; so short, in fact, that they cannot walk on them. Compared with one another, the teuthis, or calamary, is long-shaped, and the sepia flat-shaped; and of the calamaries the so-called teuthus is much bigger than the teuthis; for teuthi have been found as much as five ells long. Some sepiae attain a length of two ells, and the feelers of the octopus are sometimes as long, or even longer. The species teuthus is not a numerous one; the teuthus differs from the teuthis in shape; that is, the sharp extremity of the teuthus is broader than that of the other, and, further, the encircling fin goes all round the trunk, whereas it is in part lacking in the teuthis; both animals are pelagic.

In all cases the head comes after the feet, in the middle of the feet that are called arms or feelers. There is here situated a mouth, and two teeth in the mouth; and above these two large eyes, and betwixt the eyes a small cartilage enclosing a small brain; and within the mouth it has a minute organ of a fleshy nature, and this it uses as a tongue, for no other tongue does it possess. Next after this, on the outside, is what looks like a sac; the flesh of which it is made is divisible, not in long straight strips, but in annular flakes; and all molluscs have a cuticle around this flesh. Next after or at the back of the mouth comes a long and narrow oesophagus, and close after that a crop or craw, large and spherical, like that of a bird; then comes

the stomach, like the fourth stomach in ruminants; and the shape of it resembles the spiral convolution in the trumpet-shell; from the stomach there goes back again, in the direction of the mouth, thin gut, and the gut is thicker than the oesophagus. (See diagram.)

Molluscs have no viscera, but they have what is called a mytis, and on it a vessel containing a thick black juice; in the sepia or cuttle-fish this vessel is the largest, and this juice is most abundant. All molluscs, when frightened, discharge such a juice, but the discharge is most copious in the cuttle-fish. The mytis, then, is situated under the mouth, and the oesophagus runs through it; and down below at the point to which the gut extends is the vesicle of the black juice, and the animal has the vesicle and the gut enveloped in one and the same membrane, and by the same membrane, same orifice discharges both the black juice and the residuum. The animals have also certain hair-like or furry growths in their bodies.

In the sepia, the teuthis, and the teuthus the hard parts are within, towards the back of the body; those parts are called in one the sepium, and in the other the 'sword'. They differ from one another, for the sepium in the cuttle-fish and teuthus is hard and flat, being a substance intermediate between bone and fishbone, with (in part) a crumbling, spongy texture, but in the teuthis the part is thin and somewhat gristly. These parts differ from one another in shape, as do also the bodies of the animals. The octopus has nothing hard of this kind in its interior, but it has a gristly substance round the head, which, if the animal grows old, becomes hard.

The females differ from the males. The males have a duct in under the oesophagus, extending from the mantle-cavity to the lower portion of the sac, and there is an organ to which it attaches, resembling a breast; (see diagram) in the female there are two of these organs, situated higher up; (see diagram) with both sexes there are underneath these organs certain red formations. The egg of the octopus is single, uneven on its surface, and of large size; the fluid substance within is all uniform in colour, smooth, and in colour white; the size of the egg is so great as to fill a vessel larger than the creature's head.

The sepia has two sacs, and inside them a number of eggs, like in appearance to white hailstones. For the disposition of these parts I must refer to my anatomical diagrams.

The males of all these animals differ from the females, and the difference between the sexes is most marked in the sepia; for the back of the trunk, which is blacker than the belly, is rougher in the male than in the female, and in the male the back is striped, and the rump is more sharply pointed.

There are several species of the octopus. One keeps close to the surface, and is the largest of them all, and near the shore the size is larger than in deep water; and there are others, small, variegated in colour, which are not articles of food. There are two others, one called the heledone, which differs from its congeners in the length of its legs and in having one row of suckers-all the rest of the molluscs having two,-the other nicknamed variously the bolitaina or the 'onion,' and the ozolis or the 'stinkard'.

There are two others found in shells resembling those of the testaceans. One of them is nicknamed by some persons the nautilus or the pontilus, or by others the 'polypus' egg'; and the shell of this creature is something like a separate valve of a deep scallop-shell. This polypus lives very often near to the shore, and is apt to be thrown up high and dry on the beach; under these circumstances it is found with its shell detached, and dies by and by on dry land. These polypods are small, and are shaped, as regards the form of their bodies, like the bolbidia. There is another polypus that is placed within a shell like a snail; it never comes out of the shell, but lives inside the shell like the snail, and from time to time protrudes its feelers.

So much for molluscs.

2

With regard to the Malacostraca or crustaceans, one species is that of the crawfish, and a second, resembling the first, is that of the lobster; the lobster differing from the crawfish in having claws, and in a few other respects as well. Another species is that of the carid, and another is that of the crab, and there are many kinds both of carid and of crab.

Of carids there are the so-called cyphae, or 'hunch-backs', the crangons, or squillae, and the little kind, or shrimps, and the little kind do not develop into a larger kind.

Of the crab, the varieties are indefinite and incalculable. The largest of all crabs is one nicknamed Maia, a second variety is the pagarus and the crab of Heracleotis, and a third variety is the fresh-water crab; the other varieties are smaller in size and destitute of special designations. In the neighbourhood of Phoenice there are found on the beach certain crabs that are nicknamed the 'horsemen', from their running with such speed that it is difficult to overtake them; these crabs, when opened, are usually found empty, and this emptiness may be put down to insufficiency of nutriment. (There is another variety, small like the crab, but resembling in shape the lobster.) All these animals, as has been stated, have their hard and shelly part outside, where the skin is in other animals, and the fleshy part inside; and the belly is more or less provided with lamellae, or little flaps, and the female here deposits her spawn.

The crawfishes have five feet on either side, including the claws at the end; and in like manner the crabs have ten feet in all, including the claws. Of the carids, the hunch-backed, or prawns, have five feet on either side, which are sharp-pointed-those towards the head; and five others on either side in the region of the belly, with their extremities flat; they are devoid of flaps on the under side such as the crawfish has, but on the back they resemble the crawfish. (See diagram.) It is very different with the crangon, or squilla; it has four front legs on either side, then three thin ones close behind on either side, and

the rest of the body is for the most part devoid of feet. (See diagram.) Of all these animals the feet bend out obliquely, as is the case with insects; and the claws, where claws are found, turn inwards. The crawfish has a tail, and five fins on it; and the round-backed carid has a tail and four fins; the squilla also has fins at the tail on either side. In the case of both the hump-backed carid and the squilla the middle art of the tail is spinous: only that in the squilla the part is flattened and in the carid it is sharp-pointed. Of all animals of this genus the crab is the only one devoid of a rump; and, while the body of the carid and the crawfish is elongated, that of the crab is rotund.

In the crawfish the male differs from the female: in the female the first foot is bifurcate, in the male it is undivided; the belly-fins in the female are large and overlapping on the neck, while in the male they are smaller and do not overlap; and, further, on the last feet of the male there are spur-like projections, large and sharp, which projections in the female are small and smooth. Both male and female have two antennae in front of the eyes, large and rough, and other antennae underneath, small and smooth. The eyes of all these creatures are hard and beady, and can move either to the inner or to the outer side. The eyes of most crabs have a similar facility of movement, or rather, in the crab this facility is developed in a higher degree. (See diagram.)

The lobster is all over grey-coloured, with a mottling of black. Its under or hinder feet, up to the big feet or claws, are eight in number; then come the big feet, far larger and flatter at the tips than the same organs in the crawfish; and these big feet or claws are exceptional in their structure, for the right claw has the extreme flat surface long and thin, while the left claw has the corresponding surface thick and round. Each of the two claws, divided at the end like a pair of jaws, has both below and above a set of teeth: only that in the right claw they are all small and saw-shaped, while in the left claw those at the apex are saw-shaped and those within are molar-shaped, these latter being, in the under part of the cleft claw, four teeth close together, and in the upper part three teeth, not close together. Both right and

left claws have the upper part mobile, and bring it to bear against the lower one, and both are curved like bandy-legs, being thereby adapted for apprehension and constriction. Above the two large claws come two others, covered with hair, a little underneath the mouth; and underneath these the gill-like formations in the region of the mouth, hairy and numerous. These organs the animal keeps in perpetual motion; and the two hairy feet it bends and draws in towards its mouth. The feet near the mouth are furnished also with delicate outgrowing appendages. Like the crawfish, the lobster has two teeth, or mandibles, and above these teeth are its antennae, long, but shorter and finer by far than those of the crawfish, and then four other antennae similar in shape, but shorter and finer than the others. Over these antennae come the eyes, small and short, not large like the eyes of the crawfish. Over the eyes is a peaky rough projection like a forehead, larger than the same part in the crawfish; in fact, the frontal part is more pointed and the thorax is much broader in the lobster than in the crawfish, and the body in general is smoother and more full of flesh. Of the eight feet, four are bifurcate at the extremities, and four are undivided. The region of the so-called neck is outwardly divided into five divisions, and sixthly comes the flattened portion at the end, and this portion has five flaps, or tail-fins; and the inner or under parts, into which the female drops her spawn, are four in number and hairy, and on each of the aforesaid parts is a spine turned outwards, short and straight. The body in general and the region of the thorax in particular are smooth, not rough as in the crawfish; but on the large claws the outer portion has larger spines. There is no apparent difference between the male and female, for they both have one claw, whichever it may be, larger than the other, and neither male nor female is ever found with both claws of the same size.

All crustaceans take in water close by the mouth. The crab discharges it, closing up, as it does so, a small portion of the same, and the crawfish discharges it by way of the gills; and, by the way, the gill-shaped organs in the crawfish are very numerous.

The following properties are common to all crustaceans: they have in all cases two teeth, or mandibles (for the front teeth in the crawfish are two in number), and in all cases there is in the mouth a small fleshy structure serving for a tongue; and the stomach is close to the mouth, only that the crawfish has a little oesophagus in front of the stomach, and there is a straight gut attached to it. This gut, in the crawfish and its congeners, and in the carids, extends in a straight line to the tail, and terminates where the animal discharges the residuum, and where the female deposits her spawn; in the crab it terminates where the flap is situated, and in the centre of the flap. (And by the way, in all these animals the spawn is deposited outside.) Further, the female has the place for the spawn running along the gut. And, again, all these animals have, more or less, an organ termed the 'mytis', or 'poppyjuice'.

We must now proceed to review their several differentiae.

The crawfish then, as has been said, has two teeth, large and hollow, in which is contained a juice resembling the mytis, and in between the teeth is a fleshy substance, shaped like a tongue. After the mouth comes a short oesophagus, and then a membranous stomach attached to the oesophagus, and at the orifice Of the stomach are three teeth, two facing one another and a third standing by itself underneath. Coming off at a bend from the stomach is a gut, simple and of equal thickness throughout the entire length of the body until it reaches the anal vent.

These are all common properties of the crawfish, the carid, and the crab; for the crab, be it remembered, has two teeth.

Again, the crawfish has a duct attached all the way from the chest to the anal vent; and this duct is connected with the ovary in the female, and with the seminal ducts in the male. This passage is attached to the concave surface of the flesh in such a way that the flesh is in betwixt the duct and the gut; for the gut is related to the convexity and this duct to the concavity, pretty much as is observed in quadrupeds. And the duct is identical in both the sexes; that is to

say, the duct in both is thin and white, and charged with a sallow-coloured moisture, and is attached to the chest.

(The following are the properties of the egg and of the convolutes in the carid.)

The male, by the way, differs from the female in regard to its flesh, in having in connexion with the chest two separate and distinct white substances, resembling in colour and conformation the tentacles of the cuttle-fish, and they are convoluted like the 'poppy' or quasi-liver of the trumpet-shell. These organs have their starting-point in 'cotyledons' or papillae, which are situated under the hindmost feet; and hereabouts the flesh is red and blood-coloured, but is slippery to the touch and in so far unlike flesh. Off from the convolute organ at the chest branches off another coil about as thick as ordinary twine; and underneath there are two granular seminal bodies in juxta-position with the gut. These are the organs of the male. The female has red-coloured eggs, which are adjacent to the stomach and to each side of the gut all along to the fleshy parts, being enveloped in a thin membrane.

Such are the parts, internal and external, of the carid.

3

The inner organs of sanguineous animals happen to have specific designations; for these animals have in all cases the inner viscera, but this is not the case with the bloodless animals, but what they have in common with red-blooded animals is the stomach, the oesophagus, and the gut.

With regard to the crab, it has already been stated that it has claws and feet, and their position has been set forth; furthermore, for the most part they have the right claw bigger and stronger than the left. It has also been stated' that in general the eyes of the crab look sideways. Further, the trunk of the crab's body is single and undivided, including its head and any other part it may possess. Some crabs have eyes placed sideways on the upper part, immediately under the

back, and standing a long way apart, and some have their eyes in the centre and close together, like the crabs of Heracleotis and the so-called 'grannies'. The mouth lies underneath the eyes, and inside it there are two teeth, as is the case with the crawfish, only that in the crab the teeth are not rounded but long; and over the teeth are two lids, and in betwixt them are structures such as the crawfish has besides its teeth. The crab takes in water near by the mouth, using the lids as a check to the inflow, and discharges the water by two passages above the mouth, closing by means of the lids the way by which it entered; and the two passage-ways are underneath the eyes. When it has taken in water it closes its mouth by means of both lids, and ejects the water in the way above described. Next after the teeth comes the oesophagus, very short, so short in fact that the stomach seems to come straightway after the mouth. Next after the oesophagus comes the stomach, two-horned, to the centre of which is attached a simple and delicate gut; and the gut terminates outwards, at the operculum, as has been previously stated. (The crab has the parts in between the lids in the neighbourhood of the teeth similar to the same parts in the crawfish.) Inside the trunk is a sallow juice and some few little bodies, long and white, and others spotted red. The male differs from the female in size and breadth, and in respect of the ventral flap; for this is larger in the female than in the male, and stands out further from the trunk, and is more hairy (as is the case also with the female in the crawfish).

So much, then, for the organs of the malacostraca or crustacea.

4

With the ostracoderma, or testaceans, such as the land-snails and the sea-snails, and all the 'oysters' so-called, and also with the sea-urchin genus, the fleshy part, in such as have flesh, is similarly situated to the fleshy part in the crustaceans; in other words, it is inside the animal, and the shell is outside, and there is no hard substance in the interior. As compared with one another the testaceans present many diversities both in regard to their shells and to the flesh with-

in. Some of them have no flesh at all, as the sea-urchin; others have flesh, but it is inside and wholly hidden, except the head, as in the land-snails, and the so-called cocalia, and, among pelagic animals, in the purple murex, the ceryx or trumpet-shell, the sea-snail, and the spiral-shaped testaceans in general. Of the rest, some are bivalved and some univalved; and by 'bivalves' I mean such as are enclosed within two shells, and by 'univalved' such as are enclosed within a single shell, and in these last the fleshy part is exposed, as in the case of the limpet. Of the bivalves, some can open out, like the scallop and the mussel; for all such shells are grown together on one side and are separate on the other, so as to open and shut. Other bivalves are closed on both sides alike, like the solen or razor-fish. Some testaceans there are, that are entirely enveloped in shell and expose no portion of their flesh outside, as the tethya or ascidians.

Again, in regard to the shells themselves, the testaceans present differences when compared with one another. Some are smooth-shelled, like the solen, the mussel, and some clams, viz. those that are nicknamed 'milkshells', while others are rough-shelled, such as the pool-oyster or edible oyster, the pinna, and certain species of cockles, and the trumpet shells; and of these some are ribbed, such as the scallop and a certain kind of clam or cockle, and some are devoid of ribs, as the pinna and another species of clam. Testaceans also differ from one another in regard to the thickness or thinness of their shell, both as regards the shell in its entirety and as regards specific parts of the shell, for instance, the lips; for some have thin-lipped shells, like the mussel, and others have thick-lipped shells, like the oyster. A property common to the above mentioned, and, in fact, to all testaceans, is the smoothness of their shells inside. Some also are capable of motion, like the scallop, and indeed some aver that scallops can actually fly, owing to the circumstance that they often jump right out of the apparatus by means of which they are caught; others are incapable of motion and are attached fast to some external object, as is the case with the pinna. All the spiral-shaped testaceans can move and creep, and even the limpet relaxes its hold to go in quest of food. In the case of the univalves and the bivalves,

the fleshy substance adheres to the shell so tenaciously that it can only be removed by an effort; in the case of the stromboids, it is more loosely attached. And a peculiarity of all the stromboids is the spiral twist of the shell in the part farthest away from the head; they are also furnished from birth with an operculum. And, further, all stromboid testaceans have their shells on the right hand side, and move not in the direction of the spire, but the opposite way. Such are the diversities observed in the external parts of these animals.

The internal structure is almost the same in all these creatures, and in the stromboids especially; for it is in size that these latter differ from one another, and in accidents of the nature of excess or defect. And there is not much difference between most of the univalves and bivalves; but, while those that open and shut differ from one another but slightly, they differ considerably from such as are incapable of motion. And this will be illustrated more satisfactorily hereafter.

The spiral-shaped testaceans are all similarly constructed, but differ from one another, as has been said, in the way of excess or defect (for the larger species have larger and more conspicuous organs, and the smaller have smaller and less conspicuous), and, furthermore, in relative hardness or softness, and in other such accidents or properties. All the stromboids, for instance, have the flesh that extrudes from the mouth of the shell, hard and stiff; some more, and some less. From the middle of this protrudes the head and two horns, and these horns are large in the large species, but exceedingly minute in the smaller ones. The head protrudes from them all in the same way; and, if the animal be alarmed, the head draws in again. Some of these creatures have a mouth and teeth, as the snail; teeth sharp, and small, and delicate. They have also a proboscis just like that of the fly; and the proboscis is tongue-shaped. The ceryx and the purple murex have this organ firm and solid; and just as the myops, or horse-fly, and the oestrus, or gadfly, can pierce the skin of a quadruped, so is that proboscis proportionately stronger in these testaceans; for they bore right through the shells of other shell-fish on which they prey. The stomach follows close upon the mouth, and, by the way, this or-

gan in the snail resembles a bird's crop. Underneath come two white firm formations, mastoid or papillary in form; and similar formations are found in the cuttle-fish also, only that they are of a firmer consistency in the cuttle-fish. After the stomach comes an oesophagus, simple and long, extending to the poppy or quasi-liver, which is in the innermost recess of the shell. All these statements may be verified in the case of the purple murex and the ceryx by observation within the whorl of the shell. What comes next to the oesophagus is the gut; in fact, the gut is continuous with the oesophagus, and runs its whole length uncomplicated to the outlet of the residuum. The gut has its point of origin in the region of the coil of the mecon, or so-called 'poppy', and is wider hereabouts (for remember, the mecon is for the most part a sort of excretion in all testaceans); it then takes a bend and runs up again towards the fleshy part, and terminates by the side of the head, where the animal discharges its residuum; and this holds good in the case of all stromboid testaceans, whether terrestrial or marine. From the stomach there is drawn in a parallel direction with the oesophagus, in the larger snails, a long white duct enveloped in a membrane, resembling in colour the mastoid formations higher up; and in it are nicks or interruptions, as in the egg-mass of the crawfish, only, by the way, the duct of which we are treating is white and the egg-mass of the crawfish is red. This formation has no outlet nor duct, but is enveloped in a thin membrane with a narrow cavity in its interior. And from the gut downward extend black and rough formations, in close connexion, something like the formations in the tortoise, only not so black. Marine snails, also, have these formations, and the white ones, only that the formations are smaller in the smaller species.

The non-spiral univalves and bivalves are in some respect similar in construction, and in some respects dissimilar, to the spiral testaceans. They all have a head and horns, and a mouth, and the organ resembling a tongue; but these organs, in the smaller species, are indiscernible owing to the minuteness of these animals, and some are indiscernible even in the larger species when dead, or when at rest and motionless. They all have the mecon, or poppy, but not all

in the same place, nor of equal size, nor similarly open to observation; thus, the limpets have this organ deep down in the bottom of the shell, and the bivalves at the hinge connecting the two valves. They also have in all cases the hairy growths or beards, in a circular form, as in the scallops. And, with regard to the so-called 'egg', in those that have it, when they have it, it is situated in one of the semi-circles of the periphery, as is the case with the white formation in the snail; for this white formation in the snail corresponds to the so-called egg of which we are speaking. But all these organs, as has been stated, are distinctly traceable in the larger species, while in the small ones they are in some cases almost, and in others altogether, indiscernible. Hence they are most plainly visible in the large scallops; and these are the bivalves that have one valve flat-shaped, like the lid of a pot. The outlet of the excretion is in all these animals (save for the exception to be afterwards related) on one side; for there is a passage whereby the excretion passes out. (And, remember, the mecon or poppy, as has been stated, is an excretion in all these animals-an excretion enveloped in a membrane.) The so-called egg has no outlet in any of these creatures, but is merely an excrescence in the fleshy mass; and it is not situated in the same region with the gut, but the 'egg' is situated on the right-hand side and the gut on the left. Such are the relations of the anal vent in most of these animals; but in the case of the wild limpet (called by some the 'sea-ear'), the residuum issues beneath the shell, for the shell is perforated to give an outlet. In this particular limpet the stomach is seen coming after the mouth, and the egg-shaped formations are discernible. But for the relative positions of these parts you are referred to my Treatise on Anatomy.

The so-called carcinium or hermit crab is in a way intermediate between the crustaceans and the testaceans. In its nature it resembles the crawfish kind, and it is born simple of itself, but by its habit of introducing itself into a shell and living there it resembles the testaceans, and so appears to partake of the characters of both kinds. In shape, to give a simple illustration, it resembles a spider, only that the part below the head and thorax is larger in this creature than in

the spider. It has two thin red horns, and underneath these horns two long eyes, not retreating inwards, nor turning sideways like the eyes of the crab, but protruding straight out; and underneath these eyes the mouth, and round about the mouth several hair-like growths, and next after these two bifurcate legs or claws, whereby it draws in objects towards itself, and two other legs on either side, and a third small one. All below the thorax is soft, and when opened in dissection is found to be sallow-coloured within. From the mouth there runs a single passage right on to the stomach, but the passage for the excretions is not discernible. The legs and the thorax are hard, but not so hard as the legs and the thorax of the crab. It does not adhere to its shell like the purple murex and the ceryx, but can easily slip out of it. It is longer when found in the shell of the stromboids than when found in the shell of the neritae.

And, by the way, the animal found in the shell of the neritae is a separate species, like to the other in most respects; but of its bifurcate feet or claws, the right-hand one is small and the left-hand one is large, and it progresses chiefly by the aid of this latter and larger one. (In the shells of these animals, and in certain others, there is found a parasite whose mode of attachment is similar. The particular one which we have just described is named the cyllarus.)

The nerites has a smooth large round shell, and resembles the ceryx in shape, only the poppy-juice is, in its case, not black but red. It clings with great force near the middle. In calm weather, then, they go free afield, but when the wind blows the carcinia take shelter against the rocks: the neritae themselves cling fast like limpets; and the same is the case with the haemorrhoid or aporrhaid and all others of the like kind. And, by the way, they cling to the rock, when they turn back their operculum, for this operculum seems like a lid; in fact this structure represents the one part, in the stromboids, of that which in the bivalves is a duplicate shell. The interior of the animal is fleshy, and the mouth is inside. And it is the same with the haemorrhoid, the purple murex, and all suchlike animals.

Such of the little crabs as have the left foot or claw the bigger of the two are found in the neritae, but not in the stromboids. are some snail-shells which have inside them creatures resembling those little crayfish that are also found in fresh water. These creatures, however, differ in having the part inside the shells But as to the characters, you are referred to my Treatise on Anatomy.

5

The urchins are devoid of flesh, and this is a character peculiar to them; and while they are in all cases empty and devoid of any flesh within, they are in all cases furnished with the black formations. There are several species of the urchin, and one of these is that which is made use of for food; this is the kind in which are found the so-called eggs, large and edible, in the larger and smaller specimens alike; for even when as yet very small they are provided with them. There are two other species, the spatangus, and the so-called bryssus, these animals are pelagic and scarce. Further, there are the echinometrae, or 'mother-urchins', the largest in size of all the species. In addition to these there is another species, small in size, but furnished with large hard spines; it lives in the sea at a depth of several fathoms; and is used by some people as a specific for cases of strangury. In the neighbourhood of Torone there are sea-urchins of a white colour, shells, spines, eggs and all, and that are longer than the ordinary sea-urchin. The spine in this species is not large nor strong, but rather limp; and the black formations in connexion with the mouth are more than usually numerous, and communicate with the external duct, but not with one another; in point of fact, the animal is in a manner divided up by them. The edible urchin moves with greatest freedom and most often; and this is indicated by the fact that these urchins have always something or other on their spines.

All urchins are supplied with eggs, but in some of the species the eggs are exceedingly small and unfit for food. Singularly enough, the urchin has what we may call its head and mouth down below, and a place for the issue of the residuum up above; (and this same property

is common to all stromboids and to limpets). For the food on which the creature lives lies down below; consequently the mouth has a position well adapted for getting at the food, and the excretion is above, near to the back of the shell. The urchin has, also, five hollow teeth inside, and in the middle of these teeth a fleshy substance serving the office of a tongue. Next to this comes the oesophagus, and then the stomach, divided into five parts, and filled with excretion, all the five parts uniting at the anal vent, where the shell is perforated for an outlet. Underneath the stomach, in another membrane, are the so-called eggs, identical in number in all cases, and that number is always an odd number, to wit five. Up above, the black formations are attached to the starting-point of the teeth, and they are bitter to the taste, and unfit for food. A similar or at least an analogous formation is found in many animals; as, for instance, in the tortoise, the toad, the frog, the stromboids, and, generally, in the molluscs; but the formation varies here and there in colour, and in all cases is altogether uneatable, or more or less unpalatable. In reality the mouth-apparatus of the urchin is continuous from one end to the other, but to outward appearance it is not so, but looks like a horn lantern with the panes of horn left out. The urchin uses its spines as feet; for it rests its weight on these, and then moving shifts from place to place.

6

The so-called tethyum or ascidian has of all these animals the most remarkable characteristics. It is the only mollusc that has its entire body concealed within its shell, and the shell is a substance intermediate between hide and shell, so that it cuts like a piece of hard leather. It is attached to rocks by its shell, and is provided with two passages placed at a distance from one another, very minute and hard to see, whereby it admits and discharges the sea-water; for it has no visible excretion (whereas of shell fish in general some resemble the urchin in this matter of excretion, and others are provided with the so-called mecon, or poppy-juice). If the animal be opened, it is found to have, in the first place, a tendinous membrane running

round inside the shell-like substance, and within this membrane is the flesh-like substance of the ascidian, not resembling that in other molluscs; but this flesh, to which I now allude, is the same in all ascidia. And this substance is attached in two places to the membrane and the skin, obliquely; and at the point of attachment the space is narrowed from side to side, where the fleshy substance stretches towards the passages that lead outwards through the shell; and here it discharges and admits food and liquid matter, just as it would if one of the passages were a mouth and the other an anal vent; and one of the passages is somewhat wider than the other Inside it has a pair of cavities, one on either side, a small partition separating them; and one of these two cavities contains the liquid. The creature has no other organ whether motor or sensory, nor, as was said in the case of the others, is it furnished with any organ connected with excretion, as other shell-fish are. The colour of the ascidian is in some cases sallow, and in other cases red.

There is, furthermore, the genus of the sea-nettles, peculiar in its way. The sea-nettle, or sea-anemone, clings to rocks like certain of the testaceans, but at times relaxes its hold. It has no shell, but its entire body is fleshy. It is sensitive to touch, and, if you put your hand to it, it will seize and cling to it, as the cuttlefish would do with its feelers, and in such a way as to make the flesh of your hand swell up. Its mouth is in the centre of its body, and it lives adhering to the rock as an oyster to its shell. If any little fish come up against it it it clings to it; in fact, just as I described it above as doing to your hand, so it does to anything edible that comes in its way; and it feeds upon sea-urchins and scallops. Another species of the sea-nettle roams freely abroad. The sea-nettle appears to be devoid altogether of excretion, and in this respect it resembles a plant.

Of sea-nettles there are two species, the lesser and more edible, and the large hard ones, such as are found in the neighbourhood of Chalcis. In winter time their flesh is firm, and accordingly they are sought after as articles of food, but in summer weather they are worthless, for they become thin and watery, and if you catch at them

they break at once into bits, and cannot be taken off the rocks entire; and being oppressed by the heat they tend to slip back into the crevices of the rocks.

So much for the external and the internal organs of molluscs, crustaceans, and testaceans.

7

We now proceed to treat of insects in like manner. This genus comprises many species, and, though several kinds are clearly related to one another, these are not classified under one common designation, as in the case of the bee, the drone, the wasp, and all such insects, and again as in the case of those that have their wings in a sheath or shard, like the cockchafer, the carabus or stag-beetle, the cantharis or blister-beetle, and the like.

Insects have three parts common to them all; the head, the trunk containing the stomach, and a third part in betwixt these two, corresponding to what in other creatures embraces chest and back. In the majority of insects this intermediate part is single; but in the long and multipedal insects it has practically the same number of segments as of nicks.

All insects when cut in two continue to live, excepting such as are naturally cold by nature, or such as from their minute size chill rapidly; though, by the way, wasps notwithstanding their small size continue living after severance. In conjunction with the middle portion either the head or the stomach can live, but the head cannot live by itself. Insects that are long in shape and many-footed can live for a long while after being cut in twain, and the severed portions can move in either direction, backwards or forwards; thus, the hinder portion, if cut off, can crawl either in the direction of the section or in the direction of the tail, as is observed in the scolopendra.

All insects have eyes, but no other organ of sense discernible, except that some insects have a kind of a tongue corresponding to a similar organ common to all testaceans; and by this organ such insects taste

and imbibe their food. In some insects this organ is soft; in other insects it is firm; as it is, by the way, in the purple-fish, among testaceans. In the horsefly and the gadfly this organ is hard, and indeed it is hard in most insects. In point of fact, such insects as have no sting in the rear use this organ as a weapon, (and, by the way, such insects as are provided with this organ are unprovided with teeth, with the exception of a few insects); the fly by a touch can draw blood with this organ, and the gnat can prick or sting with it.

Certain insects are furnished with prickers or stings. Some insects have the sting inside, as the bee and the wasp, others outside, as the scorpion; and, by the way, this is the only insect furnished with a long tail. And, further, the scorpion is furnished with claws, as is also the creature resembling a scorpion found within the pages of books.

In addition to their other organs, flying insects are furnished with wings. Some insects are dipterous or double-winged, as the fly; others are tetrapterous or furnished with four wings, as the bee; and, by the way, no insect with only two wings has a sting in the rear. Again, some winged insects have a sheath or shard for their wings, as the cockchafer; whereas in others the wings are unsheathed, as in the bee. But in the case of all alike, flight is in no way modified by tail-steerage, and the wing is devoid of quill-structure or division of any kind.

Again, some insects have antennae in front of their eyes, as the butterfly and the horned beetle. Such of them as have the power of jumping have the hinder legs the longer; and these long hind-legs whereby they jump bend backwards like the hind-legs of quadrupeds. All insects have the belly different from the back; as, in fact, is the case with all animals. The flesh of an insect's body is neither shell-like nor is it like the internal substance of shell-covered animals, nor is it like flesh in the ordinary sense of the term; but it is a something intermediate in quality. Wherefore they have nor spine, nor bone, nor sepia-bone, nor enveloping shell; but their body by its hardness is its own protection and requires no extraneous support.

However, insects have a skin; but the skin is exceedingly thin. These and such-like are the external organs of insects.

Internally, next after the mouth, comes a gut, in the majority of cases straight and simple down to the outlet of the residuum: but in a few cases the gut is coiled. No insect is provided with any viscera, or is supplied with fat; and these statements apply to all animals devoid of blood. Some have a stomach also, and attached to this the rest of the gut, either simple or convoluted as in the case of the acris or grasshopper.

The tettix or cicada, alone of such creatures (and, in fact, alone of all creatures), is unprovided with a mouth, but it is provided with the tongue-like formation found in insects furnished with frontward stings; and this formation in the cicada is long, continuous, and devoid of any split; and by the aid of this the creature feeds on dew, and on dew only, and in its stomach no excretion is ever found. Of the cicada there are several kinds, and they differ from one another in relative magnitude, and in this respect that the achetes or chirper is provided with a cleft or aperture under the hypozoma and has in it a membrane quite discernible, whilst the membrane is indiscernible in the tettigonia.

Furthermore, there are some strange creatures to be found in the sea, which from their rarity we are unable to classify. Experienced fishermen affirm, some that they have at times seen in the sea animals like sticks, black, rounded, and of the same thickness throughout; others that they have seen creatures resembling shields, red in colour, and furnished with fins packed close together; and others that they have seen creatures resembling the male organ in shape and size, with a pair of fins in the place of the testicles, and they aver that on one occasion a creature of this description was brought up on the end of a nightline.

So much then for the parts, external and internal, exceptional and common, of all animals.

8

We now proceed to treat of the senses; for there are diversities in animals with regard to the senses, seeing that some animals have the use of all the senses, and others the use of a limited number of them. The total number of the senses (for we have no experience of any special sense not here included), is five: sight, hearing, smell, taste, and touch.

Man, then, and all vivipara that have feet, and, further, all red-blooded ovipara, appear to have the use of all the five senses, except where some isolated species has been subjected to mutilation, as in the case of the mole. For this animal is deprived of sight; it has no eyes visible, but if the skin-a thick one, by the way-be stripped off the head, about the place in the exterior where eyes usually are, the eyes are found inside in a stunted condition, furnished with all the parts found in ordinary eyes; that is to say, we find there the black rim, and the fatty part surrounding it; but all these parts are smaller than the same parts in ordinary visible eyes. There is no external sign of the existence of these organs in the mole, owing to the thickness of the skin drawn over them, so that it would seem that the natural course of development were congenitally arrested; (for extending from the brain at its junction with the marrow are two strong sinewy ducts running past the sockets of the eyes, and terminating at the upper eye-teeth). All the other animals of the kinds above mentioned have a perception of colour and of sound, and the senses of smell and taste; the fifth sense, that, namely, of touch, is common to all animals whatsoever.

In some animals the organs of sense are plainly discernible; and this is especially the case with the eyes. For animals have a special locality for the eyes, and also a special locality for hearing: that is to say, some animals have ears, while others have the passage for sound discernible. It is the same with the sense of smell; that is to say, some animals have nostrils, and others have only the passages for smell, such as birds. It is the same also with the organ of taste, the tongue.

Of aquatic red-blooded animals, fishes possess the organ of taste, namely the tongue, but it is in an imperfect and amorphous form, in other words it is osseous and undetached. In some fish the palate is fleshy, as in the fresh-water carp, so that by an inattentive observer it might be mistaken for a tongue.

There is no doubt but that fishes have the sense of taste, for a great number of them delight in special flavours; and fishes freely take the hook if it be baited with a piece of flesh from a tunny or from any fat fish, obviously enjoying the taste and the eating of food of this kind. Fishes have no visible organs for hearing or for smell; for what might appear to indicate an organ for smell in the region of the nostril has no communication with the brain. These indications, in fact, in some cases lead nowhere, like blind alleys, and in other cases lead only to the gills; but for all this fishes undoubtedly hear and smell. For they are observed to run away from any loud noise, such as would be made by the rowing of a galley, so as to become easy of capture in their holes; for, by the way, though a sound be very slight in the open air, it has a loud and alarming resonance to creatures that hear under water. And this is shown in the capture of the dolphin; for when the hunters have enclosed a shoal of these fishes with a ring of their canoes, they set up from inside the canoes a loud splashing in the water, and by so doing induce the creatures to run in a shoal high and dry up on the beach, and so capture them while stupefied with the noise. And yet, for all this, the dolphin has no organ of hearing discernible. Furthermore, when engaged in their craft, fishermen are particularly careful to make no noise with oar or net; and after they have spied a shoal, they let down their nets at a spot so far off that they count upon no noise being likely to reach the shoal, occasioned either by oar or by the surging of their boats through the water; and the crews are strictly enjoined to preserve silence until the shoal has been surrounded. And, at times, when they want the fish to crowd together, they adopt the stratagem of the dolphin-hunter; in other words they clatter stones together, that the fish may, in their fright, gather close into one spot, and so they envelop them within their nets. (Before surrounding them, then, they preserve silence, as

was said; but, after hemming the shoal in, they call on every man to shout out aloud and make any kind of noise; for on hearing the noise and hubbub the fish are sure to tumble into the nets from sheer fright.) Further, when fishermen see a shoal of fish feeding at a distance, disporting themselves in calm bright weather on the surface of the water, if they are anxious to descry the size of the fish and to learn what kind of a fish it is, they may succeed in coming upon the shoal whilst yet basking at the surface if they sail up without the slightest noise, but if any man make a noise previously, the shoal will be seen to scurry away in alarm. Again, there is a small river-fish called the cottus or bullhead; this creature burrows under a rock, and fishers catch it by clattering stones against the rock, and the fish, bewildered at the noise, darts out of its hiding-place. From these facts it is quite obvious that fishes can hear; and indeed some people, from living near the sea and frequently witnessing such phenomena, affirm that of all living creatures the fish is the quickest of hearing. And, by the way, of all fishes the quickest of hearing are the cestreus or mullet, the chremps, the labrax or basse, the salpe or saupe, the chromis or sciaena, and such like. Other fishes are less quick of hearing, and, as might be expected, are more apt to be found living at the bottom of the sea.

The case is similar in regard to the sense of smell. Thus, as a rule, fishes will not touch a bait that is not fresh, neither are they all caught by one and the same bait, but they are severally caught by baits suited to their several likings, and these baits they distinguish by their sense of smell; and, by the way, some fishes are attracted by malodorous baits, as the saupe, for instance, is attracted by excrement. Again, a number of fishes live in caves; and accordingly fishermen, when they want to entice them out, smear the mouth of a cave with strong-smelling pickles, and the fish are Soon attracted to the smell. And the eel is caught in a similar way; for the fisherman lays down an earthen pot that has held pickles, after inserting a 'weel' in the neck thereof. As a general rule, fishes are especially attracted by savoury smells. For this reason, fishermen roast the fleshy parts of the cuttle-fish and use it as bait on account of its smell, for fish are

peculiarly attracted by it; they also bake the octopus and bait their fish-baskets or weels with it, entirely, as they say, on account of its smell. Furthermore, gregarious fishes, if fish washings or bilge-water be thrown overboard, are observed to scud off to a distance, from apparent dislike of the smell. And it is asserted that they can at once detect by smell the presence of their own blood; and this faculty is manifested by their hurrying off to a great distance whenever fish-blood is spilt in the sea. And, as a general rule, if you bait your weel with a stinking bait, the fish refuse to enter the weel or even to draw near; but if you bait the weel with a fresh and savoury bait, they come at once from long distances and swim into it. And all this is particularly manifest in the dolphin; for, as was stated, it has no visible organ of hearing, and yet it is captured when stupefied with noise; and so, while it has no visible organ for smell, it has the sense of smell remarkably keen. It is manifest, then, that the animals above mentioned are in possession of all the five senses.

All other animals may, with very few exceptions, be comprehended within four genera: to wit, molluscs, crustaceans, testaceans, and insects. Of these four genera, the mollusc, the crustacean, and the insect have all the senses: at all events, they have sight, smell, and taste. As for insects, both winged and wingless, they can detect the presence of scented objects afar off, as for instance bees and snipes detect the presence of honey at a distance; and do so recognizing it by smell. Many insects are killed by the smell of brimstone; ants, if the apertures to their dwellings be smeared with powdered origanum and brimstone, quit their nests; and most insects may be banished with burnt hart's horn, or better still by the burning of the gum styrax. The cuttle-fish, the octopus, and the crawfish may be caught by bait. The octopus, in fact, clings so tightly to the rocks that it cannot be pulled off, but remains attached even when the knife is employed to sever it; and yet, if you apply fleabane to the creature, it drops off at the very smell of it. The facts are similar in regard to taste. For the food that insects go in quest of is of diverse kinds, and they do not all delight in the same flavours: for instance, the bee never settles on a withered or wilted flower, but on fresh and sweet ones; and the

conops or gnat settles only on acrid substances and not on sweet. The sense of touch, by the way, as has been remarked, is common to all animals. Testaceans have the senses of smell and taste. With regard to their possession of the sense of smell, that is proved by the use of baits, e.g. in the case of the purple-fish; for this creature is enticed by baits of rancid meat, which it perceives and is attracted to from a great distance. The proof that it possesses a sense of taste hangs by the proof of its sense of smell; for whenever an animal is attracted to a thing by perceiving its smell, it is sure to like the taste of it. Further, all animals furnished with a mouth derive pleasure or pain from the touch of sapid juices.

With regard to sight and hearing, we cannot make statements with thorough confidence or on irrefutable evidence. However, the solen or razor-fish, if you make a noise, appears to burrow in the sand, and to hide himself deeper when he hears the approach of the iron rod (for the animal, be it observed, juts a little out of its hole, while the greater part of the body remains within),-and scallops, if you present your finger near their open valves, close them tight again as though they could see what you were doing. Furthermore, when fishermen are laying bait for neritae, they always get to leeward of them, and never speak a word while so engaged, under the firm impression that the animal can smell and hear; and they assure us that, if any one speaks aloud, the creature makes efforts to escape. With regard to testaceans, of the walking or creeping species the urchin appears to have the least developed sense of smell; and, of the stationary species, the ascidian and the barnacle.

So much for the organs of sense in the general run of animals. We now proceed to treat of voice.

9

Voice and sound are different from one another; and language differs from voice and sound. The fact is that no animal can give utterance to voice except by the action of the pharynx, and consequently such animals as are devoid of lung have no voice; and

language is the articulation of vocal sounds by the instrumentality of the tongue. Thus, the voice and larynx can emit vocal or vowel sounds; non-vocal or consonantal sounds are made by the tongue and the lips; and out of these vocal and non-vocal sounds language is composed. Consequently, animals that have no tongue at all or that have a tongue not freely detached, have neither voice nor language; although, by the way, they may be enabled to make noises or sounds by other organs than the tongue.

Insects, for instance, have no voice and no language, but they can emit sound by internal air or wind, though not by the emission of air or wind; for no insects are capable of respiration. But some of them make a humming noise, like the bee and the other winged insects; and others are said to sing, as the cicada. And all these latter insects make their special noises by means of the membrane that is underneath the 'hypozoma'-those insects, that is to say, whose body is thus divided; as for instance, one species of cicada, which makes the sound by means of the friction of the air. Flies and bees, and the like, produce their special noise by opening and shutting their wings in the act of flying; for the noise made is by the friction of air between the wings when in motion. The noise made by grasshoppers is produced by rubbing or reverberating with their long hind-legs.

No mollusc or crustacean can produce any natural voice or sound. Fishes can produce no voice, for they have no lungs, nor windpipe and pharynx; but they emit certain inarticulate sounds and squeaks, which is what is called their 'voice', as the lyra or gurnard, and the sciaena (for these fishes make a grunting kind of noise) and the caprus or boar-fish in the river Achelous, and the chalcis and the cuckoo-fish; for the chalcis makes a sort piping sound, and the cuckoo-fish makes a sound greatly like the cry of the cuckoo, and is nicknamed from the circumstance. The apparent voice in all these fishes is a sound caused in some cases by a rubbing motion of their gills, which by the way are prickly, or in other cases by internal parts about their bellies; for they all have air or wind inside them, by

rubbing and moving which they produce the sounds. Some cartilaginous fish seem to squeak.

But in these cases the term 'voice' is inappropriate; the more correct expression would be 'sound'. For the scallop, when it goes along supporting itself on the water, which is technically called 'flying', makes a whizzing sound; and so does the sea-swallow or flying-fish: for this fish flies in the air, clean out of the water, being furnished with fins broad and long. Just then as in the flight of birds the sound made by their wings is obviously not voice, so is it in the case of all these other creatures.

The dolphin, when taken out of the water, gives a squeak and moans in the air, but these noises do not resemble those above mentioned. For this creature has a voice (and can therefore utter vocal or vowel sounds), for it is furnished with a lung and a windpipe; but its tongue is not loose, nor has it lips, so as to give utterance to an articulate sound (or a sound of vowel and consonant in combination.)

Of animals which are furnished with tongue and lung, the oviparous quadrupeds produce a voice, but a feeble one; in some cases, a shrill piping sound, like the serpent; in others, a thin faint cry; in others, a low hiss, like the tortoise. The formation of the tongue in the frog is exceptional. The front part of the tongue, which in other animals is detached, is tightly fixed in the frog as it is in all fishes; but the part towards the pharynx is freely detached, and may, so to speak, be spat outwards, and it is with this that it makes its peculiar croak. The croaking that goes on in the marsh is the call of the males to the females at rutting time; and, by the way, all animals have a special cry for the like end at the like season, as is observed in the case of goats, swine, and sheep. (The bull-frog makes its croaking noise by putting its under jaw on a level with the surface of the water and extending its upper jaw to its utmost capacity. The tension is so great that the upper jaw becomes transparent, and the animal's eyes shine through the jaw like lamps; for, by the way, the commerce of the sexes takes place usually in the night time.) Birds can utter vocal sounds; and such of them can articulate best as have the tongue

moderately flat, and also such as have thin delicate tongues. In some cases, the male and the female utter the same note; in other cases, different notes. The smaller birds are more vocal and given to chirping than the larger ones; but in the pairing season every species of bird becomes particularly vocal. Some of them call when fighting, as the quail, others cry or crow when challenging to combat, as the partridge, or when victorious, as the barn-door cock. In some cases cock-birds and hens sing alike, as is observed in the nightingale, only that the hen stops singing when brooding or rearing her young; in other birds, the cocks sing more than the hens; in fact, with barn-door fowls and quails, the cock sings and the hen does not.

Viviparous quadrupeds utter vocal sounds of different kinds, but they have no power of converse. In fact, this power, or language, is peculiar to man. For while the capability of talking implies the capability of uttering vocal sounds, the converse does not hold good. Men that are born deaf are in all cases also dumb; that is, they can make vocal sounds, but they cannot speak. Children, just as they have no control over other parts, so have no control, at first, over the tongue; but it is so far imperfect, and only frees and detaches itself by degrees, so that in the interval children for the most part lisp and stutter.

Vocal sounds and modes of language differ according to locality. Vocal sounds are characterized chiefly by their pitch, whether high or low, and the kinds of sound capable of being produced are identical within the limits of one and the same species; but articulate sound, that one might reasonably designate 'language', differs both in various animals, and also in the same species according to diversity of locality; as for instance, some partridges cackle, and some make a shrill twittering noise. Of little birds, some sing a different note from the parent birds, if they have been removed from the nest and have heard other birds singing; and a mother-nightingale has been observed to give lessons in singing to a young bird, from which spectacle we might obviously infer that the song of the bird was not equally congenital with mere voice, but was something capable of

modification and of improvement. Men have the same voice or vocal sounds, but they differ from one another in speech or language.

The elephant makes a vocal sound of a windlike sort by the mouth alone, unaided by the trunk, just like the sound of a man panting or sighing; but, if it employ the trunk as well, the sound produced is like that of a hoarse trumpet.

10

With regard to the sleeping and waking of animals, all creatures that are red-blooded and provided with legs give sensible proof that they go to sleep and that they waken up from sleep; for, as a matter of fact, all animals that are furnished with eyelids shut them up when they go to sleep. Furthermore, it would appear that not only do men dream, but horses also, and dogs, and oxen; aye, and sheep, and goats, and all viviparous quadrupeds; and dogs show their dreaming by barking in their sleep. With regard to oviparous animals we cannot be sure that they dream, but most undoubtedly they sleep. And the same may be said of water animals, such as fishes, molluscs, crustaceans, to wit crawfish and the like. These animals sleep without doubt, although their sleep is of very short duration. The proof of their sleeping cannot be got from the condition of their eyes-for none of these creatures are furnished with eyelids-but can be obtained only from their motionless repose.

Apart from the irritation caused by lice and what are nicknamed fleas, fish are met with in a state so motionless that one might easily catch them by hand; and, as a matter of fact, these little creatures, if the fish remain long in one position, will attack them in myriads and devour them. For these parasites are found in the depths of the sea, and are so numerous that they devour any bait made of fish's flesh if it be left long on the ground at the bottom; and fishermen often draw up a cluster of them, all clinging on to the bait.

But it is from the following facts that we may more reasonably infer that fishes sleep. Very often it is possible to take a fish off its guard so far as to catch hold of it or to give it a blow unawares; and all the

while that you are preparing to catch or strike it, the fish is quite still but for a slight motion of the tail. And it is quite obvious that the animal is sleeping, from its movements if any disturbance be made during its repose; for it moves just as you would expect in a creature suddenly awakened. Further, owing to their being asleep, fish may be captured by torchlight. The watchmen in the tunny-fishery often take advantage of the fish being asleep to envelop them in a circle of nets; and it is quite obvious that they were thus sleeping by their lying still and allowing the glistening under-parts of their bodies to become visible, while the capture is taking Place. They sleep in the night-time more than during the day; and so soundly at night that you may cast the net without making them stir. Fish, as a general rule, sleep close to the ground, or to the sand or to a stone at the bottom, or after concealing themselves under a rock or the ground. Flat fish go to sleep in the sand; and they can be distinguished by the outlines of their shapes in the sand, and are caught in this position by being speared with pronged instruments. The basse, the chrysophrys or gilt-head, the mullet, and fish of the like sort are often caught in the daytime by the prong owing to their having been surprised when sleeping; for it is scarcely probable that fish could be pronged while awake. Cartilaginous fish sleep at times so soundly that they may be caught by hand. The dolphin and the whale, and all such as are furnished with a blow-hole, sleep with the blow-hole over the surface of the water, and breathe through the blow-hole while they keep up a quiet flapping of their fins; indeed, some mariners assure us that they have actually heard the dolphin snoring.

Molluscs sleep like fishes, and crustaceans also. It is plain also that insects sleep; for there can be no mistaking their condition of motionless repose. In the bee the fact of its being asleep is very obvious; for at night-time bees are at rest and cease to hum. But the fact that insects sleep may be very well seen in the case of common every-day creatures; for not only do they rest at night-time from dimness of vision (and, by the way, all hard-eyed creatures see but indistinctly), but even if a lighted candle be presented they continue sleeping quite as soundly.

Of all animals man is most given to dreaming. Children and infants do not dream, but in most cases dreaming comes on at the age of four or five years. Instances have been known of full-grown men and women that have never dreamed at all; in exceptional cases of this kind, it has been observed that when a dream occurs in advanced life it prognosticates either actual dissolution or a general break-up of the system.

So much then for sensation and for the phenomena of sleeping and of awakening.

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With regard to sex, some animals are divided into male and female, but others are not so divided but can only be said in a comparative way to bring forth young and to be pregnant. In animals that live confined to one spot there is no duality of sex; nor is there such, in fact, in any testaceans. In molluscs and in crustaceans we find male and female: and, indeed, in all animals furnished with feet, biped or quadruped; in short, in all such as by copulation engender either live young or egg or grub. In the several genera, with however certain exceptions, there either absolutely is or absolutely is not a duality of sex. Thus, in quadrupeds the duality is universal, while the absence of such duality is universal in testaceans, and of these creatures, as with plants, some individuals are fruitful and some are not their lying still

But among insects and fishes, some cases are found wholly devoid of this duality of sex. For instance, the eel is neither male nor female, and can engender nothing. In fact, those who assert that eels are at times found with hair-like or worm-like progeny attached, make only random assertions from not having carefully noticed the locality of such attachments. For no eel nor animal of this kind is ever viviparous unless previously oviparous; and no eel was ever yet seen with an egg. And animals that are viviparous have their young in the womb and closely attached, and not in the belly; for, if the embryo were kept in the belly, it would be subjected to the process of diges-

tion like ordinary food. When people rest duality of sex in the eel on the assertion that the head of the male is bigger and longer, and the head of the female smaller and more snubbed, they are taking diversity of species for diversity of sex.

There are certain fish that are nicknamed the epitragiae, or capon-fish, and, by the way, fish of this description are found in fresh water, as the carp and the balagrus. This sort of fish never has either roe or milt; but they are hard and fat all over, and are furnished with a small gut; and these fish are regarded as of super-excellent quality.

Again, just as in testaceans and in plants there is what bears and engenders, but not what impregnates, so is it, among fishes, with the psetta, the erythrinus, and the channe; for these fish are in all cases found furnished with eggs.

As a general rule, in red-blooded animals furnished with feet and not oviparous, the male is larger and longer-lived than the female (except with the mule, where the female is longer-lived and bigger than the male); whereas in oviparous and vermiparous creatures, as in fishes and in insects, the female is larger than the male; as, for instance, with the serpent, the phalangium or venom-spider, the gecko, and the frog. The same difference in size of the sexes is found in fishes, as, for instance, in the smaller cartilaginous fishes, in the greater part of the gregarious species, and in all that live in and about rocks. The fact that the female is longer-lived than the male is inferred from the fact that female fishes are caught older than males. Furthermore, in all animals the upper and front parts are better, stronger, and more thoroughly equipped in the male than in the female, whereas in the female those parts are the better that may be termed hinder-parts or underparts. And this statement is applicable to man and to all vivipara that have feet. Again, the female is less muscular and less compactly jointed, and more thin and delicate in the hair-that is, where hair is found; and, where there is no hair, less strongly furnished in some analogous substance. And the female is more flaccid in texture of flesh, and more knock-kneed, and the shin-bones are thinner; and the feet are more arched and hollow in

such animals as are furnished with feet. And with regard to voice, the female in all animals that are vocal has a thinner and sharper voice than the male; except, by the way, with kine, for the lowing and bellowing of the cow has a deeper note than that of the bull. With regard to organs of defence and offence, such as teeth, tusks, horns, spurs, and the like, these in some species the male possesses and the female does not; as, for instance, the hind has no horns, and where the cock-bird has a spur the hen is entirely destitute of the organ; and in like manner the sow is devoid of tusks. In other species such organs are found in both sexes, but are more perfectly developed in the male; as, for instance, the horn of the bull is more powerful than the horn of the cow.