to the more favourable inclination of the sunbeams at this early hour."

Sea-Cucumbers.—(Plate X.)

Sea-Cucumbers, or *Holothuriadæ*, form an order of the class *Echinodermata*, approaching, in some characteristics, the *Actiniadæ*, through such genera as *Peachia* and *Edwardsia;* and, on the other hand, the *Star-fishes* and *Echini*. To the latter they more properly belong. In short, Professor Forbes considers a Sea-Cucumber in the light of a soft *Echinus* and long-bodied Star-fish combined.

True *Star-fishes*, *Echini*, and *Holothuriadæ*, all possess and use, as one means of progression, rows of movable filaments, which are contractile, and have at their tips little sucker-discs. In the latter, to which class our *Pentacta*, or *Cucumaria*, belongs, these suckers are arranged in five rows along the body, dividing it into five sides. The skin of these animals is soft and leathery. In some species the suckers are more developed on the under side, so as to form a creeping surface, in opposition to the upper or dorsal surface. But, as a rule, the animals crawl indifferently on any side. Suckers are not, however, the only means of locomotion possessed by the *Holothuriadæ;* for

they also crawl by drawing up their bodies in the same manner as the worms do. The bodies are always, in their normal form, cylindrical, but generally taper towards the extremities. They have a mouth at the anterior extremity, which is surrounded by ten feathered or branched tentacula, which can be withdrawn into the body, and are sometimes for days not exserted. They also have a circle of teeth in the mouth.

In Mr. Lloyd's collection, I had the pleasure of watching a number of very fine specimens of *Pentacta pentactes* (Plate X. fig. 2, 3), which are all white with the exception of their heads. These, when protruded, are sometimes found to be yellowish, and sometimes blackish; they are beautifully branched, and, when partially expanded, look like miniature bunches of grapes. The body, as the name implies, is divided into five sides, with a double row of suckers on each angle. These curious creatures move freely about the tanks in which they are confined, assuming various shapes, and seeking various positions. Sometimes they crawl up the glass sides of the vessel, where they maintain their hold by means of the suckers, which always adapt their length to the space they have to reach over. Sometimes they travel on the ground among pebbles, or wind their

elongated trunks worm-fashion round pieces of rock, or between seaweeds. When not in use, the suckers appear only as little teat-like tubercles, and are only converted into legs when required for use; the extremity of each, like that of the suckers of the *Star-fish*, sticks to everything it touches, and by means of them the whole body is drawn forward.

Like *Star-fishes*, Sea-Cucumbers seem to be addicted to suicide, or at least, self-mutilation. A specimen which Mr. Lloyd was bringing home in a jar some months since, being made uncomfortable by the jolting of the cabriolet, actually ejected his stomach, turning it inside out, and then threw it off, together with his head and circle of tentacles. He then fixed himself on the side of the jar, in a rather attenuated condition, near the water's edge, where he remained, showing signs of life. At first, of course, he was expected to die very soon, but he lived on; and then Mr. Lloyd began to hope that Nature would exercise her remedial power, and that a new head, stomach, and tentacula might replace the old ones. Nor is it certain that he will be disappointed in that expectation. The animal is living still, and there are some slight signs of the missing organs budding forth. The specimen in question is figured in our Plate X. fig. 1, and is clouded with a pale greenish-brown.

Among the most curious and interesting species of this family are the following :—

Psolinus brevis,

Which is small, in its natural shape like a gherkin, with long digitated feelers, and the suckers of the under side of the body long, few, and bent; so that when the animal is crawling, as it does upon stems of *Laminaria*, they look like feet, and the motion is almost like that of walking.

Cucumaria grandis.

The *Great Sea-Cucumber* is sometimes called the Sea-pudding. He is an immense creature, quite a foot long when at rest, and capable of extending himself to the length of a yard. The body is of a very dark purple colour on one side, and whitish on the other.

Thyone papillosa

Has its suckers dispersed all over the body. It is two or three inches long, and, when at rest, of an oval or pear shape. Its very tough skin has a papillose appearance, in consequence of the numerous non-retractile suckers. The following is taken from Dr. Johnston's account of this spe-

cies in captivity:—"The surfaces of the body were at first partially covered with fragments of Shells and Corallines, which were evidently retained by the suctorial power of the papillæ; and the animal on being kept a day in sea-water threw them off. It had a slow progressive movement, slower than the shadow of the dial, which was effected by elongating the papillæ of one part, fixing them to the plate, and then drawing itself forward by again contracting those elongated parts. But the papillæ were oftener used for the purpose of anchors than of feet, the creatures being of an indolent and immovable character. When stationary it was ever slowly changing its outward form; it was now shortened and swollen in the centre; then it would relax itself and become cylindrical; again, one part would be blown out, and another drawn in with a deep stricture, as if a thread had been tied round; or, again, the contraction would begin near the head, which is then made very narrow, and would spread backward, the anterior portion recovering its original diameter as the wave of constriction passed away; and sometimes the constriction will spread in the opposite direction. It often raised the posterior extremity a little from the surface of the plate and to one side, but I never saw any current flow from the aperture.

"The worm having been kept in sea-water unchanged for two or three days, sickened, and by the more frequent involutions and evolutions of the oral end evinced its uneasiness. Being left unobserved in this state for an hour or so, I found on my return that it had vomited up its tentacula, its oral apparatus, its intestinal tube entire, and a large number of ovaries which lay about the plate. The muscular convulsion must have been very great to have thus so completely embowelled the creature; and yet life was not extinct, for the tentacula contracted themselves on being touched, and the empty skin appeared by its motions to have lost little of its irritability."

A great deal of water circulates through these animals, Dr. Johnston thinking that it is first forced through the tubes of the feet, or suckers. The accumulation of water in different parts of the body at different times causes those parts to swell so as to change the form in the manner described.

Plate X. represents Mr. Lloyd's self-mutilated *Pentacta pentactes* in the horizontal position at the edge of the water, in which it has remained. The two lower specimens are from the same collection; they are in health, of a white colour, with tentacles orange and black.

CHAPTER VIII.

SEA-URCHINS AND STAR-FISHES.

COMMON ECHINUS.—MEANS OF PROGRESSION.—PROPORTIONS OF PLATES.—DIGESTIVE ORGANS.—ECHINUS MILIARIS.—SPATANGUS.—CIDARIS.—STAR-FISHES.—THEIR CLASSIFICATION.—THE ROSY FEATHER-STAR.—OPHIOCOMA.—LUIDA.—URASTER.

Sea-Urchins are distinguished from other Echinoderms by their more or less rounded form, and by their shelly box or case, which is composed of a number of plates united edgewise by integuments. On the shelly plates are tubercles of various sizes, rounded at their tops, forming *balls* corresponding with *sockets* in the ends of various spines, which are movably attached to them by that kind of joint. The spines differ in size, number, arrangement, and shape, according to the genus or species to which the specimen belongs. Radiating down the sides, and dividing the box like the quarterings of an orange, are a kind of canals or

depressions, called *ambulacra*, because they are pierced with rows of holes through which are put forth sucker-tubes, like those of Star-fishes and Sea-Cucumbers, supposed to be more or less used in locomotion. These animals have a mouth and a vent: the former below, and the latter in variable positions. Whatever relative positions these two openings take, the intestinal canal leading from one to the other is winding, and is attached to the inside of the shelly case by means of what is called an integument, as well as all the internal lining, with vibratile cilia, and which is connected with the function of respiration. They are believed to possess also a muscular apparatus, which has pulsations, and branching veins connected with it, like the heart in more advanced animals. They are also asserted to possess a nervous system like that of the *Holothuriadæ*.

Means of Progression.

The *Echinidæ* use both suckers and spines for locomotion. Of course only those on the under, or oral side, or near the base, can be used in this way. To those on the base and upper part of the sides some other functions must be assigned, and it is well known that one organ is often applied to several uses, as well as several different organs to

the same use, especially in the lower classes of animals. Both spines and suckers may come into play when the animal is crawling among stones or living in holes, the sides and roofs of which would form fulcra. The suckers are used in attaching the body to rocks, by which means the animal fixes himself firmly in his chosen position.

Professor Agassiz indeed asks, "How in fact could these small tentacula, situated as they generally are in that part of the body which is never brought into contact with the ground on which the animal moves, and overhung by calcareous solid spines; how, I ask, could these flexible tubes be used as organs of motion?" The Professor further remarks, "It is an undeniable fact, and I have observed it myself, that it is with their spines that the *Echini* move themselves, seize their prey, and bring it to their mouths, by turning the rays of their lower edge in different directions. But the correction of an error respecting the functions of the ambulacral tubes does not solve the problem relating to their nature and use. This problem we are yet unable to solve, as we know nothing more respecting them than that they are connected with the aquiferous system."

One Professor however may be as good as another in such a matter, if both have equal opportunities of observa-

tion. Professor Forbes saw them move by suckers. Both Agassiz and Forbes had living Sea-Urchins before them. Both see the spines used; one sees the suckers used as well; the inference is that both are used by the animal for progression. Mr. Forbes says, he has seen "*Echinus miliaris*, a *Spatangus purpureus*, and an *Anephidotus*, all walk along the bottom and up the sides of a dish of salt-water by means of their inferior tentacula; and the first-mentioned anchored itself by extending and bending its superior suckers, so as to reach the bottom of the dish."

The manner in which the motion by tentacles is effected may be easily understood. If we observe the manner in which those of a *Star-fish* or Sea-Cucumber elongate themselves to reach a point, and then lay hold of that point by the sucker end, we shall see that when a hold is obtained by a number of stretched tentacula, they have nothing to do but to contract in order to draw the whole body forwards. This is no doubt the way in which, a little at a time, the Sea-Egg can and does move along.

The Shell.

The shell of the Sea-Egg is often seen ornamenting the chimney-pieces of humble dwellings near the sea-side; but

few, on seeing them, would have any idea of their appearance in a living state, clothed with spines. The materials however of which they are composed, consisting of hundreds of plates nicely fitted together by their edges, and beautifully arranged in symmetrical order, with their spine-bearing tubercles, form in themselves unitedly an object of admiration. And the manner in which the whole body increases in bulk is also interesting in the highest degree. The plates are united by a membrane covering the whole, and inserted between the edges. This membrane secretes the calcareous matter of which they are composed. The matter is deposited on the edges. Every large or small angle of every large or small plate, must receive its proper proportion of the deposition in the same time; else, the form of the whole would not be retained. As in a line of soldiers abreast turning an angle, the outer man must march the fourth of a large circle, and the centre man that of a smaller one, while the inner man only turns his own body, so the upper and lower plates of the *Echinus* will require very little addition to their edges to be kept in a radiating line with those of the centre, which require large additions in the same time, to make their share of the middle circumference, and all these proportions must always be kept, or the form of the whole is lost.

Digestive Organs.

In some cabinets may be seen a conical body composed of a circle of complicated bones, ending at the apex in a circle of teeth meeting in the centre. These bones and teeth are the biting and grinding apparatus of our *Echinus*. They are placed in the centre of the body, with their grinding surfaces towards each other, and united by very powerful muscles: altogether a most formidable and complicated engine of attrition. Scattered over the surface of the shell are great numbers of small bodies among the spines, called *pedicellariæ*, the use of which is not yet ascertained. They have been considered by some naturalists as parasitic animals living on the *Echinus*. But there seems to be little reason to doubt that they are some organs belonging to the Sea-Egg itself. They are cylindrical bodies, fixed by a slender pedicle, and terminating in a set of pincers. They are flexible, and bend about in various directions. The pincers consist of three beautifully sculptured teeth, some sharp and long, others shorter. On the possible purpose for which the *Echinus* is provided with these organs, Mr. Sans suggests that Nature may have given the *pedicellariæ*, in addition to the spines and suckers, "as a sort of antennæ, partly to

seize the small animals which serve for its sustenance, partly to lay hold of whatever might approach their sensitive skin, which covers the surface of the shell, and thus, in conjunction with the prickles, protect it from injury."

The specific characters of the Egg-Urchin are, a rounded body; ambulacra continuous from mouth to opposite opening; tubercles of spines imperforate, and spines all in one form, numerous. It is generally of a purplish or reddish colour, with spines nearly white, sometimes tipped with purple.

Shore collectors cannot obtain living specimens; for it is a deep-water animal, congregating in great numbers at sea-bottoms. But now that the dredge is in active use, and it has become a business to supply Aquarians with specimens of marine zoology, we can get living Sea-Eggs *"to order"* without stirring from our homes.

Echinus miliaris is a smaller species, with proportionally larger spines, which are grooved, pointed, and tipped with purple.

Spatangus purpureus has the body depressed, heart-shaped, with the mouth forwards and the anal vent backwards, so that the animal has both an anterior and a posterior end.

Cidaris papillata has only one long spine on each inter-ambulacral plate, and these are long and straight. A *Cidaris*, with all its spines perfect and radiating from the central depressed globe, is a very beautiful object.

Star-fishes, their Classification.

1. The *Crinoidæ*, or *pinnigrade* Stars, have arms capable of independent motion, assisted by cirrhi which spring from membranes attached to the arms.—*Feather-stars.*

2. The *Ophiuridæ*, or *spinigrade* Stars, have no membranes on the arms. They have cirrhi, but the motion is effected by means of spines on the movable arms.—*Brittle-stars.*

3. The *Asteriadæ*, or *cirrhigrade* Stars, have no true or independent arms, but their bodies are lobed, or fingered, and the lobes are channeled underneath, with rows of cirrhi or suckers in the channels, which are the organs of motion. —*Cross-fish.*

One specimen of each must suffice. They are not subjects suitable to *keep* in Aquaria, as they do not live happily in confinement, but soon kill themselves, or otherwise die.

Comatula rosacea.

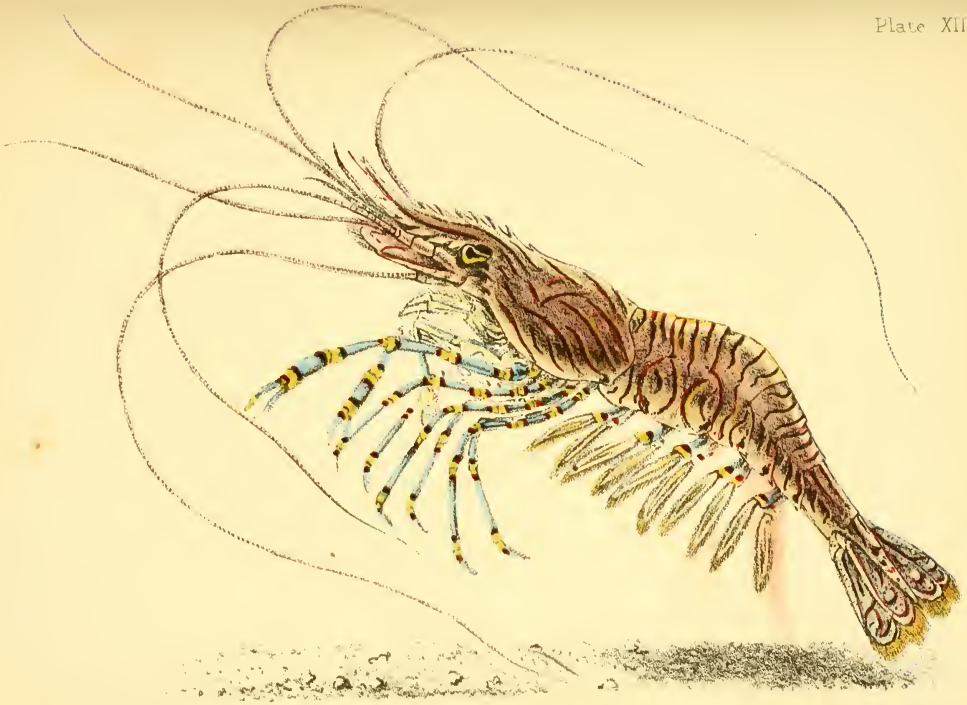
The *Rosy Feather-star* is one of the most beautiful objects in nature, and is most interesting on account of a curious feature of its animal economy. Viewed from above, it is seen as a radiating circle of ten feathers, with a smaller central circle of filiform appendages. This smaller circle hides the union of every two feathers in one joint. In fact, there are *five double* plumose arms. The feathery appearance is produced by pinnæ on each side of the arms. The pinnæ are jointed, and end in a kind of claw. Besides being of an elegant form, the Rosy Feather-star is splendid in colour, being of a bright pink, spotted with brown, while the arms are fringed with transparent cirrhi.

Those who study geology are familiar with an object called the Stone-lily, or *Lily Encrinite*, which is a kind of lily-shaped Star-fish growing upon a stem composed of calcareous rings. The nearest recent analogous form in Europe was presented by the discovery of a little pedunculated animal of the Crinoid race, by Mr. J. V. Thompson, in the year 1823. The top, or head and arms of this little Stone-lily, was seen to bear some resemblance to the Feather-star, presenting just such an appearance as that species might do if placed on a

stem. It was called *Pentacrinus Europæus*. Here was a living Encrinite. The column was flexible, and bent at the will of the animal; its base was attached to marine animals by a broad calcareous disc. In the year 1836, Mr. Thompson communicated the result of further researches in a memoir published in the Edinburgh 'New Philosophical Journal,' from which it appeared that his *Pentacrinus Europæus* was nothing but a *Feather-star* in a young state; and that the *Comatula*, in fact, began life as a fixed star and ended it as a wandering comet. In other words, the starry head floats off the stem, and the animal becomes free.

> "First, like a polype, bending on its stem,
> Its rays are spread, a starry diadem;
> It feels new powers, it struggles to be free,
> Then roams at large, unfettered in the sea."

In some tribes the reverse of this takes place, and the animal, free in infancy, becomes grave and sedentary with age. The gradations marking the change in *Comatulæ* are traced and explained by Mr. Thompson. He observed the advanced Pentacrinite beginning to form pinnæ; then the dorsal cirrhi increased from five to nine; then the detached *Comatula*, in which the pinnæ are nearly complete. These small *Comatulæ* retain the original yellow colour of the Pentacrinite near



Sowerby del et lith.

Vincent Brooks Imp

The Common Prawn, Palæmon serratus.

the top of the arms, while the lower part and body are gradually assuming the red colour of the adult Feather-star.

Professor Forbes says, "When a freshly-caught Feather-star is plunged into cold fresh-water it dies in a state of contraction; but if not so killed, or else, if not killed in spirit, it breaks itself into pieces, like an *Ophiura*. When dying, either in fresh-water or in spirits, it gives out a most beautiful purple colour, which tinges the liquid in which it was killed. This colour has been long retained in spirits. The fact was long ago noted by Bartholinus, who observed it at Naples, and whose observations on it will be found in a note to Fabius Columna."

"In captivity," says Mr. Gosse, "the Feather-star sits upon the frond of a seaweed, or upon the projecting angle of rock, which it grasps very firmly with its clawed filaments; so firmly, that it is difficult to tear it from its hold. When violence is used, it catches hold of its support, or any other object within reach, with the tips of its arms, which it hooks down for the purpose, and with its pinnæ, so that it seems furnished with so many claws, the hard stony nature of which is revealed by the creaking, scratching noise they make as they are forced from any hold, as if they were made of glass. I was surprised to find that several of the arms

were unsymmetrically short; and examining these with a lens, saw distinctly that each had been broken off and was renewed, the new part agreeing in structure and colour with the rest, but the joints were much less in diameter; and this difference was strongly marked at the point of the union, the first of the new joints being not more than one-third as wide as its predecessor. The appearance much reminded me of a lizard renewing its tail."

The full-grown Feather-star generally frequents deep water, but comes to shallow pools among the plants of *Laminariæ* in breeding times. It swims by alternating strokes of its arms, using them in the same manner as the *Medusæ*, raising itself from the bottom and swimming backwards.

Ophiocoma bellis (*Ophiuridæ*).

The Daisy Brittle-star is among the most richly coloured of radiate animals. Its central disc is pentagonal, ornamented above with variously arranged plates, intermingled with spines, arranged in such a manner as to give a daisy-like appearance to it. The rays are long, bordered by spines in rows. They are beautifully banded. The Brittle-stars are very difficult to obtain living and perfect, on ac-

count of their habit of throwing off their limbs all in pieces. The common Brittle-star, for instance, is taken sometimes in great numbers together, in a dredge, when they writhe in and out among each other with the most worm-like contortions, flinging their arms about in broken pieces, and even frightening, as Professor Forbes observes, the very seamen, who see in their threatening attitudes and suicidal actions something unearthly and unnatural. Mr. Gosse speaks of the *Ophiocoma rosula*, and the bushels of specimens which he dredged, of the most gorgeous hues, "orange, yellow, crimson, purple, blue, and white; often arranged in alternate angular bands," and of the exquisite sculptures which they preserved; but remarks that although he met with many specimens of broken arms, he could generally secure a specimen he wished for, without any very extraordinary care.

Luida fragilissima (*Asteriadæ*).

The stellate body of this, as well as the lobes or arms, is flat, covered above with spiniferous tubercles; the canals on the under side are bordered by two sets of spines, and the suckers are in two rows. A brick-red colour above, straw-colour beneath. The species varies in the colour of its arms. Mr. Bean, of Scarborough, has taken an example

of the seven-rayed form, measuring eighteen inches across. Of his experience in the capture of this species, Professor Forbes gives the following amusing account:—

"The first time I ever caught one of these creatures, I succeeded in getting it into the boat entire. Never having seen one before, and quite unconscious of its suicidal powers, I spread it out on a rowing-bench, the better to admire its form and colours. On attempting to remove it for preservation, to my horror and disappointment, I found only an assemblage of rejected members. My conservative endeavours were all neutralized by its destructive exertions, and it is now badly represented in my cabinet by an armless disc and a discless arm. Next time I went to dredge on the same spot, and determined not to be cheated out of a specimen in such a way a second time, I brought with me a bucket of cold fresh-water, to which article Star-fishes have a great antipathy. As I expected, a *Luida* came up in the dredge, a most gorgeous specimen. As it does not generally break up before it is raised above the surface of the sea, cautiously and anxiously I sank my bucket to a level with the dredge's mouth, and proceeded in the most gentle manner to introduce *Luida* to the purer element. Whether the cold air was too much for him, or the sight of the bucket too terrific, I know not, but, in a moment, he proceeded to

dissolve his corporation, and at every mesh of the dredge his fragments were seen escaping. In despair I grasped at the largest, and brought up the extremity of an arm with its terminating eye, the spinous eyelid of which opened and closed with something exceedingly like a wink of derision."

URASTER RUBENS.—(Plate XVII. upper figure.)

The well-known common Cross-fish is most generally seen of a buffish colour, although it is sometimes bright orange, purple, or red. It has generally five rays, which are rounded and taper to a point. The back of the disc and arms are spinous. The principal row of spines on the centre of the rays forms a kind of keel. The canals underneath are bordered by spines, and by adhesive, ambulatory suckers. At the extremity of each ray the eyes are found surrounded by a circle of movable spines. The mouth is protected by spines.

Of this species, Mr. Gosse gives an account, in reference to its suicidal propensities, of a case that came under his observation. That gentleman had a specimen five inches long which had been dredged in Weymouth harbour. When first put into the tank, the specimen appeared quite at home and was quite lively. It had five rays, two of which were

small. All at once it threw off a ray, and seemed to be marching on without being sensible of the loss; the leg that was left behind appearing to retain its vitality some time afterwards, moving its suckers, sometimes relaxing, then tightening their hold, but the limb was not advancing. In seven hours' time, all the rays but one were thrown off, or rather abandoned, as they remained, with their suckers active, sticking to the sides of the glass. The body in the meantime walked on with its single ray alone. When one ray had been thrown off, the remaining rays seemed so equidistant and the skin so entire that the narrator could not, by the most careful scrutiny, find the point from which the rejected member had been separated; but when the other rays were gone, the points of separation were visible. The Cross-fish continued walking about on one leg, which however fell off in the course of removal to another vessel: the disc ceased to move, and soon died.

Thus a slight dash of melancholy may be introduced occasionally to vary the amusements of a Zoological tank.

Plate XVII. fig. 1, represents a specimen of *Uraster rubens* from Mr. Lloyd's collection, which, having lost two rays, is having them replaced by young growing ones. Figs. 2 and 3 are *Goniaster equestris*.

CHAPTER IX.

SEA-WORMS.

GENERAL DESCRIPTION.—CLASSIFICATION.—OUT-DOOR STUDIES.—SERPULA CONTORTUPLICATA.—AMPHITRITE ÆGEANA.—SABELLA TUBULARIA.—SABELLA ALVEOLATA.—TEREBELLA CONCHILEGA.—NEREIS BILINEATA.—APHRODITE ACULEATA.

Marine Annelids, or *Sea-Worms,* belong to the same class as Earth-Worms and Leeches, many of whose characteristics they possess in common. All are curious in their structure and habits, while some are extremely beautiful. They are all more or less elongate and cylindrical in form, and their bodies are capable of contraction and elongation. They derive their class appellation from the fact that the body is composed of annular joints, or rings, united by a flexible skin. The first joint being variously modified as a head, and the last as a tail; the intermediate ones are generally very much alike. The heads of some

marine Worms are furnished with eyes, some with tentacula, and the mouth-apparatus is in many species formidable, suited to the carnivorous propensities of the race. Most of us know the three-cornered bite of the Leech; and his brethren of the ocean are not behind in their powers of wounding.

Coming to characters in which the Annelids differ from each other, we may notice the general divisions into which they have been cast.

The *Apoda* perform locomotion by means of sucking discs, and have no foot-like warts or bristles.

The *Chætopoda* move by means of bristles placed in bunches on wart-like protuberances.

Those of the former order are Leeches or leech-like animals, a fine example of which is seen in the *Pontobdella*, which has a long warty body and a very obvious cup-like sucker at each end. It is marine.

Those of the latter Order present many interesting peculiarities, some of them are among the prettiest objects of the tank.

Some of the variations are expressed in a homely way by Hugh Miller, in his work entitled 'My Schools and Schoolmasters.' The following passage will be read with pleasure, for it has about it all the freshness of nature.

"Nor was it merely with the edible that we busied ourselves on these journeys: the brilliant metallic plumage of the Sea-Mouse (*Aphrodita*), steeped as if in the dyes of the rainbow, excited our admiration time after time. And still higher wonder used to be awakened by a much rarer Annelid, brown and slender as a piece of rope-yarn, and from thirty to forty feet in length, which no one save my uncle had ever found along the Cromarty shores, and which, when broken in two, as sometimes happened in the measuring, divided its vitality so equally between the pieces that each was fitted (we could not doubt the experiment of Spallanzani) to set up an independent existence and carry on for itself. The Annelids too that form for themselves tubular dwellings built up of large grains of sand always excited our interest. Two hand-shaped tufts of golden-hued setæ, furnished however with greatly more than the typical number of fingers, rise from the shoulders of these creatures, and must, I suspect, be used as hands in the process of building; at least, the hands of the most practised builder could not set stones with nicer skill than is exhibited by these Worms in the setting of the grains which compose their cylindrical dwellings,—dwellings that, from their form and structure, seem suited to remind the antiquary of the round towers of Ire-

land, and, from the style of their masonry, of old Cyclopean walls. Even the mason wasps and bees are greatly inferior to these mason Amphitrites."

SERPULA CONTORTUPLICATA.—(Plate I. fig. 1.)

The fan-like and pectinated gills of *Serpulæ*, with their curious stoppers and twisted shelly tubes, give a very lively and animated appearance to an Aquarium. With the lower part of its shell attached to empty shells, stones, broken glass and pottery, it rears its upper or later circles to an elevation, from which the gorgeous paraphernalia of his head protrude in proud array, or into which they shrink when danger seems to threaten. The tubes, if followed in their twistings, will measure some inches in length, and are about a quarter of an inch or more in diameter. The same lines of growth as are seen in the shells of Mollusca mark the successive additions to its length. The mouth of the tube is slightly expanded, and similar expansions lower down mark where successive mouths were formed. Those beautiful fans which you see projected from the tube are gills. They constitute a fringe or frill, open in front and sinuously bent inwards behind. On minute examination, you find each filament of the fringe is a delicately-formed

comb with long teeth. Besides the gills, you observe a conical body on a stem, with its apex downwards, and while wondering what it is, the animal, perhaps alarmed, furls his fan and pops into his hole. Now you see the use of this organ; for when the worm has drawn his breathing apparatus safely into the tube, he shuts himself in by drawing this conical body after him and enclosing the aperture. It is, in short, a stopper. He had a pair of tentacles; one of them remained small and undeveloped, while the other was expanded and developed for the admirable use to which we have seen it put.

But how does the *Serpula* manage to creep up and down his shelly tube so rapidly, withdrawing so instantaneously when alarmed or disturbed? Along the sides of his body are seven pairs of tubercles, with a bunch of bristles in each, which may be pushed out or withdrawn. Each bristle, when microscopically examined, is seen to be "a transparent, horny, yellow shaft, the extremity of which dilates into a slightly enlarged knob. This is cleft into four points, three of which are minute, but the fourth is developed into a long, slightly divergent, highly elastic, tapering and finely pointed spear." By pushing these bristles against the sides of the tube, and prizing up the body by their means, the upward

movement is effected. The retreating motion is performed by a minute, ribbon-like muscle, on which are fixed many thousands of hooked teeth, which firmly hold to the inner lining of the tube, while the muscles contract with a jerk and draw the animal down.

Amphitrite (?) Ægeana.—(Plate II.)

On first visiting the Zoological Society's collection, I noticed spring up between the stones in a centre tank a transparent, bell-shaped cup, formed by a circle of fan-like folds. At the outer angle of each fold was a stiff-looking rib, ending in a free, projecting point. The bell was about an inch high, was placed upon a neck or stem, and had a funnel-shaped hollow in the centre, towards which the inner angles of the folds converged. It was not like the Anemones, for there was no body to be seen; and if the ribs, or projecting points of the ribs, were tentacula, they were exceedingly different from those organs in general. It was more like *Sabella*, the feathery expansions of whose gills are such pleasing objects, but there was a one-sidedness about these, that was unlike the circular funnel of my stranger. Presently, while wondering what it could be, it suddenly contracted, folding itself up exactly as we do an umbrella, and looking

very much like one on a small scale. After stopping for a moment as if in hesitation, with its folds contracted, it made another sudden movement and was lost among the stones. It was not long however before it reappeared and reopened. On inquiry I found that others as well as myself had been puzzled by this pretty creature. Not only did no one at that time know what it was, but no one knew how it came where it was. Perhaps, like Topsy, it would say if endowed with speech, "'Specs I growed!" I frequently returned to watch its habits, which I found very interesting. Not only did it flap up its folds when retiring, but frequently also for the purpose of getting rid of any morsels that were disagreeable to it, which were shot up ten or twelve inches by the action. This was often repeated; and sometimes the stroke was repeated with such regularity that a person noticing the successive columns of ejected water exclaimed, "Well, I never!" "Never what?" asked his companion. "Never saw a water-thing *smoke*."

It turned out to be a worm of the same species that was discovered by Professor Forbes in the Ægean Sea, described but not named by him in a communication to the 'Annals and Magazine of Natural History,' and published by Chénu in his 'Illustrations Conchyliologiques' under the name which we apply to it above.

It is a curious circumstance that two such animals as this Annelid and the Actinoid described in the same communication, and since named "*Edwardsia*," should have been discovered in the Ægean at the same time, and also subsequently have made their appearance contemporaneously as British species; the one obtained in numbers at Ilfracombe, by Mr. Lloyd, the other springing up spontaneously among gravel in the Regent's Park tanks. Both present anomalous characteristics, distinguishing them from the rest of their class; both form new links in the chain of beings;—the one a free Actinoid and the other a free Worm, both investing themselves with a leathery sheath of their own secretion.

The *Ægean* example of our *Amphitrite* (?) is described as living in sand where the sea is three or four feet deep; its position being indicated by funnel-shaped cavities, when the gills are not expanded. The flower formed by this circle of gills we have described above; if touched, it suddenly contracts and shrinks into the sand. Its body is a ringed worm which moves freely up and down in the case. The case is gelatinous and smooth, slightly constricted in correspondence with the rings of the body. It tapers to a point at the posterior end, where it is made solid by filling

up behind the animal. In this respect our *Amphitrite* resembles some species of Mollusca, which fill up the cavities of their shells behind them, still, as the shell grows, keeping their bodies near the open end of the cavity. The body consists of a hundred and forty rings of a reddish-brown colour, with paler belts between. Each ring has a contractile tuft of bristles on each side, serving as feet. The flower-funnel consists of two fasciculi of long filaments webbed together; each filament furnished with a finer set of filaments on their inner edges. Currents of water are seen continually flowing up and down this funnel very rapidly, caused by cilia on the secondary filaments. Our solitary specimen is very pale compared with the Ægeans, which have more of a purple tint; its circle of gills make a very pretty flower nevertheless. I follow the French author in applying the name as above, but only do so provisionally, agreeing with the late lamented Professor Forbes as to the probable necessity for giving it another generic appellation.

Sabella tubularia.

Our London collections contain living specimens of this magnificent Worm, which forms a stiff leathery tube, almost like the shell of a *Serpula* in appearance, but not so in

structure. It presents a beautiful double fan of gills, at the end of its projected tube. It is rather a large Worm, beset with the usual bundles of satiny bristles, golden tinted. The fans are broadly plumose and spirally curved, forming a kind of shallow funnel, white and brown banded. Mr. Gosse has noticed, in another species, *S. vesiculosa*, a power of reproducing mutilated parts, and even forming entirely new fans.

Sabella alveolata.

Congregations of this Worm make parallel tubes of sand, fitting into each other, and composing a mass resembling a honeycomb. Entire floors of caves are sometimes covered with this structure. The species is commonly called the "*Honeycomb Worm.*"

Terebella conchilega.—(Plate I. fig. 2, 3.)

In turning over loose stones and gravel on a sandy shore at low-water, you may find very brittle tubes composed of minute pebbles, grains of sand, and small shells, neatly fitted and cemented together. They are the work of a marine mason, who has built them for his own occupation. The Terebella is a worm, which, instead of the fan-like

Sowerby del. et lith.

Vincent Brooks Imp

Ascidians. Ascidia hyalina, in Sea-weed, Phyllophora rubens.

comb of gills displayed by the *Sabellæ* and *Serpulæ*, only puts forth a truncated head adorned by a great number of long thread-like tentacles. These tentacles, wandering far and wide, adhere to little specks of sand and bits of shell, which they bring together and cement in a circular wall, so as to form their tube. This gravelly dwelling is not made, like some tubes, by the mere fortuitous rolling together of particles in the glairy secretion surrounding the body of the animal; but regularly and systematically laid on, fragment by fragment, to the edge of the structure. At the larger end of the tube may be observed a number of very thin branching tubes, formed of more minute grains of sand. These are sheaths, with which the working tentacula have temporarily clothed themselves, and from which they have withdrawn.

Specimens in captivity were observed by Mr. Gosse to abandon their tubes and crawl about the glass jar by means of their tentacles, which adhered to its sides. They also creep, body downwards, on the surface of the water in the same manner that Water Snails do. Individuals may be seen at the present time (or might have been a week or two since) working away in the construction of their brittle habitations, both at Mr. Lloyd's establishment and at the Park Gardens.

Nereis bilineata.

The *Two-lined Worm* is of a light red colour, with two white lines running all down the body. It has been observed to inhabit the deserted shells of *Buccinum*, in connection with the *Hermit*, or *Soldier Crab, Pagurus Bernhardus*. While feeding the latter, Mr. Gosse observed the worm to protrude from between the body of the Crab and the Whelk, glide round the Crab's cheek, pass between the upper and lower foot-jaws, seize and carry off the morsel of food, retreating with it into his hole to consume it at leisure. Sometimes the Crab would put his claws into the hole and recover the prize; sometimes he would startle the Worm and make him let it go; at other times he would submit to his loss and disappointment like a philosopher: a curious association this, between the "*soldier*" and the "*thief*."

Aphrodita aculeata.

The common "*Sea-Mouse*" attracts attention by the shining metallic lustre of its coat of bristles. Although a worm in nature, its shape is oval, and its figure plump. It is frequently met with in dredging over muddy ground, and is sometimes thrown up on the beach. It is three

or four inches in length; the back is of a muddy or mouse-colour; the sides clothed with silky hairs which reflect the prismatic colours of the rainbow. It crawls by means of bunches of stiff bristles, which terminate in sharp, barbed claws. On its colours, as observed in the Aquarium, Mr. Gosse makes the following remarks: "Perhaps it is most beautiful by candle-light, where red and orange reflections predominate; by day, pearly greens and blues prevail. This difference is owing to the position of the light, and the angle at which it is reflected. Thus, if the eye glance along the bristles towards the light, which is reflected at an obtuse angle, the reflected rays will be lilac, passing into ultramarine; if the angle of reflection be a right angle, the rays will be green; if the light be between the observer and the animal, not directly but obliquely, so as to make the angle more or less acute, the reflections will take yellow, orange, scarlet, and crimson hues."

The *Aphrodita* in crawling lifts up its tail and folds it into a groove above; the groove so formed leads to an opening in the hinder part of the back. We hear of false bottoms, but this creature has a false back. That felt-like skin on the back is merely an outer covering through which is filtered the water as it passes to the breathing apparatus.

It is thus strained before it is used, and leaves the muddy sediment which imparts the peculiar colour which we observe. Underneath this false back in an ample cavity, at the bottom of which is the true dorsal skin. Upon this we find two rows of overlapping plates, which are the breathing apparatus; these plates being alternately elevated and depressed. When elevated, water comes through the felt and fills the cavity; when depressed, it is expelled at the posterior groove, from which intermittent currents may be seen to flow.

Plate I. contains,—fig. 1. a group of *Serpula contortuplicata*, showing the varieties in colouring of the fans. Fig. 2 is the curiously constructed tube of *Terebella*; and fig. 3 is the worm out of its tube, from a specimen in Mr. Lloyd's collection.

CHAPTER X.

NIGHT-LIGHTS AND ENTOMOSTRACA.

NOCTILUCA MILIARIS.—ENTOMOSTRACA.—DR. BAIRD'S ACCOUNT OF THEIR HABITS.—CHIROCEPHALUS DIAPHANUS.—ARTEMIA SALINA.—CYPRIDÆ.—CYCLOPS QUADRICORNIS.—LERNEONEMA SPRATTÆ.

"Awaked before the rushing prow
The mimic fires of ocean glow,
Those lightnings of the wave:
Wild sparkles crest the broken tides,
And, flashing round, the vessel's sides
With elfish lustre lave;
While far behind, their livid light
To the dark billows of the night
A blooming splendour gave."—*Scott.*

Speaking of the animalcula which, like the land glow-worm, shine with their own light, Pennant says, "While rowing at night, I have seen the whole element as if on fire around me; every oar spangled with them, the water shining with more than ordinary brightness. I have taken up

some of the water in a bucket, seen them for a short time illuminate the whole and then disappear." On our own coasts, this magnificent effect, produced from small causes, has often been witnessed by those who, during the summer nights, are out at sea. Among the marine animals producing this effect is the beautiful *Noctiluca*, an excessively minute globular animalcule with a tail setting out from a small indentation, which seems by its jerks to be the organ of locomotion. In the Mediterranean, as well as on our own seas, this creature is seen in myriads, lighting up the waves as they strike against each other or objects in contact with them.

Spix, the traveller, tried some interesting experiments with sea-water when thus illuminated. He had some of the water placed in buckets, and found that the hand or any other object dipped in the water shone with a phosphorescent light. When the water was shaken, the lights seemed to be eliminated like electric sparks. The minute globules, when examined with a microscope, were found to be of various sizes, but all minute, and it does not appear that the whole body of any specimen is illuminated at once, but different parts at different times. It was observed that each one had at one end a small, navel-like opening, within

which were moving filaments inside the skin, which appear as if destined to protrude for the purpose of attachment. Dark spots were also noticed, within which Spix supposed might be either the spawn or the undigested remains of prey. These little creatures soon die when taken out of the sea, but while still living they seem to associate in groups caused by mutual attraction, when in their individual movements they come within the radius of the attracting power. As they are never seen in salt-water during the day, it appears probable that they may sink to the bottom and rest there until night, and, like

"The merry elves of Fairyland,"

wait to enjoy their gambols

"By the moonbeam's sportive light;"

themselves supplying a fictitious resemblance, when the real beams of that luminary are wanting, or mingling their lesser coruscations with hers in sportive rivalry.

The position of this sparkling atom in the scale of nature is very uncertain, but the impression generally entertained is that it has a considerable affinity with the *Foraminifera*, although it has no shell. I should have rather supposed that it would come nearer to the *Medusæ*, several of which

are luminous. But since this Work is not undertaken for the purpose of settling doubtful affinities, I must leave this question with a confession of incompetence. My object is rather to collect and to present to my readers the results of observations made on water-animals imprisoned for the purpose in vessels of their native element.

How many of the Infusoria may yet turn out to be luminous we do not know, but many of the Annelids, Medusæ, and fishes are known to be so. Dr. Baird gives an account of luminous appearances occasioned by *Entomostraca*. He tells us of "the broad bright flash, vivid enough to illuminate the sea for some distance round, while the most splendid globes of fire were seen wheeling and careering in the midst of it, and by their brilliancy outshining the general light." Dr. Baird drew a bucketfull of water, and "allowed it to remain quiet for some time, when upon looking into it in a dark place, each animal could be seen distinctly emitting a bright speck of light. Sometimes this was like a sudden flash, at others appearing like an oblong or round luminous point, which continued bright for a short time, like a lamp lit beneath the water, and moving through it, still possessing its definite shape, and then suddenly disappearing. When the bucket was sharply struck on the outside, there

would appear at once a great number of these luminous bodies, which retained their brilliant appearance for a few seconds, and then all was dark again. They evidently appeared to have it under their own will, giving out their light frequently at various depths in the water, without any agitation being given to the bucket. At times might be seen minute but pretty specks of light darting across a piece of water, and then vanishing; the motion of the light being exactly that of a *Cyclops* through the water. Upon removing a tumblerfull from the bucket and taking it to the light, a number of *Cyclopes* were accordingly found swimming and darting about in it." These observations lead to the conclusion that the large globes of light were *Medusæ*, and that the more generally spread flashes were occasioned by the lanterns of thousands of minute *Entomostraca*.

Entomostraca.

The minute Crustacea described under this name include many species of exceedingly different forms and habits. They are found in ponds and ditches in great numbers, as well as in nooks and corners of marine tide-pools, and the

parasitic sorts are taken from the fish to which they adhere. They abound in water which we daily drink, and which quenches the thirst of our cattle. They are believed to be of great use in the economy of Nature, in ventilating the water, especially the standing pools, which might otherwise soon become putrid, while they give food to many marine and fresh-water animals. By some authors they are considered, as a class, to be vegetable feeders, but actual observation seems to contradict this, especially in reference to the *Cyprides*. "In a vessel," says Dr. Baird, "in which I have kept full-grown *Chirocephali* there were mixed with them many specimens of the *Cypris tristriata*. In a few days the *Chirocephali* might be seen to become languid in their movements, and assume an unhealthy appearance. The *Cyprides* had become their deadly enemy. They might be seen ever and anon to fasten themselves to the delicate feet of the poor *Chirocephali*, and wofully impede their course through the water; and when, either from these annoyances or from any other cause, they ceased to be able to move with any degree of rapidity, hosts of these little carnivora might be observed to attack them before life was extinct, anticipating as it were their victim's death. Then, when life had fairly ceased, they rioted, as it were, upon their

flesh, and in a few hours little but the external covering was left."

In speaking of "Night-Lights," I have already quoted Dr. Baird's observations on some of the *Entomostraca*, and here must mention, that having had but little opportunity of investigating these little creatures myself, this part of our book must take the character of a compilation more completely than some of the others. Dr. Baird's work on the subject is so full of interest to all who appreciate the study of Nature, that we trust the few extracts which will be here presented from it will rather have the effect of inducing persons to read it, than of satisfying them with what little they find here. A glass of water from the spring will not lessen a desire to visit the fountain-head. What I intend to do is just to give a few extracts showing the nature and habits of the *Entomostraca*, as derived from observations, most of them on living specimens in water.

They are all aquatic; they are covered with a shell or carapace, which is either horny or coriaceous, sometimes found of one piece, in other cases of two pieces, resembling the valves of a bivalve shell. Their gills are attached either to the feet or organs of mastication. Their feet are jointed and hairy. They moult, or change their shell, as they grow.

Chirocephalus diaphanus.

This is one of the most beautiful kinds, frequenting pools of water. From its general form and exquisite transparency it has been called the "Fairy Shrimp." "They swim upon their back; and in fine warm weather, when the sun is not too strong, they may be seen balancing themselves, as it were, near the surface by means of their branchial feet, which are in constant motion. On the least disturbance however they strike the water rapidly with their tail from right to left, and dart away like a fish, and hasten to conceal themselves by diving into the soft mud, or amongst the weeds at the bottom of the pool. They are nearly transparent, and are of a reddish colour, with a slight tinge of blue in some parts." "When placed in a glass of clear water," says Prévost, "the elegance of its form, the ease and softness of its movements, its silvery transparency or its brilliant colours, its large black eyes, the small spot which it carries on its head, the crown of the male, are a beautiful sight, which the most indifferent observers cannot see without pleasure." When young the eyes of this little crustacean are represented by a single spot between the antennæ in front of the head; a pair of well developed pedunculated

eyes afterwards appear, to which the muscular and nervous organization is gradually transferred, leaving the original single eye a mere disconnected spot!

Artemia salina.

It resembles *Chirocephalus,* but is confined to salt-water, and, as it seems, the salter the better; for it abounds "in the Salterns at Lymington, in the open tanks or reservoirs where brine is deposited previous to boiling," attaining by evaporation a strength of saltness that destroys other animals. By the rapid motion of their feet they assist so materially in clearing the brine that the workmen take care to stock with them those tanks where they do not so much abound. "They are manifestly omnivorous, swallowing everything that comes in their way. Like the *Chirocephalus,* the undulatory motion of their branchial feet causes a current of water to flow in the kind of canal formed between them, which carries everything within reach to their mouth. In this way we see them devouring their own young." "If we observe," says M. Joly, "in a small quantity of liquid, the mother at the time of parturition, we see the young group themselves round her body, and there is nothing more pretty, graceful, and agile, than this little

troop. But soon the scene changes; one, two, or three young ones are involved in the current which the motion of its fins causes, they pass into the gutter situated between these organs, and from thence come to the mouth of the mother. She at first disperses them, as being inconvenient bodies—perhaps she may even wish to spare them; but soon afterwards they present themselves again, and are pressed upon by the stiff hairs which form the branchiæ, then by the papillæ, lastly by the jaws, they arrive at the mandibles reduced nearly to a pulp, and they are swallowed as any other substance would be." Their chief enemy is a salt-water beetle.

Cypridæ.

The *Cypridæ* present the curious anomaly of insects or crustaceans the bodies of which are covered by a carapace sembling a bivalve shell. Their eyes are single and fixed; their jaws are branchiferous; their feet in pairs, adapted for locomotion; they *exuviate*, or renew their shell, as soon as it becomes too small for the body. It is then thrown off completely, and the hairy coverings and cases of even internal parts of the body are got rid of to be renewed. "These little creatures seem to be very lively in their native ele-

ment, being almost constantly in motion, either swimming about rapidly by the action of their antennæ, or walking upon the plants and other solid bodies floating in the water. Instead of being fixed in one place, and condemned to live amidst eternal darkness, like the molluscous animals to which they bear such striking resemblance in external covering," "they," to use the words of Müller, "by opening their valves enjoy light and move at their will, sometimes burying themselves in the mud, sometimes darting through the water, the humid air of their atmosphere. If they meet any unforeseen object, they conceal themselves all at once in their shells and shut the valves, so that force and address seek to open them in vain." *Cypris* having two pairs of feet has been called a "quadruped crustacean;" but the *Cythere* has three pairs of feet. The former belong to fresh water, the latter are mostly marine; the former swim, but the latter do not; they walk among the branches or leaves of *Conferva* or *Fuci*, where they delight to dwell. When shaken out from their hiding-places into a bottle or tumbler of water, they may be seen to fall in gyrations to the bottom, without ever attempting to dart through the watery element, as is the case with the *Cyprides*. Upon reaching the bottom they open their shells and creep along the surface of the glass;

but when touched or shaken they immediately again withdraw themselves within their shell, and remain motionless. "This inability to swim is no doubt owing to the want of those pencils of long hairs or filaments which adorn the superior and inferior antennæ of the *Cyprides*, and which we have seen are the organs by which they swim."

From an observation made by Dr. Baird following the above quotation, it is evident that when it was written the means had not been discovered of keeping salt-water in a state fit to sustain life in marine animals. That gentleman states that the rapidity with which salt-water, when kept in a small vessel in a room, became putrid, was so great that he could not extend his information so much as he could have wished; at the same time expressing an opinion that "the labours of any inquirer after them would assuredly be rewarded with much success." Now that such facilities are afforded for inquirers, by means of Aquaria, surely some will be found to take up this family and complete its natural history.

Cyclops quadricornis

Has a horny covering, and is something like a tadpole in shape, with one eye and a long plated tail. The female

S.Sowerby del.et lith. Vincent Brooks Imp.

Naked gilled Mollusca. 1 Eolis coronata. 2. Gills of the same. 3 Doris flammea. 4 Gills of the same. 5 Tentacle of the same. 6 Eolis despecta. 7 Eumenis marmorata. 8. Spawn ribband.

carries an egg-bag externally, one on each side of the body. "M. Jurine instituted some experiments upon the *C. quadricornis*, to see how far this power (of reproducing mutilated members) existed in this family. In his first attempts he failed, the animals having died before they moulted, and without showing any change in the mutilated members. At length however he succeeded. He cut off about two-thirds of an antenna of a female, which lived and moulted, reappearing after moulting with beautiful, perfect, new antennæ, the old one of the cast shell not having shown the least indication of a change." "Some authors have asserted that these insects possess a wonderful power of resisting drought, and that when, by reason of the summer heats, the marshes become dried up, the little creatures do not die, but as soon as the mud is again moistened by the rain they recover entirely. Jurine doubted this, and commenced a course of observations to prove that they have not this faculty. He selected twelve of the *Cyclops quadricornis*, removed them out of the water, and allowed them to remain fifteen minutes dry; seven of them he found to be irrecoverably dead, the remaining five revived. Again he selected twelve others, and allowed them to remain twenty minutes dry; eleven out of the twelve died. A third time he selected twelve, and after

exposing them to the air in a dry state for twenty-five minutes, he found that all had perished."

Whatever may be thought as to the conclusiveness of these experiments, it seems certain that the power of the insects to resist cold is greater than that which enables them to resist drought. Müller "exposed some individuals in a glass vessel to a freezing air, and, when fully frozen, he continued the exposure for twenty-four hours. At the end of that time he placed the vessel containing their bodies in a warm bath, watching the effect of this upon them frequently during the succeeding twenty-four hours, but without seeing any motion. Next morning however upon looking into the vessel he observed, not without wonder, the insects alive, and swimming about as before congelation, the females with their bags of eggs adhering to them as usual."

The *Lerneadæ* are a parasitical family, which by various means attach themselves to fish upon which they prey. In some cases this is done by means of the foot-jaws, which are strong and hooked. "In others it is by means of two long appendages springing from the upper part of the thorax, one on each side, and uniting at the tip, forming at their junction a sort of round button. In a third set again the organs of attachment are a series of horns or appendages proceeding from the sides of the head."

As, when seen in the adult state, the *Lerneadæ* are always immovably fixed upon the fish upon which they feed, their motions are principally of a secondary nature. *With* the unhappy fish, it is true, they are moved about briskly enough from place to place, but *on* the fish their motions must be very confined; for in their case

"The labours of a mortal life"

consist simply in drawing in their food and propagating their kind.

An interesting question here arises, as to the means by which they originally obtained their position? For they have no feet or swimming organs to propel them, and no eyes to show them the way. The answer to this question consists in the fact, that in their young state they are differently constituted, and possess an eye, and in some degree the power of locomotion. "When they first come out of the egg they are of an oval shape, and very much resemble the young of the *Cyclopidæ*. They possess a large eye, situated in the centre of the anterior and upper part of the body, and are provided with two pairs of swimming feet and a pair of jointed antennæ. As in the *Cyclopidæ*, the young *Lerneadæ* cast their skin repeatedly before they arrive at

maturity. After first moulting, the body is seen plainly divided into two parts, the anterior of which is furnished with three pairs of swimming-feet, and the posterior with two pairs of swimming-feet. No doubt there are a good many stages of development to go through before they assume the mature form, but it has not yet been possible to follow them out. It is not the least curious part of the history of these singular-looking animals, that the young should thus stand on a higher stage of development than the mother; and that their progress from youth to maturity should be in the directly opposite ratio to that of all the other Crustacea. At what period of their existence they fasten themselves upon their prey is at present unknown; but no sooner apparently does this happen than the eye disappears, and the feet either disappear also, or are transformed into other organs."

Lerneonema sprattæ

Is a long cylindrical body, with two posterior appendages and a narrow neck. It has the head shaped like the head of a harpoon, on each side of which is a hook turned backwards. When the creature attaches itself to the head, near the eye, of the Sprat, it buries its head in the substance of

the poor fish, from which it cannot be extricated without tearing the neck off, the two side hooks taking so firm a hold in the flesh. In Sowerby's 'Miscellany' is a figure of an unfortunate sprat so ornamented, looking as if some submarine bull-fighter had baited him with harpoons and gay streamers. A curious mistake was committed by De Blainville in reference to this plate. Seeing the body and posterior appendages drawn as attached to the fish, with the head invisible, and then a separate figure of the head and neck as taken out of its burrow, that author copied the figures and described them as two distinct species.

The only opportunity I have had of observing a living specimen of the Entomostracous division of Crustacea, was that afforded me by the attendant at the Zoological Society's Fish-house, who had just taken from a pike a specimen of *Argulus foliaceus*, which is in the habit of infesting many kinds of fresh-water fish, such as carp, trout, stickleback, and pike. It is about the tenth of an inch in diameter,—a very interesting object for the microscope. It is of a rounded oval shape, and looks like a broad shield, within which the body, eyes, legs, and mouth appear, leaving outside the margin, only the tail and hind pair of legs. One pair of (so-called) legs is converted into a pair of flexible cylinders,

terminating in sucker-cups, by means of which this parasite fixes itself upon its prey. It is not however immovably attached to the fish upon which it lives, for it can detach itself for a time and swim freely in the water, indulging in merry gambols, one of its movements consisting in turning over and over. One observer says that "he has seen an individual turn over a hundred times in a minute, and that it swam afterwards with such velocity, sometimes skimming the surface, at others plunging deeper in the water, that he could scarcely follow his motions with its eye."

We have now however dwelt long enough on a class which, however interesting, must not be permitted to encroach upon space which can hardly be spared from the more peculiar objects of Aquarian study.

CHAPTER XI.

CRUSTACEA.

NATURE AND CONSTRUCTION.—EXUVIATION.—CASTING LIMBS.—METAMORPHOSES.—THE PRAWN, PALÆMON SERRATUS.—THE COMMON SHRIMP.—THE COMMON LOBSTER.

Crabs, Lobsters, and Shrimps, are the most familiar forms of this curious class of marine animals. They are all jointed animals, the body being composed of distinct segments; they have jointed limbs, also composed of distinct, movable segments; they breathe by means of gills, which are in some cases covered and in others exposed. With very few exceptions they have two compound eyes; generally four antennæ, three pairs of masticating jaws, and two or three pairs of foot-jaws, in descriptions called "*pedipalps;*" the second and third pairs of foot-jaws sometimes assuming such shape and functions that they may be interchangeably called foot-jaws, or a sixth and seventh pair of legs. Accordingly, they

may have five or seven pairs of legs. All the legs, joints of the tail, body, and head, are covered by a horny or shelly *crust*, from which their name is derived, and which causes them to be placed, in commercial and domestic classification, with scallops, cockles, oysters, and periwinkles, under the general appellation of "*Shell-fish*."

The "Stalk-eyed Crustacea," or those which have the eyes placed on a movable pedestal, include those familiarly known as table articles, and worthily represented by the common eatable *Lobster*, the great eatable *Crab*, and the brown market *Shrimp*, or more luxuriant *Prawn*. Reserving the *Entomostraca* for another Chapter, let us apply our observations to the above representatives and their constituents.

Professor Bell has well explained the construction of these animals in the Introduction to his 'History of Stalk-eyed Crustacea.' The body of a crustacean is jointed, or composed of segments or rings, with appendages or limbs attached to each. "The true normal number of segments," remarks the Professor, "taking the whole class, appears to be twenty-one, of which, according to our present knowledge, seven must be considered as belonging to the head, and an equal number respectively to the thorax and the

abdomen. Now although it is true there is not a single known species in which all these segments are found in a distinct and tangible condition, there being in all the forms more or fewer of them so inseparably united together as to offer no other means by which to predicate their existence, than those already alluded to,—yet, on the other hand, there is not one which may not be found distinctly formed in some or other of the species. The appendages too, which have been already slightly mentioned, are no less subject to the most extraordinary variation both of form and office; many of them serving in one case the purposes of locomotion; in another, the reception and preparation of food; in another, the attachment of the branchiæ; in another, the support and protection of the eggs. When therefore we consider the almost endless diversity of form under which the species composing this class of animals appear, the astonishing discrepancy which exists in the forms and relative proportions of the different regions of the body, and the other parts of their organization, for the performance of offices equally various, and see that all these diversities are produced only by modifications of the typical number of parts, we cannot but be struck by so remarkable and interesting an illustration of the great economical law, as it may be termed, that

the typical structure of any group being given, the different habits of its component species or minor groups are provided for, not by the creation of new organs or the destruction of others, but by the modification in form, structure, or place, of organs typically belonging to the group."

We learn, then, that there is a normal or theoretic number of parts which would compose a perfect or *beau idéal* crustacean, but which are not all distinguishable in any single species. Some are fully developed in one and altogether wanting in another form; some are soldered together in one order so as to be indistinguishable as separate parts, while in another order they are distinct.

"In order to give a general idea" of the manner in which the various segments and appendages are modified in different species, Mr. Bell remarks, "that the ocular peduncles are the only appendages which are never devoted to any but their normal objects. The antennæ are, as has been before observed, sometimes modified into locomotive organs. The cephalic appendages about the mouth, the mandibles, and mamillæ, are sometimes rudimentary, at other times they are modified into mere organs of apprehension. The thoracic members are sometimes locomotive organs, at others they subserve the nutritive function: the remaining thoracic

members are in some cases prehensile, in others ambulatory, in others natatory, in others partially branchiferous, and so on. The abdominal sometimes serve the purpose of swimming, at others of bearing and protecting the eggs, at others they are partially converted into branchiæ. Besides the modifications, some or other of them are, in many forms, either wholly wanting or rudimentary."

Exuviation.

It is a peculiarity in this class of animals, that after they have, like insects, passed through various metamorphoses, or changes and conditions,—after they have arrived at their adult and ultimate state, shape, and functions,—*they continue to increase in size*; yet the hard, stony, shelly, or horny covering with which they are invested does not increase in size. There is no provision for its enlargement by marginal additions to the plates of which it is formed, such as obtain in the shells of molluscous animals. We have heard of the beautiful lap-dog sold to a lady, which was soon after found to be ill, and on the doctor being sent for was relieved by ripping up a *false skin* in which he had been invested. The poor wretch had, like the Crabs, *grown*, while his outer coat had *not*, and the doctor's scissors were

the only means of saving him. But how fares it with Crabs and Lobsters, who have no doctors nor scissors? The strange fact is, that they have the power of bursting their shell, withdrawing from it, leaving every part perfect as before, but empty. The eyes, feelers, mandibles, all the delicate members which have been covered by shell, even if internal, are all withdrawn from their sheaths, and the whole collection of sheaths remains as one whole and entire investment, cast off.

You may place a Shrimp in a vase by himself, you may leave him unobserved for a time; on returning, behold there are two! No: one, though perfect in shape, is "in substance unsubstantial:" it is a ghost, a transparent empty integument, which forms the "*alter ego*" of the Shrimp. Even while still invested by the covering now thrown off, the Shrimp had been prepared for a change by the gradual formation of a new one underneath the old; and this new one, although soft when first exposed by the sloughing of the other, soon becomes as hard as its predecessor, and far more bright.

In some of the higher forms, the exuviation takes place annually with regularity, the size increasing in each moult. In other forms it is a much more frequent phenomenon.

Mr. Warrington has observed it to take place every twelve days in summer, in the common Prawn. Although the moulting and increase of growth continues after the adult state of the crustacean, yet it does not continue throughout life; and it is mentioned as a proof of this that *Barnacles*, whose size proved them to be of several years' growth, have been found on the thick and stony carapace of Lobsters and Crabs, still living.

When the animal, becoming too large for its shell, is about to moult, it leaves off feeding and retires to a safe hole or corner, for security during the process. The crust becomes loosened, the animal begins restlessly to rub its limbs against each other, and twisting about the segments of its body. Presently it will throw itself on its back, and swell out its body so as to burst the membrane which unites the carapace to the abdominal plates. Raising the carapace, it soon loosens it from its attachment. By slow and apparently painful exertions, the legs, antennæ, eyes, and other members are disengaged, and the whole case is empty. There are specimens of the common Lobster's cast shells at the Zoological Society's Gardens, which are as perfect as if the animal were still inhabiting them.

Casting Limbs.

Crustacea are known occasionally to cast or throw off a limb voluntarily; and if they have thus lost a limb, or it has been accidentally torn off, it can be reproduced. The following account of this curious process is from Mr. Goodsir, in the 'Annals of Natural History,' vol. xiii. p. 67 :—

"It has long been known that the animals belonging to this class have the power of reproducing parts of their body which have been accidentally lost. If one of the more distant phalanges of a limb be torn off, the animal has the power of throwing the remaining part of the limb off altogether. This separation is found to take place always on one spot only, near the basal extremity of the first phalanx. The author has found that a small glandular-like body exists at this spot in each of the limbs, which supplies the germs for future legs. This body completely fills up this cavity of the shell for the extent of about half an inch in length. The microscopic structure of this glandular-like body is very peculiar, consisting of a great number of large nucleated cells, which are interspersed throughout a fibro-gelatinous mass. A single branch of each of the great vessels, accompanied by a branch of nerve, runs through a small

foramen near the centre of this body; but there is no vestige of either muscle or tendon, the attachments to which are at each extremity. In fact, this body is perfectly defined, and can be turned out of the shell without being much injured. When the limb is thrown off, the blood-vessels and nerve retract, thus leaving a small cavity in the new-made surface. It is from this cavity that the germ of the future leg springs, and is at first seen as a nucleated cell. A cicatrix forms over the raw surface, caused by the separation, which afterwards forms a sheath for the young leg."

Metamorphoses.

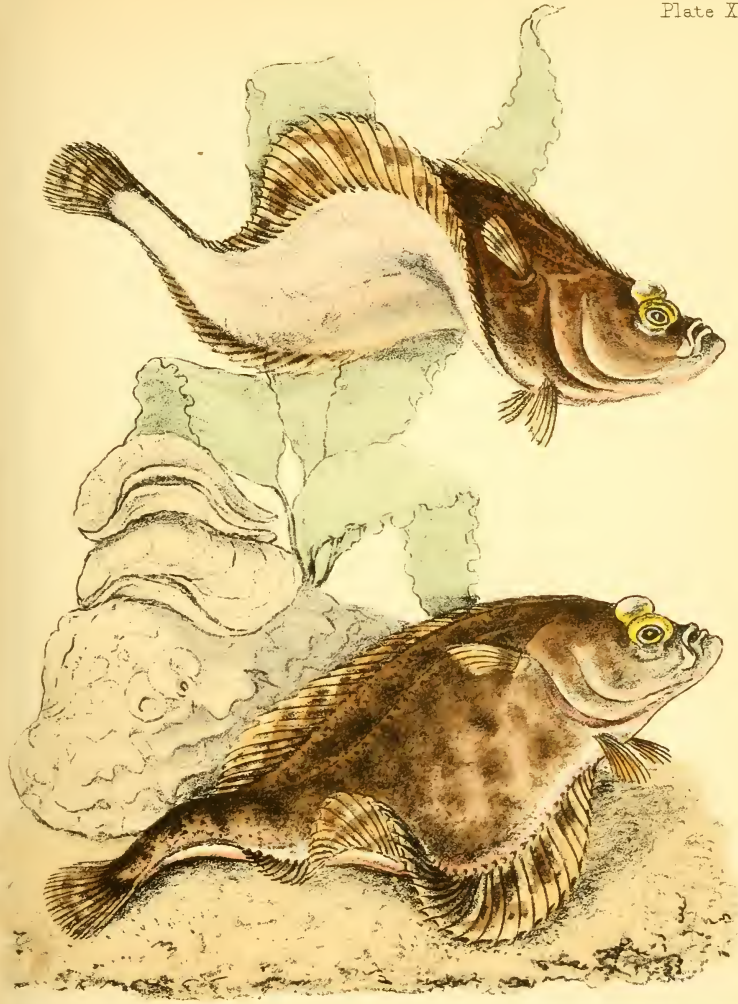
The changes of form, which take place in *Crustacea* previous to their adult condition, are not the least interesting part of their history, which, although hinted at long ago, has only been clearly brought to light, and investigated, within a comparatively recent period. There were certain forms of *Crustacea* which were not well understood, but constitute the genus Zoea of authors. These have been ascertained to be nothing but larva conditions of so many forms of higher members of the class.

In the year 1778, a Dutch Naturalist, named *Slabber*, published a work, in which is described and figured a crustacean

which was afterwards called "*Zoea taurus.*" He had taken several specimens, and placed one of them in sea-water for the purpose of observation (an early Aquarium, by the bye). On the third day he found its movements becoming slower and its colour paler. Subjecting it to the microscope, he found that the front part of the animal had changed its form, and on the fourth day it had changed in every part. A large spine on the carapace of the first form had disappeared in the second; and, together with other changes, the tail had changed from a two-pronged fork to a broad flap, or spade. The second form of this *Zoea*, as figured by Slabber, turns out to correspond with that of several subsequently observed species, the larvæ of *Palæmon*.

Palæmon serratus.—(Plate XII.)

Few tenants of an Aquarium are equal in beauty to *Palæmon serratus*, or large Prawn. Even the boiled specimens, as seen in the shops, are not without attraction; but living, they are indeed exquisite. The transparent body, with zebra-like markings; the delicate tinting and spotting; the elegant curved and serrated horn; the brilliant, sparkling eyes; the gracefully curving and waving antennæ; the slender legs, with their bright blue and yellow bands; the



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Young Flounders.

neatly-turned hands, and the fan-like tail; every line, every joint, every limb, presents some separate beauty of form and motion: the whole combining in a picture, of which the dead specimens, as seen and eaten, can give but a poor idea.

Wishing to give my readers a view of this elegant creature, I was desiring an Aquarian to procure me a specimen, that I might have him before my eyes for a few days, to watch his movements, and, if possible, to get a life-like portrait. Unfortunately, just then it was difficult to get specimens. "Could you not take the figure from Bell's 'Crustacea,' and colour from Gosse's description?" suggested my friend. "No; Bell's figure is a woodcut, and very unfavourable for a ghost-like transparency. Mr. Gosse's description, beautiful as it is, or any other man's description, must fail to do justice to the Prawn." So, failing to get a live specimen "for my very own," as the children say, I have been fain to draw the details from a dead specimen, which, by the way, is far less ghost-like than a living one, and then to watch the flitting shadows in the zoological tanks, to get something of their pleasing hues.

The most striking peculiarity of a Prawn, in distinction from a common Shrimp, is the elegantly-curved proboscis in front of the carapace, which is notched like the saw, but

more pointedly and sharply. The eyes are placed on rather large peduncles, have a startled kind of stare, and, if seen by candle-light, reflect a golden glare, like those of a cat. There are two spines on the front of the carapace, which is cylindrical and smooth. Seemingly coming out from underneath each eye is a jointed stalk, supporting the internal or superior antennæ, each with three filaments, the shortest not so long as the rostrum, but the others long and flowing. On the peduncle of the outer antennæ is, on each side, an oval or oblong plate or scale, fringed with hair, from beneath which the long flowing outer antennæ make their appearance. All these antennal filaments are neatly ringed throughout; and when the animal is on the watch for food, they are all waving about in every direction. It is quite astonishing how quickly the Prawn detects the presence of any falling scraps in his vicinity. I saw several, when being fed, apprehend minute morsels which they could not have seen, nor even touched with their antennæ; so as to lead to the conclusion that these must be organs of smell. And even when the fragments dropped between pebbles at the bottom, it was wonderful to see how the little two-fingered hands or pincers would dive down and pick them out. In the figure, immediately below the antennæ plate, are the

curved, brushy, outer foot-jaws, admirably adapted for retaining food brought to the mouth by the pincers. Beneath these will be seen, partly doubled back, a very slender pair of feet or arms, each with a little pincer-brushed hand. These are in advance of the true pincer-arms, and not, like them, adapted for seizing prey. What is their use? They are in constant request as cleansing instruments. The Prawn loves to be clean, and he takes surprising pains to keep himself so; and these tooth and nail-brushes are placed so as to be capable of reaching every part of the body. Drawing up his tail and abdomen, he subjects their under surface to the most careful revision, scrubbing and poking between the lappets of the shell and the body, diving into every crevice, and with the pincer-hand picking out every speck too large to brush away. Next to these useful instruments are the larger pincers, whose use is obvious; then come three pairs of slender walking legs, with pointed claws; and then, under the plates of the abdomen, are the five pairs of what are called "abdominal false feet." They are used partly in swimming, and partly in holding the eggs of the female. The plates covering the joints of the abdomen have broad, fringed lappets at the sides; and the tail, with its four oval plates, acts as a terminal fin.

The first Prawn I had the pleasure of seeing in an Aquarium was one which had in his arms a lump of red meat, as large as his carapace. He was swimming about with it, apparently in great excitement; and we could see his mandibles and foot-jaws all busily at work tearing and nibbling the piece. The keeper told us that it would be all consumed in a very short time. We were much amused by a scene which occurred between a Prawn, evidently bent on mischief or fun, and a White Anemone. The former sailed up majestically almost close to the latter, and cautiously put forward one of its fore-legs till it touched a feeler of the Zoophyte. The touch of the feeler was adhesive, and other feelers in the immediate neighbourhood bent towards the one touched, as if to help to hold the intruding leg; but all of a sudden the Prawn jerked away, looking saucily, as much as to say, "Would you, though?" He repeated this movement, first with one leg, then with another; then sailed away a bit, and returning from another quarter; till at last, seeming to grow tired of the joke, he moved quietly away. It was but a dangerous game to play, too: for if inadvertently the Prawn had exposed too much surface to the Anemone, and had allowed too many of its tentacles to reach it, they would have gained a purchase, the rest of the feelers

would have surrounded and entangled his legs, and then, dragging him into the central vortex, would have engulfed him in the body of the animal. The latter catastrophe, in fact, did occasionally occur—many a Prawn making a meal for a Sea-flower through carrying the joke a little too far. In some cases however it was no fun, but a real combat between Crustacean and Zoophyte; the former trying to rob the latter of some *bonne bouche;* sometimes succeeding in pulling it out from the Sea-flower's mouth, at other times being himself engulfed. The process of exuviation is easily observed, and very interesting in the Shrimp and Prawn tribe. In the summer, Mr. Warrington has observed it to take place in his specimens as often as every twelve days. The small cleansing nippers and brush are at this time particularly busy, being employed not only in cleaning, but in assisting the separation of the outer plates of the covering previous to removal. The whole integument, after removal, is entire. Prawns are very tame in an Aquarium, soon learning to come and be fed; and indeed a pretty sight it is to see them at a meal. It is necessary however to avoid placing Prawns in the same tank with smaller animals of the Shrimp kind. The latter would infallibly be devoured.

Crangon vulgaris.

It is a curious habit of the *Common Shrimp*, and other species, to burrow in the sand (which most of them resemble in colour), leaving only their eyes exposed, watching for prey. For this reason they are called by the fishermen "Sand Raisers."

Homarus vulgaris.

The *Common Lobster* is a splendid animal, as seen in the tank. After moulting, all the purples and blues are rich and deep, the specks bright, and the fringes clear. After a time, however, the sporules of thread-like *Conferv*æ begin to vegetate on the crust, till by degrees they become quite a forest growing on his back, his claws, and even on his antennæ. This arises from his sluggishness, although he does not let "the grass grow under his feet." Finding a dark hollow in some archway, the Lobster wiles away his time, very seldom moving from his hiding-place; and when he does move out, it is like Birnam-wood coming to Dunsinane. When the Lobster is about to moult he is still more retired in his habits than before, and ceases even to feed. The process of exuviation has been already described. Several specimens of cast shells are exhibited at the Zoolo-

gical Gardens, which have been thrown off in a very perfect condition by animals in the Society's collection.

Many other points of interest will occur in reference to the peculiarities of this class and their habits. We are only yet beginning to study these things as we ought. A spirit of investigation is just rising up among us, to which the Aquarium has given a great impulse.

Nor is the shore inferior in the opportunities it affords to real lovers of nature, who, having eyes, see, and see to some purpose. My readers will admire, with me, the spirit of observation evinced in the following extract from Hugh Miller's work, entitled 'My Schools and Schoolmasters.'

"There are Professors of Natural History that know less of living nature than was known by Uncle Sandy; and I deemed it no small matter to have all the various productions of the sea with which he was acquainted, pointed out to me in these walks, and to be put in possession of his many curious anecdotes regarding them.

"He was a skilful Crab and Lobster fisher, and knew every hole and cranny along several miles of rocky shore, in which the creatures were accustomed to shelter, with not a few of their own peculiarities of character. Contrary to the view taken by some of our Naturalists, such as Agassiz, who hold

that the Crab—a genus comparatively recent in its appearance in creation—is less embryotic in its character and higher in its standing than the more ancient Lobster, my uncle regarded the Lobster as a more intelligent animal than the Crab. The hole in which the Lobster lodges has almost always two openings, he has said, through one of which he sometimes contrives to escape when the other is stormed by the fisher; whereas the Crab is usually content, 'like the rat, devoid of soul,' with a hole of only one opening; and besides, gets so angry in most cases with his assailant, as to become more bent on assault than escape, so loses himself through sheer loss of temper. And yet the Crab has, he used to add, some points of intelligence in him too. When, as sometimes happened, he got hold, in his dark narrow recess in the rock, of some luckless digit, my uncle showed me how that after the first tremendous squeeze he began always to experiment upon what he had got, by alternately slackening and straitening his grasp, as if to ascertain whether it had life in it or was merely a piece of dead matter; and that the only way to escape him on these trying occasions was to let the finger lie passively between his fingers as if it was a bit of stick or tangle, when, apparently deeming it such, he would be sure to let it go;

whereas, on the least attempt to withdraw it he would at once straiten his gripe and not again relax it for mayhap half an hour.

"In dealing with the Lobster, on the other hand, the fisher had to beware that he did not depend too much on the hold he had got of the creature, if it was merely a hold of one of the great claws. For a moment it would remain passive in his grasp, he would then be sensible of a slight tremour in the captured limb, and mayhap hear a slight crackle, and presto! the captive would straightway be off through the great dark water-hole and only the limb remain in the fisher's hand. My uncle has however told me that Lobsters do not always lose their limbs with the necessary judgment; they throw them off when suddenly frightened, without first waiting to consider whether the sacrifice of a pair of legs is the best mode of obviating the danger. On firing a musket immediately over a Lobster just captured, he has seen it throw off both its great claws in the sudden extremity of its terror, just as a panic-struck soldier sometimes throws away his weapons. Such in kind were the anecdotes of Uncle Sandy."

CHAPTER XII.

CRABS.

CARCINUS MÆNAS.—ITS HABITS.—METAMORPHOSES.—CANCER PAGURUS.—SOFT CRAB.—OBSERVATIONS IN A TANK.—GALATHEA STRIGOSA.—PORCELLANA PLATYCHELES. — THE HERMIT CRAB. — ITS PUGNACITY.—CHOOSING A HOUSE.—CAUTION.—METAMORPHOSES.

The *Carcinus mænas,* or *Common Shore Crab,* is a rather dangerous fellow to keep in an Aquarium, unless care be taken that other small and delicate animals are not exposed to his attacks. He is very pugnacious, and it is necessary to remove him, if of any size, from smaller individuals of his own species; else he will amuse himself by breaking off their claws, and nipping pieces out of their sides. He is however rather afraid of good strong Anemones, generally avoiding them. He is a good scavenger, routing among the sand and pebbles, and picking out with his claws little decaying scraps which would otherwise injure the water by their decomposition.

Being naturally fitted for shallow water and shelving shores, the *Carcinus* is one of the most familiar objects of all our coasts. Not a tide-pool but contains some specimen, old or young, lurking between the crannies of rocks, or half hiding under the pendent weeds. High up on the shore too, on sand or shingle, even in the caves at the foot of cliffs left dry by the receding tide, there may the Shore Crab be found. At every part of the coast it is a most favourite amusement among children to stand on quays and jetties, letting down bunches of offal into the water, and drawing them up with these Crabs holding tightly to them with their tenacious pincers.

Their flesh being of a delicate and sweet flavour, these Crabs are much eaten by inhabitants of the coast, and many are sent up to metropolitan markets. It is more however as a delicacy than for food that they are sought for, their substance being far from solid, and each shell containing very little flesh.

The carapace or great shell of this species is very pretty, especially in the earlier stages, when the colours and markings are more brilliant, and set off by transparency. The general colour is darkish- or greyish-green above, with a little reddish tinting beneath and about the legs. They

are much mottled, with whitish spots and darker markings symmetrically arranged.

The carapace is broader than long, and widest in front. The front edge between the eyes is five-lobed, and its continuation on each side of the eyes is notched into four or five teeth. The front pincers are large, and all the claws pointed. In the last pair of legs however may be observed a disposition in the last joint and claw to spread and flatten. For though the Common Crab does not swim, he sometimes gives a kind of swimming jump through the water, using the hind legs as flappers. In the Swimming Crabs we shall find this character developed more fully, and then the hind legs are used as swimming paddles.

Placing a Crab and a Lobster side by side, we should be ready at first to pronouce them very different animals. Their general figures are almost the opposites of each other; but when we come to compare the parts we shall find the difference less than we suspected. The great dissimilarity of form arises principally from this,—that in Crabs the abdominal portion, or tail, is not largely developed, and instead of being a free cylindrical body, moving in joints, it is flattened and doubled up in front of the thorax, so that only one or two narrow joints of it are seen from above; whereas in a

Lobster it constitutes a large proportion of the body, and is free, the tail being broadly expanded and used as a flapper. Between these therefore there are intermediate forms, such as *Galathea*, which has its abdomen free in swimming, but habitually tucked close under the body, like a crab when at rest. The Hermit Crab likewise has the abdomen long and cylindrical, but ill-formed, and kept wound round the columella of a shell.

The metamorphoses or changes of condition undergone by Crustacea have already been spoken of. They take place at successive stages before maturity, each stage bringing them nearer to their ultimate form. As in the immature, or Zoe state, the tails of Crabs as well as Shrimps and Lobsters are free, there is much less difference between them than when mature. In fact, they are all shrimp-like in form. But they have sessile eyes, *i. e.* eyes not elevated upon stalks.

The following observations on the "sloughing" of this species are taken from Sir J. Dalyell. That gentleman had kept for some time a specimen of *Carcinus mænas*, of medium size, of a brown colour, with one white limb. "One summer evening it was put outside the window in a capacious glass vessel of sea-water. In the morning, a form exactly resem-

bling its own, only somewhat larger, lay in the water. This was the same animal, which had performed exuviation, and extricated itself from its old shell during the night. The resemblance between both forms was complete; everything was the same; even the white limb was seen in both.

"Another specimen kept was of smaller size; its colour was green, with three white patches on the back. In the course of little more than a year five exuviations took place at irregular intervals; the new shell and the animal becoming larger each time."

On the premature changes or metamorphoses Mr. Couch gives the following particulars. He procured some specimens with ova ready for shedding, transferred them to captivity in separate basins, and in sixteen hours found large numbers of the young Zoes swimming about with all the activity of life. "There could be but little doubt that these young creatures were the young of the captive Crabs. In order however to secure accuracy of result, one of the Crabs was removed to another vessel, and supplied with filtered water, that all insects might be removed; but in about an hour the same creatures were observed swimming about as before. To render the matter if possible still more certain, some of the ova were opened, and the embryos extracted;

but I shortly afterwards had the pleasure of witnessing, beneath the microscope, the natural bursting and escape of one precisely similar in form to those found so abundantly in the water. Thus then there is no doubt that these grotesque-looking creatures are the young of the *Carcinus mænas;* but how different they are from the adult need hardly be pointed out." They are about the sixteenth of an inch long, a kind of tadpole, with the body oval, surmounted by a large, long spine. The pupil of the eye is large, surrounded by rays. There is a kind of snout in front, and a pair of leaf-like swimming appendages. The hind legs of the body are natatory. The tail is long, cylindrical, divided into five joints, forked at the end, and armed with stout bristles.

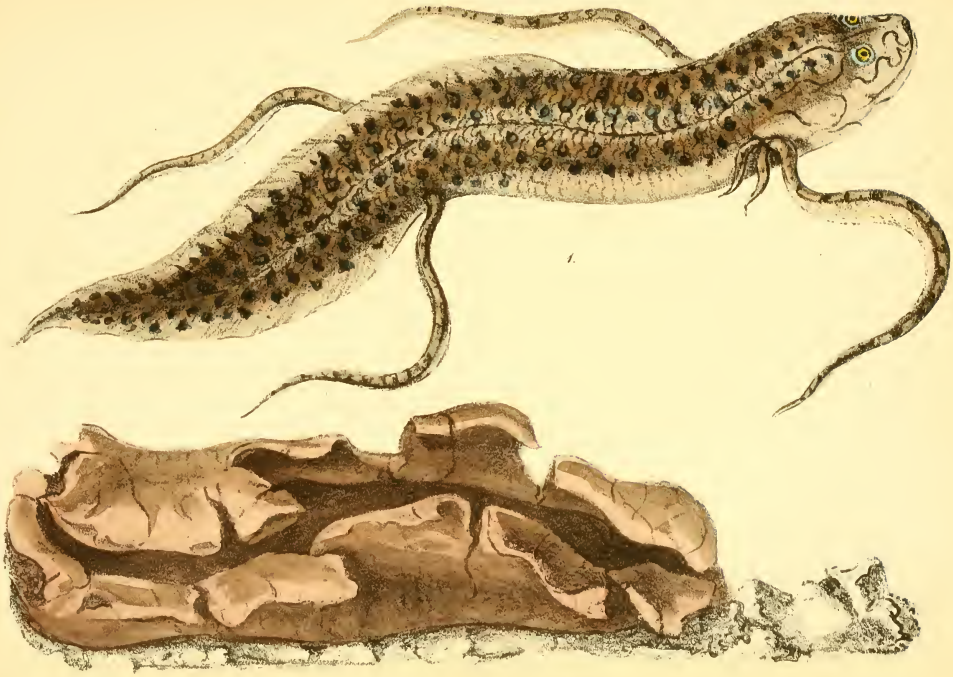
These odd little creatures swim about with restless activity; but when the shell begins to harden they become less active, till presently they retire to the sand at the bottom of the vessel, to cast their shells and acquire a new form. The second change relieves them of the tadpole appearance, and sets their eyes upon foot-stalks. The front claws become nippers, the other claws more like those of full-grown Crabs, and the tail smaller. In this stage it has more of the general form of a Lobster than of its parent Crab. One or two changes more, and then is produced one

of those little, transparent, tender Crabs, which children are so fond of racing upon the sands.

Cancer pagurus.

The *Great Eatable Crab*, if not as familiar on the shore as the preceding, is quite as well known in markets and fishmongers' shops. Its large size and pleasant flavour recommend it to notice, and have caused its habits to be observed by those who are commercially interested in its capture. It is known on every part of our coasts, particularly the rocky parts; but the larger it grows the more it is disposed to retire to deep water. The condition of a soft Crab, or one which has just thrown off its shell, before the new one has had time to harden, has often been described. At that time they get into as retired a hole as they can find; and the fact often mentioned seems to be pretty well established, that when the female is in that condition the male is frequently found in her company.

When full-grown it is of a reddish-brown colour, and the claws, very large, are tipped with black; but the young are sometimes quite white. Sir J. Dalyell gives an account of a specimen observed in captivity which will be found interesting.



Sowerby del et lith. Vincent Brooks Imp

1. Mud fish of the Gambia. Lepidosiren annectans. 2. Case in which it was enclosed for six months within a ball of Clay.

"A young white specimen of the Common Crab was subjected to observation on the 29th of September. The body might have been circumscribed in a circle three-quarters of an inch in diameter, and the extended limbs by one and a half inch in diameter. Its first exuviation ensued on the 8th of November, the second on the 30th of April following, and the shell then produced subsisted till the 12th of September, when another exuviation took place, introducing a new shell of such transparent white that the interior almost shone through it. All the shells were white, and increased somewhat in size successively. This last shell, of the 12th of September, subsisted until the 29th of March, being a hundred and ninety-seven days, when it was thrown off during another exuviation. But what was remarkable, the animal now had only the two large claws; the other eight limbs were deficient. Resting on its breast as it was, I did not at first discover the fact that the creature presented a strange and very unusual aspect. However, it fed readily and proved very tame though helpless; often falling on its back, and not being able to recover itself, from the deficiency of its limbs. I preserved this mutilated object with uncommon care, watching it almost incessantly day and night; expecting another exuviation, which might be attended with interesting

consequences. I felt much anxiety for its survivance. My solicitude was not in vain. After the defective shell had subsisted eighty-six days, its tenant in the meantime feeding readily, the desired event took place in a new exuviation on the 23rd of June. On this occasion a new animal came forth, and in the highest perfection, quite entire and symmetrical, with all the ten limbs peculiar to its race, and of the purest and most beautiful white. I could not contemplate such a specimen of Nature's energies restoring perfection, and through a process so extraordinary, without admiration. Something yet remained to be established: was this perfection permanent, or was it only temporary? Like its precursor, this specimen was quite tame, healthy, and vigorous. In a hundred and two days it underwent exuviation, when it appeared again perfect as before, with a shell of snowy white, and a little red speckling upon the limbs. Finally, its shell, having subsisted a hundred and eighty days, was succeeded by another of equal beauty and perfection, the speckling upon the legs somewhat increased. All the shells had gradually augmented, so this was larger than the others. The extended limbs would have occupied a circle of four inches in diameter. About a month after this exuviation the animal perished accidentally, having been

two years and eight months under examination. It was an interesting specimen, extremely tame and tranquil, always coming to the side of the vessel as I approached, and holding up its little claws as if supplicating food."

Porcellana platycheles.

The *Broad-claw* is a curious little fellow, with the whole body very much flattened, fitting him to hide in narrow horizontal crevices. His pincers are very broad, flat, and hairy, and capable of inflicting a very severe bite. Valuable however as are his pincers, he parts with them easily to effect his escape when seized, knowing that, as

> "He who fights and runs away
> May live to fight another day,"

so

> He who throws his limbs away
> May have them new another day.

When placed in an Aquarium, the Broad-claw is seen at first to move briskly, by using its tail or abdomen as a flap, although habitually it is kept doubled up under the body, as in other Crabs. It soon finds a hole or cranny to hide in, and generally keeps out of sight. A little specimen I saw at Lloyd's, lived pretty constantly under a common

Limpet which was placed in his jar. Living in this secluded style, and seldom moving about in search of prey, the poor little animal would find it difficult to procure the necessary food, if it were not for an instrument with which he is provided. The outer foot-jaw is largely developed, and furnished with a network of hairs, which, when thrown out, form, in returning, a spoon-shaped sieve, which, letting the water escape, brings into the mouth all the animalcules within its grasp. I should have said the outer *pair* of foot-jaws, for there is a pair of them. They are shaped like scythes, and used alternately. Those who have seen the movement describe it as beautiful, and resembling those of the cirrhi of the *Balanus;* but, in the latter case, the action is simultaneous in both members.

Galathea strigosa.

A very pretty and merry Aquarian, with a form between that of Crabs and that of Lobsters. It uses the tail freely, jerking its body up and down the sides of the tank, and looking as if it had the power of crawling on perpendiculars. It is very prettily marked with stripes of blue between the red.

The Hermit or Soldier Crab.—(Plate XI.)

The common species, Pagurus Bernhardus, is the one usually seen in tanks, where it presents a most interesting object. Crawling clumsily about with a shell not its own upon its back, it seems as if it were not in its natural condition, and yet that is the condition in which it is always, or almost always, found: and if by any accident the hermit is deprived of his portable cell, he is about as uncomfortable as a fish out of water till he finds another, and if unsuccessful dies. There seems to be something so strange in this habit of choosing the covering of another animal for a dwelling, and the parts of the body which are protected by it appear so contorted, ill-formed, and irregular, that I am tempted almost to refer it to some accident of very frequent occurrence. Might it not be, that the Zoe or Tadpole form of some common species, produced where empty shells of different sorts and sizes lie strewn plentifully among pebbles and sand, falling into some of the hollows, and becoming confined, or liking the condition, remained in it through subsequent changes, and that thus what is first an accident becomes a habit? Even if this were the case, it would require a course of observation and many experiments to esta-

blish it, and in the meantime we must be content to take the obvious facts as we find them.

The front, or exposed part, then, of the common Soldier resembles that of other Crabs in some degree. The two first claws are pincers, always unequal in size; the next two pairs are long, arched, and pointed, very well adapted for ambulatory purposes. The front part of the thorax, or body, only, is covered by the shield or carapace, which in other Crabs covers the whole body. Then comes the hinder part of the thorax, which is soft, and two pairs of legs, which are small, irregular, and very feebly developed. The abdomen is a membranous sac of irregular form, with very rudimentary plates, and terminating in a crustaceous tail of three joints, the second with appendages or flappers. From the unprotected condition of the hinder part of this animal, it will be easily understood that it requires constant shelter.

When two "Soldiers" meet in an Aquarium, there is generally a passage-of-arms between them, being very pugnacious animals, each one trying to seize the other with his strong claws, the object being to wrench the enemy out of his tenement and feed upon the unprotected part of his body: and this atrocious design is sometimes carried out. But in other cases the fight is not for the possession of the

person, but for the shell of the victim. A *Pagurus* has been seen to approach another whose shell he envied, and seizing him as it were by the shoulders, dragged him suddenly from his hole, into which he almost as quickly thrust his own body. The dispossessed hermit, exhausted by the encounter, and unable to find another dwelling, dies. Now and then a *Pagurus* wishes to change his house, because he has grown so large as to find it inconvenient. Several observers have spoken of the extreme caution with which he effects the change. Carrying his present habitation on his back, he goes on his travels to seek for a larger one. Presently, guided by his antennæ, as well as by sight, he finds a shell which he thinks may be larger than his own. His first care is to find whether it is inhabited; for although the aperture is empty near the rim, it is quite possible that the mollusc may have withdrawn some distance within the shell; so the *Pagurus* puts in his long claws, feels and probes the depth of the cavity as far as he can reach, all round, and then, when satisfied that the shell is empty, raises his abdomen and tail, flaps it into the hollow, turning a summerset, coils his body round the columella and finds himself at home. Nor does his caution cease here; for sometimes, if not quite certain of the suitability of his new dwelling, he keeps firm

hold, with his long claws, of the old one, carrying it about with him, and sometimes even re-entering it and then trying the new one again, till quite decided in his own mind as to which is the best to occupy for a permanency. The *Paguri*, in choosing their shells, do not appear generally to object much to their outsides being occupied by the parasitic Anemone, which is so frequent a companion of the Hermit. A *Nereis*, or Sea-Worm, often shares the hollow of the shell with the Crab, while Acorns, or *Balani*, often occupy its outer surface. Whether these associations are fortuitous, or whether chosen by the animals on account of expected mutual advantages, is a question which will perhaps find its solution when Aquarians have had more opportunities of watching their habits. The more I see of these interesting creatures, the more firmly am I convinced that there is a great deal to be learned about them yet; and a very pleasant occupation will it be to "work out," as Naturalists term it, the various points of their natural history,—their birth, their metamorphoses, their exuviations, and their associations.

Zoe of Pagurus.

"The Zoe of the Pagurus," says Mr. H. Goodsir, "when

it escapes from the egg, or a short time after, is perfectly transparent, the thoracic portion of the body is slightly opaque, and the eyes are black. The abdomen however is perfectly translucent, and the observer requires to look very attentively before it can be defined. On being excluded from the egg, the young animal is doubled upon itself; the abdominal portion of the body is bent closely under the thoracic portion; and it is kept in this position by means of a thin sac or membrane. It very soon frees itself from this by a few violent efforts; and then the antennæ, the feet, and the abdomen all become free and extended. The proximate half of the abdomen only is confined within the sac; the distant half is quite free. The Zoe of this species is destitute of spines; the spine on the dorsum of the carapace and the frontal spine being absent. As soon as the young animal frees itself of the sac before mentioned, the thorax apparently becomes much smaller. This arises from the contents of the sac escaping, and the thorax proper only being left."—'Edinburgh New Philosophical Journal,' 1842.

There is nothing to prevent any amateur observer from pursuing his inquiries through every stage of existence in the Hermit Crab.

Plate XI. shows a *Pagurus* occupying the shell of a *Buccinum undatum,* which is surmounted by a parasitic Anemone; a smaller specimen below occupies a Periwinkle. A dead *Pagurus* out of the shell lies at the bottom.

CHAPTER XIII.

WATER-INSECTS.

ARGYRONETA AQUATICA.—ITS NESTS UNDER WATER.—DEPOSITION OF EGGS.—GENERAL HABITS.—DYTICUS MARGINALIS.—AIR INVESTITURE.—BREATHING.—LARVA.—FEEDING.

The *Argyroneta*, Plate XVIII., is a curious, darkly-coloured Spider, common in many parts of France, England, Germany, and Switzerland; very remarkable for its habit of plunging into and living under the water. It differs in this respect from ordinary Spiders, as well as in the fact of the male being larger than the female. As the abdomen is covered by a kind of fur, which repels the water and prevents the skin from getting wet when the animal is under water, therefore its body or abdomen is covered with a bubble of air, which has the appearance of a silver pellicle, and suffices for respiration in the absence of branchial opercula. Thus supplied with breathing apparatus, they

live principally under water, but come out to change their skin, and at times, also, to chase terrestrial insects, which they drag beneath the surface as soon as caught.

The most curious circumstance connected with these Water-Spiders is the manner in which they construct nests under the water, for residence, and for the deposition of eggs, and fill them with air brought from the surface.

In constructing its nest the *Argyroneta* rises to the surface, and, with its head downwards, places the point of its abdomen in contact with the external air. Expanding the filaments at that point, it encloses, in again sinking, a small bubble of air, which it retains in a rounded form, independent of the bubble which covers the rest of its abdomen. It then swims towards the edge of the plant to which the nest is to be attached, and touches the little bubble in such a manner as to make it leave its own body, and adhere to the edge of the plant. The Spider again mounts, brings down another bubble, and so on in succession, until he has a mass of small bubbles collected, around which he then begins to spin a web, by means of which he brings the separate bubbles together, so as to form a single one large enough to contain his body. Living afterwards in this little balloon, the Spider spreads filaments round the aper-

ture, by which means are caught and detained many small water-insects which compose its food. Sometimes insects are caught in the water, brought to the surface, and devoured dry, or else taken and consumed in mid-water; sometimes those caught in mid-water are carried to the nest; sometimes, as with Land-Spiders, they are hung up as stores for future consumption.

The nest made by the male Spider is smaller than that of the female, and sometimes constructed in its vicinity. This is when he is about to make love. And then he makes a tube or channel of communication between the two, through which his visits are made. Other males sometimes attack and try to enter the same nest; combats take place, during which the nest is broken and the air escapes. For depositing her eggs, the female makes a large cocoon, which is netted in by a much tougher and stouter material than that which is used for the ordinary purposes of residence; and this is much thickened at the roof, so as to present the appearance of a small sheet of glazed cotton wadding. The materials are evidently distinct, one being of a silky nature, the other hyaline, and perfectly transparent.

The air-bell or nest, in which the Spider resides, differs very much in different cases and different situations. They

are generally rounded at the top, and flattened at the base, with an aperture which the Spider sometimes seems to find with considerable difficulty, by feeling with its feet before inserting the body. When placed in a jar with water, the *Argyroneta* fixes his bell sometimes to the edge of the jar, and at other times to the stones placed in it, or the aquatic plants growing in it; but when the objects are wanting, he will hang his nest upon cross filaments carried from one side of the jar to the other.

Professor Bell has recently communicated the following very interesting observations to the Linnæan Society respecting our insect and his subaqueous habits, in a series of experiments. They were made in consequence of Mr. Gosse having denied the fact of the *Argyroneta* ever filling his cell with air brought from the surface: —

"No. 1. Placed in an upright cylindrical vessel of water, in which was a rootless plant of *Stratiotes*, on the afternoon of November 14. By the morning it had constructed a very perfect oval cell, filled with air, about the size of an acorn. In this it had remained stationary up to the present time.

"No. 2. November 15. In another similar vessel, also furnished with a plant of *Stratiotes*, I placed six *Argyronetæ*.

The one now referred to began to weave its beautiful web about five o'clock in the afternoon. After much preliminary preparation, it ascended to the surface, and obtained a bubble of air, with which it immediately and quickly descended; and the bubble was disengaged from the body, and left in connection with the web. As the nest was on one side, in contact with the glass, enclosed in an angle formed by two leaves of the *Stratiotes*, I could easily observe all its movements. Presently it ascended again, and brought down another bubble, which was similarly deposited. In this way no less than fourteen journeys were performed; sometimes two or three very quickly, at other times with a considerable interval between them; during which the little animal was employed in extending and giving shape to the beautiful transparent bell, getting into it, pushing it out at one place, and rounding it at another, and strengthening its attachment to the supports. At length it seemed to be satisfied with its dimensions, when it crept into it, and settled itself to rest.

"No. 3. The only difference between the movements of this and the former was, that it was rather quicker in forming its cell. In neither vessel was there a single bubble of oxygen evolved by the plant. The manner in which the

animal possesses itself of the bubble of air is very curious, and, as far as I know, has never been accurately described. It ascends to the surface slowly, assisted by a thread attached to the leaf, or other support below, and to the surface of the water. As soon as it comes near the surface, it turns with the extremity of the abdomen upwards and exposes a portion of the body to the air for an instant; then with a jerk it snatches, as it were, a bubble of air, which is not only attached to the hairs which cover the abdomen, but is held on by the two hinder legs, which are crossed at an acute angle near the extremity; this crossing of legs takes place at the instant the bubble is seized. The little creature then descends more rapidly, and regains the cell always by the same route, turns the abdomen within it and disengages the bubble.

"No. 4. Several of them when I received them had the hair on the abdomen wetted, and I placed them on the blotting paper till they were dry. On returning them to the water, two remained underneath a floating piece of cork, and the hair, being now dry, retained the pellicle of air which is ordinarily observed. One of the two came out of the water, attached the cork to the glass, and wove a web against the latter, against which it rested about

Sowerby del. et lith.

Vincent Brooks Imp.

Star Fish 1. Uraster rubens, which, having lost two limbs is in process of restoring them
2. Star Fish. Goniaster equestris. 3 Under side of the same. 4 Balænophyllæa regia.

a quarter of an inch above the surface of the water. After remaining there about two days, it resumed its aquatic habits, and, like all the others, formed its winter habitation. I have now no fewer than ten which have formed their cells, in which they are perfectly at rest, and evidently hibernating."

De Lignen, having placed too many *Argyronetæ* together in one jar, some of them ate the others; the solitary male first falling a sacrifice to the jealousy of the females. De Walkenaer however observed a contrary circumstance; he placed in a goldfish-glass a large number of specimens, with a branch of coral. Having waited to see the female make her bell and attach it to the branch or coral, he next noticed a large strong male constructing his nest near hers. Being then obliged to leave them for a time, he was surprised to find on his return, only that male and female with their young left; the rest of the females having disappeared. They had made good meals for the family circle. Mr. Bell also found that his specimens diminished in number from the same cause.

Their nests are constructed in spring and autumn, and the winter is passed in them.

An accident lately occurred at Mr. Lloyd's establishment

which might be suggestive of a new train of inquiry, and an experiment or two. Mr. Lloyd observed one of these Spiders which had fallen from the outside of his own jar into a tank of salt-water; but he had immediately protected himself from the action of so unaccustomed an element by constructing a bell, in which, when found, he was comfortably ensconced, apparently suffering no inconvenience from the novelty of his situation. Mr. Lloyd, however, thinking the poor Spider could but be ill at ease, rescued him from his position and restored him to his own jar. I confess I should like to have seen how long he could defy the briny fluid; and am not quite sure whether, if an opportunity occurred, I might not be cruel enough, "by the merest accident," to drop some poor straggler into sea-water, just to try whether he could not become naturalized in it.

Our Plate XVIII. represents *Argyronetæ* and their cells in water. The upper oblong nest is formed of thicker material, especially at the roof, than the other. It is the cocoon, in which are deposited the eggs; the lower ones are the air-bells in which the *Argyronetæ* reside. The small bells, hanging in thready weed on the right hand, are those formed for the young.

Dyticus marginalis, or Water-Beetle.
(Plate XIX. fig. 4.)

Lively and interesting, but dangerous inmates, are these Beetles of the fresh-water tanks, in which they are quite at home. For in their natural haunts they prefer stagnant or still, to running water. They swim with very great agility, their hind legs acting in concert, and looking like oars. I have noticed that when the Beetles are descending from the surface, they carry, wrapped round the end of their abdomens, a bubble of air, which apparently assists them in keeping the head downwards in diving. When at the bottom, a portion, or even the whole, of this bubble becomes disengaged or absorbed, and they mount, head upwards. The bubble is very bright and silvery in appearance, and is no doubt retained by means of a few fine hairs on the abdomen. These Beetles are very voracious in their habits, seizing and devouring small aquatic insects and mollusca, and sometimes destroying young fish. The keeper of the Chelsea Botanic Gardens complains of these insects destroying his gold and silver fish by nibbling at their dorsal and pectoral fins.

Mr. Westwood relates that a specimen of *D. marginalis*,

which was kept in water three years and a half, fed with raw beef, destroyed a specimen of *Hydrous piceus*, which was twice its own size, piercing it with the jaws on the only vulnerable point, namely on the under side, at the insertion of the head and thorax, and so sucking its juices. Esper observed that a *D. marginalis* so completely sucked the blood out of the pieces of meat it was fed with, that they looked like small masses of white, floating on the surface.

They ascend frequently to the surface for the purpose of breathing, and would sometimes almost appear as if they were performing that operation through their tails; for they lie immersed all but the hinder extremity, which protrudes from the surface. Here they appear at rest, balancing on their oar-legs, which are stretched at right angles. Although pretty constant denizens of the pool, they cannot remain without occasional access to the air; and sometimes, creeping up the rushes to take flight, they mount up in the air perpendicularly, like the lark, till out of sight. The descent is equally direct, resembling rather a fall than a flight. It is stated that they are guided in their descent by the reflection of light upon the water's surface; for they have sometimes been deceived and have fallen with violence upon

glazed garden frames which had apparently been mistaken for water.

During the winter, their habits are by no means uniform. Some bury themselves, and remain for the season in a state of torpidity; others retain their natural briskness, and will remain in the water after it has been frozen over, swimming under the surface and coming to accidental openings to take air.

Many of these particulars are gathered from Mr. Westwood's account in his popular and accurate work. I have had no opportunity of watching the *Dyticus* in its native haunts, but have been obliged to content myself with observing its movements in a fresh-water tank. These movements are curious enough. The manner in which the insect bustles about, first diving down in a great hurry, as if business of importance was on hand and there was not time to do it in, then suddenly appearing to change its mind, reverse its balance, and return in the same direction, is very amusing. Now it will waddle along the leaves; then skim the surface; then rest for a few moments, giving his extremities an airing; then down he goes again straight to the bottom, and remains for awhile with his body half buried among the pebbles. What he is doing among these same

pebbles we do not exactly know, but his actions look very much as if he were rummaging for minute insects and Crustacea, which have taken refuge between them. He appears resolved literally to leave no stone unturned to get a living. I have only once witnessed him in the act of seizing larger prey, and then it was an unfortunate *Planorbis* or Flat-coiled Water-Snail. At first the *Dyticus* seemed to be roaming about in quest of something, first under, then over, the leaves of a Water-lily. At last, in a rather dark corner, he seemed to perceive suddenly a *Planorbis* which was browsing upon the stem of a plant just under the shade of a broad leaf. He darted at this, seized it, and then putting his tail out of water, apparently for the purpose of taking in a fresh supply of air, moved slowly down, bearing the Snail with him. He held it, as represented in Plate XIX., by his fore feet, turning round the coil until the aperture of the shell was opposite his mandibles, when he began nibbling away at the animal. In vain did the poor Mollusc try to withdraw within his shelly fortress, for the Beetle picked off the edges of his shell bit-by-bit, so as to expose the body as fast as it was withdrawn. All the way down to the bottom of the tank was this process continued, air-bubbles rising to the top, and bits of

broken shell falling, till the Beetle reached a stone near the bottom with his burden, where I left him still busy at his work.

A Water-Beetle, in the act of devouring a *Planorbis*, is represented in Plate XIX., in company with Newts.

CHAPTER XIV.

MOLLUSCA.

AQUARIAN OBSERVATIONS ON MOLLUSCA.—LITTORINA LITTOREA.—LIMNÆA STAGNALIS.—ASCIDIA VITREA (?).—NUDIBRANCHIATE MOLLUSCA.—DORIS BILAMELLATA.—PURPURA LAPILLUS.—SAXICAVA RUGOSA.—PECTEN OPERCULARIS.—PHILLINE QUADRIPARTITA.—SEPIOLA VULGARIS.

Mollusca have not yet been introduced very extensively into Aquaria, although they are very interesting objects when admitted. They may never become so popular as Sea-flowers or Crustacea, but earnest students of Nature will find much pleasure and instruction in watching their habits, and examining their structure. Of the few Aquarian observations that have been as yet made, many are recorded by Mr. Clarke, and published in Forbes and Hanley's 'British Mollusca.' Some few of these are repeated in my 'Popular British Conchology,' and some are added. Having been so

recently engaged in that compilation, I feel that it would be out of place to enter into a very elaborate history of this class in the present book; but a few interesting examples may be given.

Littorina littorea.

On entering the Society's Fish-house, among the first objects that attract notice are a number of snow-white, rounded, or oval discs, studding here and there the sides of marine tanks. Going a little nearer you perceive behind each of them the head and shell of a common Periwinkle. Crawling up the glass sides till they arrive near the water's edge, they will often remain without motion for a considerable length of time, holding on by their white sucker-discs. And sometimes they rise above the water, preferring to remain dry for a time, in imitation of their natural habits. When observed in the latter position, they are often ruthlessly pushed down by the keeper. On my asking whether the poor Molluscs, accustomed as they were to be left dry on the rocks by the receding tide, could really live always immersed as they seemed condemned to do here, the keeper replied by pointing out to me hundreds of tiny Periwinkle fry, with transparent shells, to

show that the species was not only thriving, but freely breeding in their present position. I must confess, however, that I felt far from satisfied with the demonstration; for while the young seemed to be brought forth plentifully and to grow freely, the old ones seemed to die off rather fast; and I cannot imagine why the poor creatures should not be allowed to take an airing when so disposed.

The movements of Periwinkles are so slow, and they remain so long in a given spot, that seaweeds often take root and grow on the outside of their cumbrous shells.

They are very useful in a tank, their occupation being that of scavengers. The seeds of marine plants held in suspension in sea-water, are apt to fall and adhere to surfaces and begin to grow, and their accumulation tends not only to obscure the glass so as to check our observations, but also their too great abundance tends to render the water unhealthy. To check this overgrowth and prevent the glass sides of the tank from becoming opaque, a few Periwinkles are put in, and very soon put in motion an apparatus well adapted for mowing down the minute turf of *Confervæ*.

This apparatus consists of a rasp-tongue, set with curved teeth. If we notice one of these animals feeding with his

mouth towards us on the glass, we see his black-striped snout beyond the circle of his foot. In the centre of this we see a pair of lips open, and then a glassy organ rolling out between. This is the tongue, which, giving a kind of sweep, rolls back into the mouth, and the lips close over it again. So the scavenger goes on, taking one sweep after another, and even leaving a series of curved marks behind him, like those left by the scythe of a mower. On taking a dead specimen and dissecting the head, the tongue may be found. At the mouth-end it is formed like a narrow spoon turning back upon the throat, to which it is fixed; the other end is a thread-like coil lodged in the stomach. Along the spoon and the whole length of the coiled thread are three rows of curved teeth. What we have seen, in witnessing the Mollusc feeding, is the convex surface of the spoon, rasping up the food and coiling backwards as it rasps. The food is passed along the triple row of teeth, and becomes fully masticated in the coils of spiral thread in the stomach.

Most persons are acquainted with the horny operculum with which the Periwinkle shuts himself up in his hole. It is fixed on the back of his foot; so that, in retiring, his head enters first, then his neck and the forepart of his

foot; lastly, the end of it pulls the horny lid into its place. *Trochi* with conical shells have somewhat similar habits, and their tongues are similarly formed and similarly used.

Limnæa stagnalis, and other Water-Snails.

What *Littorina* does for Marine, *Limnæa* does for Fresh-water Aquaria. The latter may be seen in the tanks, mowing away at the microscopic vegetation which would otherwise obstruct our view. The shell of *Limnæa stagnalis* is elegantly formed, transparent, and obliquely conical, while those of *Planorbis*, another genus of Water-Snails, is a flat spiral coil; but the animals are very much alike in nature and habits. *Paludina*, which has an oval shell of rounded whorls, is speckled all over the body with minute dots of gold.

Although the Water-Snails are in some sense useful as scavengers, they are also mischievous as devourers of useful and sightly vegetation, biting through the leaves of *Vallisneria*, and other plants, as remorselessly as Garden-Snails make holes in cabbages. The smaller species, such as *Limnæa auriculata* and *L. glutinosa*, *Physa fontinalis* and *Bithinia tentaculata*, are the most useful and least harm-

less. The following interesting observations were communicated by Mr. Warrington, in the tenth volume of the 'Annals of Natural History.' "These Water-Snails have the extraordinary power of moving along the surface of the water with great rapidity, with their shells downwards, the foot being attached as it were to the atmospheric air. The *Planorbis* also can fix itself, without any apparent means of attachment, by his side to the flat surface of the glass, and will remain thus for several days.

"In watching the movements of the *Limnææ*, I was for some time under the impression that they had a power of swimming or sustaining themselves in the water; as they would rise from the bottom of the pond, a portion of the rockwork, or a leaf of the plants, and float for a considerable period, nearly out of their shells, without any apparent attachment, and, by the contortion and gyration of their body and shell, move some little distance in a horizontal direction from the point which they had left. On more carefully watching this phenomenon however, I found they were attached by a thread or web, which was so transparent as to be invisible, and which they could elongate in a similar way to the Spider; they also possessed the power of returning upon this thread by gathering it up as it were,

and thus drawing themselves back to the point which they had quitted.

"A *Limnæa stagnalis* had glided its way along a young and short leaf of the *Vallisneria*, which terminated below the surface of the water, and, having reached the extremity, launched itself off from it; after moving about with a sort of swimming and rolling motion in a horizontal direction for some time, it lowered itself gradually, and in effecting this the long flexible leaf of the *Vallisneria* was bent with an undulating motion, corresponding exactly with every movement of the Snail, showing clearly that it had a firm attachment to the extremity of the leaf. On another occasion a *L. glutinosa* gradually rose from the surface of a piece of submerged rock, and, when at the distance of about three or four inches from it, stayed its progress, floating about in a circumscribed horizontal direction for some time; at last it rose suddenly and rapidly to the surface, evidently from the rupture of its thread of attachment. The most convincing proof however of this fact that I can perhaps adduce, and one that I have often repeated with all the before-mentioned *Limnææ*, is that when the Snail has been some inches distant from the supposed point of attachment, a rod or stick has been carefully introduced and slowly drawn on one side, be-

tween them, in a horizontal direction; and by this means the Snail can be made to undulate to and fro, obeying exactly the movements of the rod. This requires to be done very gently, as if too much force is used the web is broken and the Snail rises rapidly to the surface of the water."

Ascidia vitrea (?).—(Plate XIII.)

This is a shell-less Mollusc of the Tunicate Order, apparently as simple in form as a *Polype*. The beautiful group which I have attempted to portray in my Plate was brought from Ilfracombe. Eight or ten specimens have nestled in a bunch of *Phyllophora rubra*. They consist of a bottle-shaped sac with two necks and mouths. They are jelly-like and transparent, and their open mouths are scalloped, with a little marking of red and opaque-white at each notch. Scarcely any motion is to be observed, excepting every now and then either the large opening or mouth, or the smaller one, suddenly shut sup, soon to be opened again. Sometimes an intruding substance is thrown out with force, and the apertures kept closed for some time after.

Nudibranchiate Mollusca.—(Plate XIV.)

The *Naked-gilled Mollusca* have no shells, and their gills

or breathing-apparatus consists of variously shaped organs, arranged on different parts of their sides and bodies, but all external. Some of them from their complicated branching gills are almost like moving trees, or more like Slugs with a forest on their backs; others are of plainer make, and have the gills exserted, in the form of a branched star, through the mantle. A few of the forms are represented in the Plate. The following are Mr. Gosse's observations on one of the species, as to its habits and reproduction.

"Doris bilamellata,

"Of which there were three in the vessel, was very social in confinement, continually finding out one another and crowding close up together. They crawl round the pan, generally resting close to the surface, often with the mantle a little raised, so that the air may reach the body.

"Feb. 22nd. The *Doris bilamellata* laid a ribbon of spawn, attached to the side of the pan, almost at the surface of the water; it adhered by one edge, and formed an imperfect spine or cup, the ribbon being bent upon itself, the upper edge or brim leaning a little outward and being puckered. The general substance is white and opaque, owing to a vast number of minute eggs enveloped in a clear jelly. The

Sowerby del et lith. Vincent Brooks Imp

The Water-Spider, Argyroneta aquatica, and air-bubbles, with young.

colour therefore appears uniform, except that a clear line runs round just within the edge, caused by a narrow space free from eggs. The ova, although numerous and close-set, occupy only the central portion of the band, there being a considerable space of transparent jelly without them on each surface. On the 19th of March I cut off a small piece of the ribbon of spawn and examined it beneath a microscope; I found that the young were fully formed, each enclosed in a globular egg, perfectly transparent and colourless. The young *Doris*, unlike the adult, which is a naked Slug, inhabits a transparent shell, formed like that of the Nautilus, from the mouth of which project two large fleshy circular discs, set round with long cilia. These latter organs were in constant and vigorous vibration, by the motion of which each little animal revolved freely in its egg-shell, incessantly turning upon its centre in every direction. Sometimes one would suddenly suspend the motion of its cilia as if tired; then, after having rested a few moments, put forth one cilium in a cautious manner, then another, and in a moment the whole were again in vibration, and the little embryo was gyrating in its giddy dance."

Carnivorous Ferocity of the Nudibranchiata.

Mr. Gosse relates that having placed a large specimen of *Anthea cereus* in the Aquarium, with three individuals of *Eolis papillosa,* he found, on visiting the tank one day, that one of the latter was busy eating the tentacles of the former, to which it clung tenaciously in opposition to endeavours made to pull it away. On his next visit the two other *Eolida* had joined in the carnage. All three exhibited signs of great fierceness, adhering to parts between the anthers by the point of the foot, and stretching forwards to the point of attack, erecting and reversing their branchiæ. When removed to a considerable distance they returned to the charge, from any part of the vessel, as long as they remained in it.

PURPURA LAPILLUS.

This has a thick oval shell, and belongs to the Order *Gasteropoda:* foot and body being one. When the shell is banded with rich brown or yellow, it looks very pretty in an Aquarium. But the animal is very voracious. Its proboscis is a formidable weapon, capable of penetrating through shells of small Periwinkles, Limpets, and

even those of thick shelled, full-grown Mussels. When dead, a vessel of cream-coloured matter may be found in the body, under the veil of the tentacles. On opening the membrane the matter exudes, and if spread upon linen colours it yellow; the yellow changes to pea-green, thence after a time to grass-green; becoming bluish by degrees till it is quite blue. A tinge of red next begins to appear, increasing until the general tint is purple. This is *one* of the *purple dyes*, and has been used in commerce for the purpose of colouring linen. The *name* however was originally applied to a *Murex*. I have just seen a specimen of this Mollusc living in one of Mr. Lloyd's tanks, covered entirely with small *Balani*, each throwing out its network of cirrhi from between the opening opercula.

Saxicava rugosa

Has the power of boring into rocks and enclosing its body and bivalve shell, in the hole it has scooped out for a dwelling. It lives near the surface, so as to protrude its siphon, which appears like a crimson wart on the face of the rock, withdrawing it instantly on being disturbed.

Pecten operecularis.

The *Common Painted Scallop* is an object of great beauty. Not only its shell is finely painted (either variegated with red, brown, and white markings), but the fringed and brilliantly coloured mantle lining the shell, and showing itself as the animal lies with his valves a little gaping. Near the edge of this mantle are a great number of thread-like tentacles, capable of contraction and expansion; and between these are seen a number of minute circular points, generally believed to be eyes, looking very much like them, and well placed for use in that capacity. The *Pecten* adheres to surfaces by means of a byssus of small threads which it throws out between its valves on the upper side; and when placed in a jar will attach itself to the glass at the sides; here it will hang with its two half-circles of eyes apparently on the watch. At times however it will move about by means of leaps effected by blowing out jets of water suddenly from between the edges of the mantle.

Philline quadripartita.—(Plate X. fig. 45.)

When this Mollusc is crawling, it presents the appear-

ance of a broad, flat, opaque, white slug, with the dorsal disc divided into four lobes. The two side lobes of the disc are the edges of the mantle turned up; the front lobe covers the head, and the back lobe hides from view a very beautiful broad, white, transparent shell, known more generally by the name of *Bullæa aperta*.

Sepiola vulgaris.

The *Cuttle-fish* tribe, being more oceanic than littoral, do not thrive well in confinement. They will not live many days in a tank, but while they do live their habits are not uninteresting. Of course the larger species are too cumbersome for the purpose, but the smaller ones have often been preserved in confinement long enough for observations on their habits. In some respects they approach the Radiate groups of animals; having the mouth central, on the top of the head, and the organs of prehension and locomotion, arms or legs, placed in a circle around it. In other respects they incline towards the vertebrate groups; some of them being provided with an internal bone or pen, which may be considered a rudimentary vertebral column. Others are furnished with a shell. The soft bone sold in shops for birds to nibble at belongs to *Sepia officinalis;*

and the shell called *Paper Nautilus*, or Argonaut, belongs to an *Ocythoë*, another member of the class *Cephalopoda*.

When *Sepia vulgaris* is first placed in a vessel, it darts about in a restless manner, by forcing jets of water from a funnel which is situated beneath the body. Having in this manner explored every part of its prison, it will hold itself in suspense in mid-water, all the time flapping with a pair of fin-like wings. When at the bottom of the tank it has a very curious way of crawling by means of its arms, which are then bent angularly for the purpose. The manner in which the little creature changes colour is very surprising. "We can scarcely," says Mr. Gosse, "assign any proper hue to it. Now it is nearly white, or pellucid, with a faint band of brown specks along the back, through which the internal viscera glisten like silver. In an instant, the specks become spots that come and go, and change their dimensions and their forms, and appear and disappear momentarily. The whole body, arms, fins, and all the parts which before appeared free, display the spots, which, when looked at attentively, are seen to play about in a most singular manner, having the appearance of a coloured fluid injected with constantly varying force in the substance of the skin. Now the spots become rings, like

the markings of a panther's skin; and as the little creature moves slightly, either side beneath the fin is seen to glow with metallic lustre, like that of gold leaf seen through horn. Again, the rings unite and coalesce, and form a beautiful netted pattern of brown, which colour increasing, leaves the interspaces a series of white spots on the rich dark ground."

The *Sepiola* has a habit of burrowing in the sand. The funnel again comes into play, and by blowing the sand away in puffs, gradually makes a hole large enough to contain the animal's body. But if stones, and scraps too large to be blown away, are mixed with the sand, the arms pick them out by means of the sucking discs with which they are furnished. The *Cephalopoda* are supplied with an inky fluid, which they sometimes discharge in a cloud when irritated, for the supposed purpose of hiding from their enemies.

But *Mollusca*, as a class, have yet to be studied by means which the Aquarium and the Microscope will place at our disposal. Several varieties of *Nudibranchiate Mollusca* are figured in Plate XIV. Plate XIII. represents a group of Ascidians, belonging to the Tunicate order, nestled in a bush of *Phyllophora rubens*.

Philline quadripartita and its shell are seen at Plate X., in company with *Pentactes*.

CHAPTER XV.

FISHES.

FISHES IN VIVARIA.—GASTEROSTEUS ACULEATUS.—NEST-BUILDING.—PLATESSA VULGARIS.—GOBIUS NIGER.—MUGIL CHELO.—LEPIDOGASTER BIMACULATUS.—SYNGNATHUS LUMBRICIFORMIS.—FRESH-WATER FISHES.—LUMINOSITY OF FISH.—HERRINGS.—'SCHOOLS AND SCHOOLMASTERS.'—LEPIDOSIREN, OR MUD-FISH.

Although fishes are beautiful objects to be kept in an Aquarium, some of them are difficult and dangerous. Difficult, because from their delicate organization they are peculiarly susceptible of injury from any impurities in the water; dangerous, because of their pugnacity and voracious habits. Others, with proper care, live well and safely. The manners of fishes in confinement, with the exception of nest-building species, are not particularly attractive, although some of the gentler kinds become very tame, and will learn to come and feed from the fingers. The beauties of their conformation and colouring are however set off to great advantage in a vessel

with straight sides. Ordinary globes in which gold-fish are kept distort the figure, but through flat glass we get a side view of their rich tints and very solemn countenances.

Great advances in the science of ichthyology may be expected to take place as aquaria become common, but as yet fishes have not formed a very prominent feature in them. Very few salt-water fish have as yet been introduced, and those belonging to fresh-water have to be assorted with great care, to prevent mutual destruction.

In this department therefore we must be content to notice a few of the observations which have been made upon some kinds confined in tanks. We begin with a fresh-water species, which, from its habit of building a nest for its young, is very interesting.

Gasterosteus aculeatus.

The common Stickleback of our pools and brooks, so well known to boys in every rural neighbourhood, may be easily preserved, and if placed near the breeding season with a few familiar water-plants growing in the tank, will generally reward the possessor by an exhibition of its constructive powers. The following account is taken almost entire from Mr. Hancock's communication, published in the

'Zoologist' for 1854. Being drawn up from actual observation, it is better than a florid description would be.

"We have, for some time past, kept a glass trough filled with aquatic plants and animals; the bottom of this vessel is covered with mud, and the rockwork filled up in the centre is overgrown with a delicate, hair-like conferva; a few floating plants spread over the surface of the water, and innumerable *Entomostraca*, and other small crustaceans, as well as various animalcules, swarm in all parts; the minute but deadly poison-armed *Hydra* also prevails where food is so plentiful; and a solitary individual of the great water-beetle rambles over its watery domain, lord and master of all. Several of the fresh-water Mollusca also people the trough, which on the whole has very much the appearance of a miniature pond. Into this home were put four or five Sticklebacks last May, and they at once made themselves perfectly at ease. One, without the least hesitation, took possession of a certain spot, which it guarded with the greatest tenacity, attacking vigorously any of its companions that might happen to approach the chosen locality. The Beetle too, which sometimes came paddling slowly by, was pounced upon and unceremoniously tumbled over, but, secure within his scaly armour, as the knights of old, he little heeded the

onslaught of his naked assailant; so, overpowering all opposition, he scrambled onward in his undeviating path.

"This fish was rather small, had the throat of a bright red colour and the eyes of a brilliant bluish-green. At first, all the others were pale; but in the course of a few days one of them gradually assumed the rich hues of that already described, and soon afterwards it also became attached to a spot, taking up its abode in one of the corners of the trough. On examining attentively the two selected localities, a nest was found in each, composed of a collection of delicate vegetable fibres, resting on the bottom of the trough, and matted into an irregular circular mass, somewhat depressed, and upwards of an inch in diameter; the top being covered over with the same materials, and in the centre having a large hole. The fishes scarcely ever strayed from their nests, but were constantly on guard, defending or repairing them; they were perpetually prying into the hole at the top, and thrusting their heads right into it. On one occasion, one of them entered by this hole and slowly forced itself right through the side of the nest; as it gradually moved onwards, its body had a peculiar lateral vibratile motion. They would frequently seize hold of the nest and give it a violent tug, shaking and tearing loose the vegetable

matter of which it was composed; at other times they would carry to it, in their mouths, fine conferva-stems, and press them with considerable force into the walls of the nest, or thrust them into the hole, which by this means was partially concealed.

"Occasionally, each was observed hovering over its nest, with the head close to the orifice, the body being inclined upwards at an angle of about forty-five degrees, fanning it with the pectoral fins, aided by a lateral motion of the tail. This curious manœuvre was apparently, so to speak, for the purpose of ventilating the spawn, which would be distinctly seen through the orifice at the top; at least by this means a current of water was made to set in towards the nest, as was rendered perfectly apparent by the agitation among the particles of matter attached to it. This fanning or ventilating process was repeated at short intervals during the day, and every day until the spawn was hatched, to accomplish which, took between two or three weeks.

Only one nest contained spawn; the other was torn in pieces, and the materials scattered about, in the hope that we might have the pleasure of seeing it reconstructed. In this we were not disappointed; the fish immediately began to form a new nest in exactly the same spot, and by the

following day it was more than half completed. It took a mouthfull at a time, and was at some pains in adjusting each load, and spreading the materials out, and pressing them down with its mouth; it then drew its body slowly over the whole, vibrating all the time, in the same peculiar manner as when it forced its way through the nest as before stated."

When the young fry began to appear and flit about the sides of the nest, the parent's assiduity increased. When the little innocents endeavoured, too young and inexperienced, to wander from the precincts of the castle, they were actually caught, swallowed, brought back, and redeposited in safety. But it required the mother's unremitting exertions for several days after the fry was hatched, to keep them within bounds, so as to preserve them from danger. The old fish frequently took the young ones into its mouth to preserve them, and once did so almost from the hand of the observer, who had taken it up, and, after swimming about with it, blew it out in a thicket of confervæ.

Platessa vulgaris.—(Plate XV.)

Mr. Gosse remarks of flat-fish generally, that, "though easily caught, they are of little value, for they do not live

long in a tank, and are uninteresting from their sluggish habits, as they lie perfectly still on the bottom for hours together, trusting for concealment to the similarity of their russet colour to that of the sand." This may be true; yet, on our first visit to the Zoological Fish-house, we were much interested with a number of specimens of the common Flounder. The water was rather dingy, and the whole tank darkened by large pieces of over-hanging rock; at first, no life was seen; we took it for an empty vessel, and were passing by, when a sudden slight commotion and a flash of white arrested us, and from the dark bottom we saw rising with a wavy motion one or two of the common Flounders. In swimming they showed their white undersides; and the undulating motion of their fringing fins, as one wave followed another from the pectoral region to the tail, the flashing golden hue of the odd, cunning-looking eyes, and the gentle curves of the whole body, united in an exhibition of unexpected grace and elegance. We were particularly struck with the attitude which I have tried to represent in the Plate. When one has risen, another, roused by the commotion, begins to raise his head and look about him in a very curious manner. Still keeping the bulk of his body flat on the surface, but raising more and

more of his shoulders, supporting the elevation by stiffening out the first rays of his fins, and rolling his eyes about with a cunning and cautious aspect, he prepares to follow the example. Presently the vessel is alive with sportive flat-fish, now rising perpendicularly, now scudding along horizontally, now sidewise, now edgewise; first showing the dark, then the white disc. This lasts but a few minutes. One by one they slacken their motions and drop down; not settling finally without taking another survey with lifted shoulders. One by one they flatten on the sandy bottom, till the last lies "flat as a flounder" at rest, and all is over. The tank is dark and empty as before.

Gobius niger.

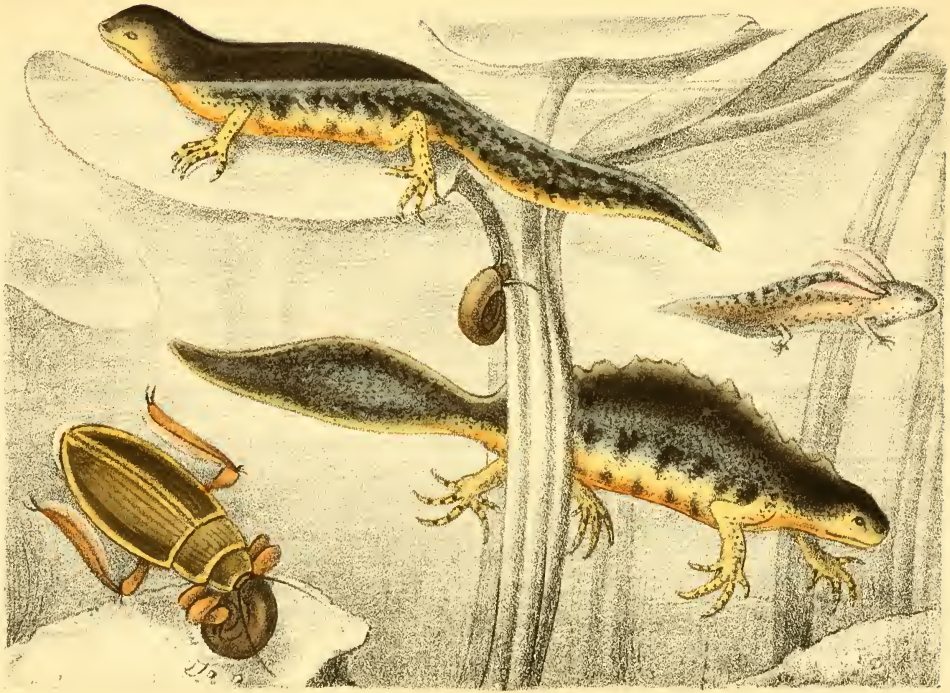
The *Goby* is a small fish, distinguished by his shape, which is broad at the shoulders, tapering off towards the tail, so as to give him a tadpole appearance. This fish soon familiarizes itself with its situation, and tamely but greedily feeds from the hand. In saying "tamely," we must be understood as towards the fish's proprietor, and not as towards his companions in the tank. Towards these, even of his own species, he is most ferocious, and will swallow another Goby not much smaller than himself. The Goby

generally lives as much out of sight as possible, under shelter in dark corners, but darting out occasionally, rarely rising to the surface, except for the purpose of seeking prey. It is very remarkable for the changes that constantly take place in its colours, like those of a Chameleon, but more decided. Sometimes, it is of a general blackish hue, clouded with darker patches. Sometimes, it is pale brown with dark and white spots. Possibly this is connected with the animal's "*feelings*," for he is observed to become darkest when most excited; and, when devouring a victim, lours over him "black as night."

The ventral fins of this fish are united so as to form an oval sucking disc. It enables the fish to seize and retain a hold on surfaces which he is not inclined to relinquish for the moment. He adheres, by means of this sucker, to pieces of rock and sides of the tank. I think he uses it partly in crawling, as he sometimes is observed to do, over perpendicular and diagonal surfaces.

Mugil chelo.

The habits of the *Grey Mullet* are the reverse of the preceding, for, while the latter generally remain quietly near the bottom of the tank, the former affects the surface,



Sowerby del et lith

Vincent Brooks Imp

Newts. 1 Triton cristatus, female. 2. Male. 3 Young. 4. Water Beetle, Dyticus marginalis devouring a Planorbis

and rarely descends. The Mullets are very hardy, living sometimes uninjured when other animals die from impurity in the water. Keeping near the surface, which becomes better aerated than lower down, and frequently taking mouthfulls of air by putting their noses out of water, they keep themselves supplied with what proportions of the different gases are most conducive to their health. Their restless activity in swimming to and fro, showing off their bright silvery stripes, renders them pretty and lively tenants of their watery cage.

Lepidogaster bimaculatus.

Another little tadpole-shaped fish, commonly known as the "*Two Spotted Sucker*," which, like the Goby, has its ventral fins united in a sucking disc. It is prettily coloured with pale red, with a deep red spot on each side. It does not poise its body steadily in the water, nor swim with the gliding motion of other fishes, but first adhering to one surface, and staying there for a short time, suddenly darts a little way off and adheres to another, or else crawls with a clumsy, wriggling motion. But the greater part of its time is spent in stillness, fixed to a particular spot, and probably feeding on animalcules.

Syngnathus lumbriciformis.

The *Worm Pipe-fish* has a slender, eel-like body, about five inches in length. The head is large, terminating in a turned-up nozzle. It is marbled on the sides with spots of white, edged with black lines; the neck is marked in the same manner; the general colour of the body being of a brownish-yellow, becoming silvery under the tail. But the full beauty of the animal can only be explained by a series of details which would be too tedious to read. Mr. Gosse remarks, that "in captivity the manners of this pretty little fish are amusing and engaging. Its beautiful eyes move independently of each other, which gives a curious effect as you watch its little face through a lens; one eye being directed towards your face, with a quick glance of apparent intelligence, while the other is either at rest, or thrown hither and thither at various other objects. I was strongly reminded of that strange reptile, the Chameleon." The tail of the Pipe-fish is prehensile; with the tip of it coiled round a stem, it will sway its body to and fro in graceful curves.

Fresh-Water Fishes.

Carp, golden, Prussian, or silvery, are handsome fish,

live well in tanks, and become very tame and even docile. They can be fed with small red worms and young water-snails. They will also, after a time, learn to take bread, and like it too; but care must be taken not to give them too much.

The Golden Carp love warm water; many of them are reared in waters which receive the waste steam from factories. In the Botanical Gardens, Regent's Park, in the water green-house containing *Victoria regia*, are immense numbers of Golden Carp, luxuriating and breeding freely in very warm water. At Hampstead too, at certain parts of the day, the waste water is liberated from the engine water-works into the adjacent pond. At these times some common Carp are seen congregating under the pipe, evidently enjoying the warmth, and dispersing after the temperature of that part is assimilated with the rest of the pond.

Loach, *Minnows*, *Tench*, and *Gudgeons*, have their various beauties, live pretty well in Aquaria, and are worth observing; but beware of the voracious *Pike*, for at a very early age he is fatal to fishes of larger bulk than himself.

Luminosity of Fish.

This is a subject upon which naturalists have not yet

written much, although it is known that many of these animals possess the power of illuminating the ocean, and some of them may be induced to exhibit their peculiarity in confinement. The *Pyrosoma*, for instance, has been described as presenting a very luminous appearance seen in a tank by night. When in motion it changes, passing through the colours of a bar of red-hot iron to that of a white heat, represented by a phosphorescent colour. We have seen the heads of common Mackerel shining brightly in a dark cellar; and, as Mr. Swainson has observed, "When we consider how many hundreds of species, more especially those which live in deep water, are covered with scales of a rich and shining silver hue, infinitely more brilliant when those fishes are alive and in their native element than as they are commonly seen after having been caught, it becomes highly probable that the brilliant radiance with which they are clothed, is to effect some other purpose than mere ornament." Although *Herrings* have not yet been kept in Aquaria, it will not be uninteresting to conclude this Chapter with the following account of their brilliant luminosity, by Hugh Miller, in 'My Schools and Schoolmasters.'

"As the night gradually darkened, the sky assumed a

dead and leaden hue; the sea, roughened by the rising breeze, reflected its deeper hues with an intensity approaching to black, and seemed a dark uneven pavement, that absorbed every ray of the remaining light. A calm silvery patch, some fifteen or twenty yards in extent, came moving slowly through the black. It seemed merely a patch of water coated with oil. But, obedient to some other moving power than that of either tide or wind, it sailed aslant our line of buoys, a stone-cast from our bows; lengthened itself along the line to thrice its former extent; paused as if for a moment; and then three of the buoys, after erecting themselves on their narrower base with a sudden jerk, slowly sank." One—two—three buoys! exclaimed one of the fishermen, reckoning them as they disappeared; *there* are ten barrels for us secure. We commenced hauling; the nets approached the gunwale. The first three appeared, from the *phosphoric light of the water,* as if bursting into flames of a pale green colour. Here and there a Herring glittered bright in the meshes, or went darting away through the pitchy darkness, visible only by its own light. The fourth net was brighter than any of the others, and glittered through the waves while it was yet several fathoms away; the pale green seemed mingled with broken sheets of snow,

that, flickering amid the mass of light, appeared, with every tug given by the fishermen, to shift, dissipate, and form again; and there streamed from it into the surrounding gloom myriads of green rays, an instant seen and then lost, —the retreating fish that had avoided the meshes, but had lingered, till disturbed, beside their entangled companions. It contained a considerable body of Herrings. As we raised them over the gunwale, they felt warm to the hand; for, in the middle of a large shoal, even the temperature of the water is raised, a fact well known to every Herring fisherman; and, in shaking them out of the meshes, the ear became sensible of a shrill, chirping sound like that of a mouse, but much fainter, a ceaseless cheep, cheep, cheep, occasioned apparently (for no true fish is furnished with organs of sound) by a sudden escape from the air-bladder."

Lepidosiren annectans.—(Plate XVI.)

The 'Illustrated London News' lately containing an account of this remarkable animal as now living in a tank at the Crystal Palace, it became necessary for the writer of an 'Aquarium' to visit that establishment, as well as to consult the description in the 'Linnæan Transactions,' by Professor Owen. The visit was made on a gloomy day, and it

was with some difficulty that I found that part of the establishment in which the "Mud-fish" was to be seen. At length, after manfully resisting the temptation of music in passing through the great transept, I gained an interview with his Mudship, and must confess myself agreeably surprised at his much more pleasant appearance than the 'London News' figure had led me to expect.

The *Lepidosiren* is on the whole rather a graceful fish than otherwise, and the mud colour, or greenish chocolate, is well set off by numerous symmetrically arranged lines, and some well defined leopard-like spots. Its chief peculiarity consists in the two pairs of limbs, which are neither legs nor fins, properly so called, but are flexible jointed filaments, bordered by fin-like fringes, and occupying the positions of the pectoral and ventral fins of ordinary fishes, such as the salmon. They are used in swimming; the scythe-like sweep of the anterior pair giving them great power in propelling the body forwards; which is effected at a rate which may be considered rapid for its proportionate weight and size. On the back, and on both sides of the tail, is a continuous fin-like keel, like that of the tadpoles of frogs and newts, which further assists in progression. The body is eel-like, but not so much so as in

another species. The breathing apparatus is complicated, and, besides internal, there are two external gills exserted from behind, and above the exsertion of the front pair of limbs. The head is not so snub, nor the aspect so ferocious, as the recently published figure makes them appear. On looking at the figure too, one would be at a loss to assign any particular function to these limbs; but on seeing them in action, their use is apparent, and I overheard a Frenchwoman pronounce them to be "*nageoires.*" Very good "*nageoires*" they certainly are, besides being well adapted for cutting through the mud in which this fish loves to reside.

The Mud-fish moves freely and gracefully in the water, sometimes coming to the surface to obtain a supply of air, and feeding upon small animals. The nostrils open within the mouth. There were three specimens brought to England from the River Gambia, enclosed in balls of hard clay, in which they had been buried for eight months, without any communication with the air. When the balls of clay were put into water, they cracked and broke. In the middle of these balls were discovered dark-coloured oval bags, which, afterwards bursting, liberated their inmates. These immediately swam about and were quite ready to break their

long fast by feeding greedily upon the worms, small frogs, and pieces of meat that were given to them.

The largest specimen is about sixteen inches long and two inches broad. The three specimens were presented by Captain Chamberlayne to the Crystal Palace Company. The rudimental filamentary fins are considered as analogous to the four ordinary extremities in vertebrate animals. Their internal supports are in each a jointed cartilaginous ray. On the whole, the opinion of Professor Owen that the *Lepidosiren* is a fish, has been well sustained. For, while on one hand, the reptile-like development of the air-bladder, and its conversion into an organ of aerial respiration; the tadpole-like appearance of the dorsal and tail fringe; the external gills, so like those of young newts; and the absence of regularly rayed true fins, seem to point to an affinity with aquatic reptiles: on the other hand, its true fish-scales, and many other points in its general anatomy, show it to be a fish. Into these points I do not now enter, but must refer my readers to vol. xviii. of the 'Transactions of the Linnæan Society,' contenting myself with quoting one argument of Professor Owen's. "In the organ of smell, we have at last a character which is absolute in reference to the distinction of fishes from reptiles. In every

fish it is a sac communicating only with the external surface; in every reptile it is a canal with both an external and an internal opening. According to this test the *Lepidosiren* is a fish." The only opening of the nostril is within the mouth.

Our Illustrations of Fishes are, Plate XV., *Platessa vulgaris,* young, in attitudes described in the text; and Plate XVI., *Lepidosiren* swimming, with the hibernaculum shown at the bottom.

CHAPTER XVI.

FRESH-WATER ANIMALS.

THE GREEN HYDRA.—TRITON CRISTATUS.—A PANIC.—HABITS.—FROGS.—FRESH-WATER TORTOISES.—EMYDIDÆ.—MARINE TORTOISES.—TURTLES.—HABITS OF EMYS CONCENTRICA.—TRIONYCHIDÆ.—MUD-TORTOISES.—HABITS OF MARINE TURTLES.—ALLIGATORS.

Hydra viridis.

The chapter on "Hydroid Zoophytes" did not describe this wonderful fresh-water animal, which every one may, but very few ever do, procure, and examine, and experiment upon. It is more than a hundred years since Trembley, at the Hague, and Baker, in London, created a sensation by their revelations on the nature, habits, and reproduction of these little polypes, of which there are several species found in our ponds and ditches, adhering to the commonest water-plants. They are wonderfully simple in form and structure, consisting of a tube or sac with a prehensile disc at one

end and a mouth at the other, surrounded by a circle of retractile tentacles or feelers. Like Actinias, they are capable of collapsing the entire body into a little knob or button, and then, again expanding, they spread out their feelers to search for prey, which consists of minute insects and small worms. The touch of their feelers partly paralyzes their victims, which are swallowed entire and digested in the stomach. This is not their only movement, for they can crawl something in the manner of some caterpillars, by bringing the two extremities of the body together, making a bow in the middle, then moving the head a pace and bringing up the hinder disc to it. Like some plants, they are propagated either by buds or cuttings; the former, of course, the most natural. A little bud is seen at the side of the full-grown polype, it increases, it puts forth its circle of tentacula, and after a few days separates from the parent and becomes independent. The other method of propagation is the result of those curious and perhaps not really cruel experiments which originally caused so much excitement among naturalists. The Hydra may be divided and subdivided into a great number of parts; and each part will, under favourable circumstances, become a new polype. If the head be cut off, a few days will give a new body to

the head, and a new head, with a complete circle of tentacles, to the body; and the vital functions appear so little disturbed by the operation, that young polypes will be forming on the separate parts of the parents during the process of restoration. The result is similar if the body be cut in strips lengthwise; each strip will close round into a tube, and its proper circle of tentacles made up. It is also possible to turn the body inside-out as you would turn a stocking, and yet all the functions of life would proceed as before; digesting food within the sac, and reproducing without.

Triton cristatus.—(Plate XIX.)

Some years since, the village of Walton-on-Thames "was thrown into a state of considerable excitement," as the newspapers say, by the writer, then a little boy, passing through it with a prize in his pocket-handkerchief. The prize was a living creature, which unfortunately contrived to escape for an instant through the folds, and while being recaptured, was seen by a woman standing at the cottage door with a child in her arms. Greatly alarmed, she called out to know if the silly boy wanted to get poisoned, and so carry death into his home. She communicated her alarm

to her nearest neighbour, who in equal terror went to fetch her husband from his work. But before his arrival, some valiant workmen were passing by, and being appealed to, made a vigorous onslaught on the two-inch monster, and cut him into small pieces with their trowels! It was a poor water-newt, and the villagers then, as in Shakespeare's time, reckoned the species among noxious and dangerous animals more or less connected with supernatural agency. How would the Waltonites be astonished to see these animals floating innocently among water-lilies in the tank, without any covering or other means of protecting the public from their power! Setting aside the supernatural, however, we may remark that an idea of the poisonous powers of toads and newts has been very general, and it has probably arisen from the moisture secreted by the animal to keep in active operation the breathing apparatus of the skin. This moisture is acrid and irritating, and would very likely tend to increase the inflammation of any wound on which it might happen to be pressed.

The Amphibia are intermediate in their structure between fishes and true reptiles; and in the two orders which we are about to notice, namely that containing the frogs and toads, and that containing the newts, a transition of organization

takes place, transforming the animal from a fish to a reptile in habits and shape. At one time the animal is endowed with organs fitted exclusively for breathing water, like the gills of fishes, with limbs suited for swimming; at another time it is provided with air-breathing lungs and fitted for land movements either by leaping or running.

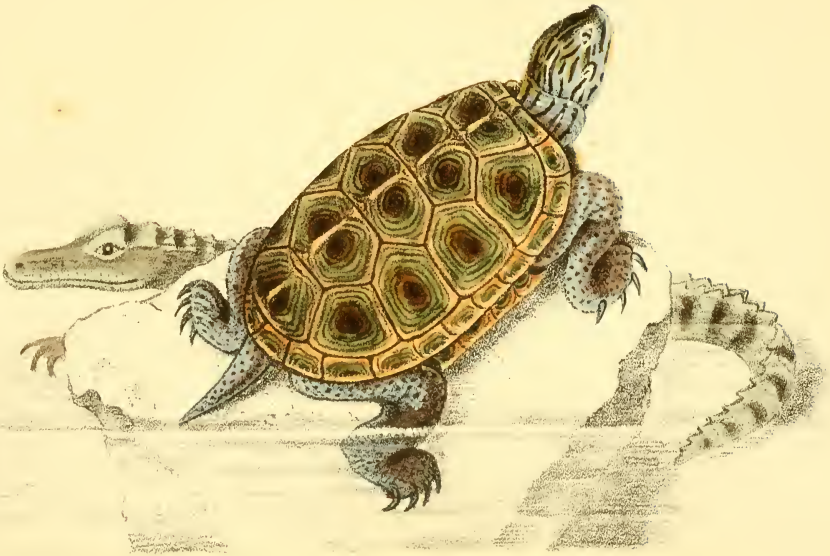
Habits of the Common Water Newt.

The female of *Triton cristatus* is observed, at breeding time, to wander about in search of a suitable leaf of some aquatic plant. When she has found one which is likely to answer her purpose, she takes her position on one side, holding on to the edge with her fore feet, while with the hind feet she draws the other edge over by means of her hind feet, so as to fold it, and then depositing a single egg within the fold, glues it by the mucus surrounding the embryo, so as effectually to secure it from injury.

During the months of May or June many of the leaves of aquatic plants will be found thus neatly folded and glued together in the ponds and ditches; but in order to observe the process, the female should be taken and placed in a tank at the proper season, with suitable plants for the purpose, so that the egg may be deposited under the eye.

When first deposited, the egg is a little buffish-white ball surrounded by a jelly-like envelope within which it moves freely; in a few days it unrolls and gradually assumes a tadpole form, still within its envelope. In this state may be seen the simple rudiments of gills striking out at the sides of the head. The front pair of these gills constitutes holders by which the animal afterwards clings to objects, and immediately behind the gills are little knobs which are afterwards developed into anterior legs. Two bands of brown spots are seen running down the back. It then leaves the egg and swims about as merrily as most tadpoles do, and while the anterior gills become more distinct and useful as holders, the hinder ones become beautifully branched. By degrees the fore legs are developed, and the hinder ones appear at first in a very rudimentary form. A fin-like keel extends along both edges of the tail and over the back, and the transparency of the whole body is such that the circulation can be seen in almost every part. After the complete formation of gills, they begin to be gradually absorbed, while the formation of true lungs is going on, until at length, towards the end of autumn, it is an air-breathing reptile, and no longer a fish.

It is stated that the young Newt, retiring from the water



Sowerby del et lith.

Vincent Brooks Imp

Fresh-water Tortoise, Emys concentrica, & Young Alligator

after his first season and the loss by absorption of his tail and dorsal fins, seeks some distant spot for his first hibernation, in a damp cellar, or under half-buried stones, and for the first three years does not return to the neighbourhood of the ponds, not being yet sufficiently strong to resist the attacks to which he would be exposed, and as yet unprepared for breeding. At the end of the period mentioned however he goes back to the water and is provided with new fins for his tail and a new crest for his back, becomes fish-like in his habits, and seeks a mate. At the end of the season again, the fishy ornaments are once more absorbed, and the Newt returns again to land; this time, however, not seeking distant solitudes, but hibernating in crevices and clay-banks coiled up in company with others of his race, of whom he is no longer afraid. Here they remain until the next breeding season; the males acquiring crest and fins at the beginning of every aquatic season, and losing them preparatory to assuming terrestrial habits at the end.

The full-grown *Triton* feeds on live aquatic animals, which it is capable of swallowing entire. Its manner of seizing prey is rapid and efficient, often enabling it to secure large bodies. Water Mollusca not unfrequently fall a prey to its voracious appetite, their shells having been found in

the stomach when opened, sometimes crushed, but always empty. They feed too on the young of their own species as well as of the smooth species, which is considerably smaller. The following experiments and observations are, among others, recorded by Mr. Higginbotham in the twelfth volume of the 'Annals of Natural History.'

"I kept a little male Newt, *Lissotriton punctatus*, in a basin of clear water, quite alone.

"The markings of the skin of this Newt at this time were bright and distinct, and the dorsal crest was deep. At eight o'clock on the morning of the 30th, I noticed that it was particularly dull, and would scarcely move on being touched, and I feared it was going to die from its confinement and want of food; it was very thin, but its epidermic covering had undergone no change, and its summer dress was as bright as ever. Upon again looking at the little animal at eleven o'clock, I found that it had assumed the colours and form of the Newt in winter, approximating those of the female, and in the water its entire exuvium was floating about, so thin and transparent as to look a mere film, but still quite perfect, excepting the fissure by which the body had emerged.

"The Newt was now of a brown colour, and the black

spots on its surface less distinct; the dorsal crest, which before was deep, was merely represented by a ridge, and the tail had diminished by one-third of its vertical depth, this difference being principally on its dorsal surface. The integument was very thin, the cutaneous bloodvessels being quite apparent through it. It was very active, and swam about the basin with renewed life and vigour. The slough was a perfect cast of the whole body, limbs, and tail; it was quite entire and not torn or broken in any part, excepting that it had been split straight down the middle line on the ventral surface, from the symphysis of the lower jaw to the point of the tail, and had thus simply peeled off the body, beginning from the belly and passing off the sides and then from the back, taking away the dorsal crest. It is remarkable that there was no fissure or crack in the cuticle from the legs and feet, but it had slipped off the limbs exactly as a glove would if pulled off by the extremities of the fingers, and was not inverted; in this respect resembling the slough from the tail of the snake or slow-worm, the tail of them being said to slip out of its covering like a sword out of its scabbard.

"The little sheaths of legs, feet, and toes, were very beautiful; they were almost transparent, excepting the points

corresponding to the black markings of the skin; here they were blackish, and their integrity was so complete that when removed from the basin the water did not run through them, but distended them like tiny gloves."

In the tanks of the Zoological Society we have an opportunity of observing the Water Newts in fine condition, floating among the water-lilies or occasionally coming in contact with that curious insect the "Water Beetle." On visiting them lately, however, I have noticed that these specimens, being in a great measure prepared for terrestrial existence, seem rather anxious to get their heads out of the water and cling to anything that floats on the surface. In order to meet this desire, the keepers have placed a little bit of wood in the tank, just large enough to form a raft for one, or at most two, Newts. If any more cling to it, down goes one side of the raft. While I was there, some five or six were trying to get on at once, and happy was the one fortunate enough to have a place on the floating edge as the other side plunged. It was a happiness of short duration; he would soon be edged off his perch, or his side would be over-balanced. A continual struggle was going on, and I observed one poor fellow, who having made several ineffectual attempts to get a place on the raft, at length gave

it up in despair, and plunging up and down, now and then, by a strong effort, leaping half out of the water.

Frogs.

During the breeding season every boy may sport his own Aquarium in the shape of a pan or tub, in which he may place spawn or young tadpoles for the purpose of scientific observation. Here he may watch the development of the animals in their various stages, until they become reptiles, leave the water, perch on the edge of the vessel, and leap away.

It would be no bad plan to let this experiment take place in a garden, where the permanent residence of Frogs might be encouraged by continued supplies of moisture, so that the pursuit of knowledge might be accompanied by useful results. It is not perhaps generally known how useful frogs and toads might be to the gardener, their food consisting chiefly of those very pests which cost him so much pains to get rid of. They will swallow slugs and insects entire, and are sometimes seen to take several at a meal. Instead, therefore, of persecuting and killing these useful and innocent creatures, it would be advantageous to encourage them to a great extent, as their voracity in a garden

would go far towards exterminating the ruthless enemies to utilitarian gardening.

In watching the development of the young Tadpole into the more perfect animal, it is observed that as soon as the gills have attained their greatest development, they begin to diminish in size, and are gradually reduced so as to be contained within a cavity and enclosed by a kind of valve in the skin. The eyes being perfectly formed and the lips becoming movable, the Tadpole begins to be active in securing food, which in this state is of a vegetable nature. The fin-like web on the tail becomes much enlarged, to fit it for rapid motion in search of food. By degrees little tubercles at the sides of the body successively announce a commencement in the production first of the hinder and then of the fore limbs. In proportion as the hinder legs become developed, the tail-fin wears away, and then the tail itself becomes gradually absorbed, till, "small by degrees and beautifully less," it is finally lost altogether, and the animal uses his hind legs with webbed feet for progression through the water, until, emerging from that element, he uses them for leaping on land. Now, no longer a vegetable-eating Tadpole, he is an air-breathing Frog, feeding on insects and worms. For the latter change the young Tadpoles

had been gradually prepared by feeding partially on animal food before their final development, and the author of the 'History of British Reptiles' relates that, suspecting a fratricidal disposition among the little creatures, he placed several more or less advanced specimens in a large globe of water, and "observed that almost as soon as one had acquired its limbs it was found dead at the bottom of the water and the remaining Tadpoles feeding upon it. This took place with all of them successively excepting the last, which lived on to complete its change, and for a considerable time afterwards."

These amphibious creatures live in great enjoyment in fresh-water Vivaria combined with fern-cases, as introduced by Mr. Lloyd, in which Frogs and Newts can leave the water for a while and disport themselves merrily among the branches of Ferns in the upper part of the case, and then hop or glide down again into the water below. They are fond also of finding anything that will float on the surface and sustain the weight of their bodies. In a garden tank belonging to a friend at Croydon, round the sides of which a kind of grotto is built, there is, among minerals, plants, madrepores, and shells, a large specimen of *Haliotis*, or ear-shell. It is a large open shell, and, the holes being stopped

up, capable of floating. My friend has frequently observed this shell in use by the Frogs as a boat; several remaining upon it at the same time, and moving it by their overhanging legs and arms!

Emydidæ.

Fresh-water Tortoises, which spend their time in and about the margins of lakes and rivers, have (as compared with land tortoises) forms well adapted for the requirements of their existence. The shell is flatter, and the openings for the limbs are wider, to allow of the freer action required for swimming. The feet are more slender and rather flattened. The toes are expanded and connected by a membrane. The claws are long and sharp, to enable them to seize and tear their prey, which consists of aquatic animals. In short, on seeing an *Emys* of the true typical form, you at once recognize a creature formed to paddle about and take his prey in the waters; while he can, with equal facility, crawl about on the banks or sun himself upon any rocky elevation within his reach. One family of Fresh-water Tortoises, the *Trionychidæ*, are remarkable for having their whole body covered with a strong coriaceous skin, instead of the horny plates which usually cover the bony box in

which the body is enclosed. They are remarkably flat and expanded at the sides, so that they can lie in wait unobserved in the mud at the bottom of rivers and lakes, watching for the passing by of any little living dainties to which they may take a fancy; when, suddenly, the long neck is darted forth, and the captive, be it fish, mollusc, frog, lizard, or insect, is seized, drawn down, and devoured, without its captor taking the trouble to move from his hiding-place.

Marine Tortoises, or *Turtles,* constituting the family of *Cheloniadæ,* are still more perfectly formed for swimming. The body is flat; the shell too small to admit the retraction of the head and feet; and the feet are formed into paddles as perfect as those of the Seal. Their food, like that of the Land Tortoise, is almost entirely vegetable.

There are many good specimens, *Emys concentrica,* etc. (Plate XX.), in the fish-house of the Gardens, in company with some juvenile Crocodiles and some other species of *Emys.* The Crocodiles seem to keep apart from and to take no notice of their companions; but the Tortoises crawl very freely over each other's backs. In general their movements are slow enough, but at times, when pursuing their food, they are capable of some degree of animation. Sometimes the *Emydes* will creep gradually and cautiously

up to their victim, stretching their necks till the head is near enough, and then suddenly snapping it with the jaws. Sometimes they will pursue a frog or a fish with great rapidity, and immediately tear it to pieces and devour bit by bit in a very short time. They can be kept easily in ponds or tanks, or any vessels turned for the purpose into Aquaria, by being fed with bits of meat when living animals cannot be easily procured.

The peculiar concentric furrows and markings on the plates of the shell of *Emys concentrica* would, if constant in all ages and conditions, distinguish this from all other species, but in some varieties this character is scarcely visible, nor does it make its appearance in the very young specimens. On first leaving the egg the plates of the young shell exhibit neither furrows nor markings; when half-grown, the concentric furrows appear, and soon become deep and strong; then, as the animal advances in age, the furrows become less and less strongly marked, while the concentric bands of colour become more and more distinct.

The flesh of some American Fresh-water Tortoises is known to constitute an article of food so delicious that it does seem a pity not to make some decisive effort to naturalize them in our own country and introduce them

into our markets. I have met with persons from America who, having tasted it, pronounce it excellent; while, as a nourishing and easily digested food for invalids, it is beyond all praise.

From partial experiments which have already been made for purposes of science by individuals, it does appear probable that the *Emydidæ* might be brought to bear this climate. Specimens sent from Carolina have remained in health during summer and autumn, have hibernated at the bottom of a small pond in the winter, and have been resuscitated by the returning warmth of spring. Nor do I know why a little artificial heat, such as might be obtained in a winter-house, should not be applied with advantage. We see how some kinds of fish multiply and swarm in botanical hot-houses, and why should not these "fresh-water turtles" be induced by similar comforts to consider themselves equally at home and to become equally prolific?

One interesting circumstance connected with these animals is, that they occasionally shed the horny plates which cover their bony shell one at a time, the new plate being formed underneath before the old one is thrown off, when the new plate is found to resemble the old one exactly, ex-

cepting that it looks a little brighter and fresher at first; but in a few days even this difference is no longer observable.

In eating fish, which constitutes a considerable proportion of the food of the carnivorous *Testudinata,* they will almost always reject the air-bag, which, floating on the surface of the water, tells its tale of the murder which has been committed. This circumstance is so well known, that those who seek the Tortoises are guided in their estimate of the comparative number of those inhabiting any particular lake or pond they may visit by the number of these tell-tale air-bags floating on its waters.

Mud Tortoises.

The *Trionychidæ* have no horny plates covering the shell, but are invested with a strong coriaceous skin; there is a free flapping edge of a leathery substance at the sides. They burrow in the mud at the bottom of rivers and lakes; and by means of their very long necks can instantaneously seize their prey without the necessity of moving from their position.

"They aid the separation of their food, which they seize with their jaws, by tearing it with their long sharp claws. Thus they pursue, seize, and tear in pieces living frogs and

other aquatic reptiles, fish, and even young water-birds; and so forcible and violent is their bite, that I have known a stick of half an inch in diameter at once snapped asunder by the jaws of a snapping Turtle, *Chelydra serpentina;* and a specimen of *Trionyx*, lately in possession of Mr. Cross, of the Surrey Zoological Gardens, snapped off the finger of a sailor when on his voyage to this country."

Fresh-water Tortoises generally seize and hold their food with such tenacity that they may often be caught in the same manner as we sometimes see little boys catching crabs, namely by tying a piece of meat or entrail to a string, permitting the Tortoise to seize it, and then suddenly drawing it out of the water.

Turtles.

Although *Marine Testudinata* have not yet been made the subjects of study in an Aquarium, yet, closely connected as they are with the family we have just dismissed, it may be interesting to mention one or two facts connected with them. "The food of the green Turtle consists of marine plants, especially the sea-wrack, *Zostera marina*. They graze at the bottom of the water, coming at intervals to the surface to breathe. As this mode of taking their food

renders them liable to swallow with their aliment a considerable quantity of sea-water, there is a beautiful structure lining the interior of the œsophagus, by which this is effectually avoided. This consists of a great number of horny pyramidal bodies with which the whole interior of the œsophagus is furnished, all of them directed backwards towards the stomach; by which means, although the food and water together can be readily swallowed, yet when the stomach is retracted, the water can be expelled, and the food itself retained. On Ascension Island, on the shores of the Gulf of Florida, and in many other places, innumerable multitudes of Turtles arrive at a period of year differing in different species, but in all during the early part of summer. It is from the *Turtle*, and not from the Tortoise properly so called, that the beautifully transparent plates are taken and formed into combs and other articles; these plates are sometimes eight or ten inches wide.

Alligators.—(Plate XX.)

The existence of several young Alligators in the fresh-water basin included within the limits of the Zoological fish-house, living in harmony with *Emydidæ* and *Trionychidæ*, may seem to give a right to the family of *Crocodilidæ*

to be considered in this work; especially as we are never likely, unless travelling to other climes, to become very familiar with the habits of Crocodiles or Alligators in full growth and enjoying their natural freedom. The best external character by which we may distinguish Alligators from Crocodiles is that the muzzle of the Crocodile, as seen from above, narrows behind the nostrils, whereas that of Alligator becomes broader, widening out towards the back of the head. The writer of this book is not competent to form a very oracular opinion on a class of animals which he has not systematically studied; but he inclines much to the opinion expressed by an author of natural history articles in the 'Penny Cyclopædia,' that the distinctions between the two sets of animals are rather specific than generic. The usual food of Alligators is fish, which they take chiefly by night. Assembling in great numbers, they make for the mouth of some creek or arm of the river, driving the fish before them into it; then diving down under the shoal, each one secures his victim, and coming to the surface with it, throws it up into the air and catches it again. This is done to get rid of the water taken into the mouth with the fish, before they finally swallow it. All food too large to be swallowed at once, is laid by in some place of security

and concealment until it has become sufficiently softened by putrefaction to admit of being torn up by the teeth and claws, when it is brought to shore and devoured. The young specimen in the Zoological fish-house happened to be feeding when we were there, and a piece of fresh beef which was presented to it seemed too large to be swallowed crosswise. The Alligator made some attempts to get it placed lengthwise, but was unsuccessful, so he remained on the surface of the water with the meat across his jaws and a piece hanging down at each side. Some saucy little Water Tortoises in the same tank, seeing this, came round the mouth of their distressed companion, and began snapping and tugging away at the pendent morsels, regardless of his superior size and powerful jaws. Bit by bit the piece was reduced to what the Alligator thought a convenient size, and just as he was about to jerk it round into his throat, one of the audacious *Emydidæ* seized it with a sudden snap and carried it off without the slightest resistance or apparent resentment on the part of the injured Crocodilian.

One remarkable circumstance in reference to Alligators is the immense disparity in size between the newly hatched young and the full-grown individual. According to reliable

information, the young are about six inches in length, and full-grown individuals sometimes measure fourteen or fifteen feet. Now, if we can suppose any proportionate ratio of growth between the animals in captivity and those in their native condition, it will appear that an enormous time must be consumed before the adult size can be attained. Specimens received at the Gardens nine inches long, eight or nine years since, have only yet reached a length of about thirty inches! at which rate it would take forty-five to fifty years to attain maturity!

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