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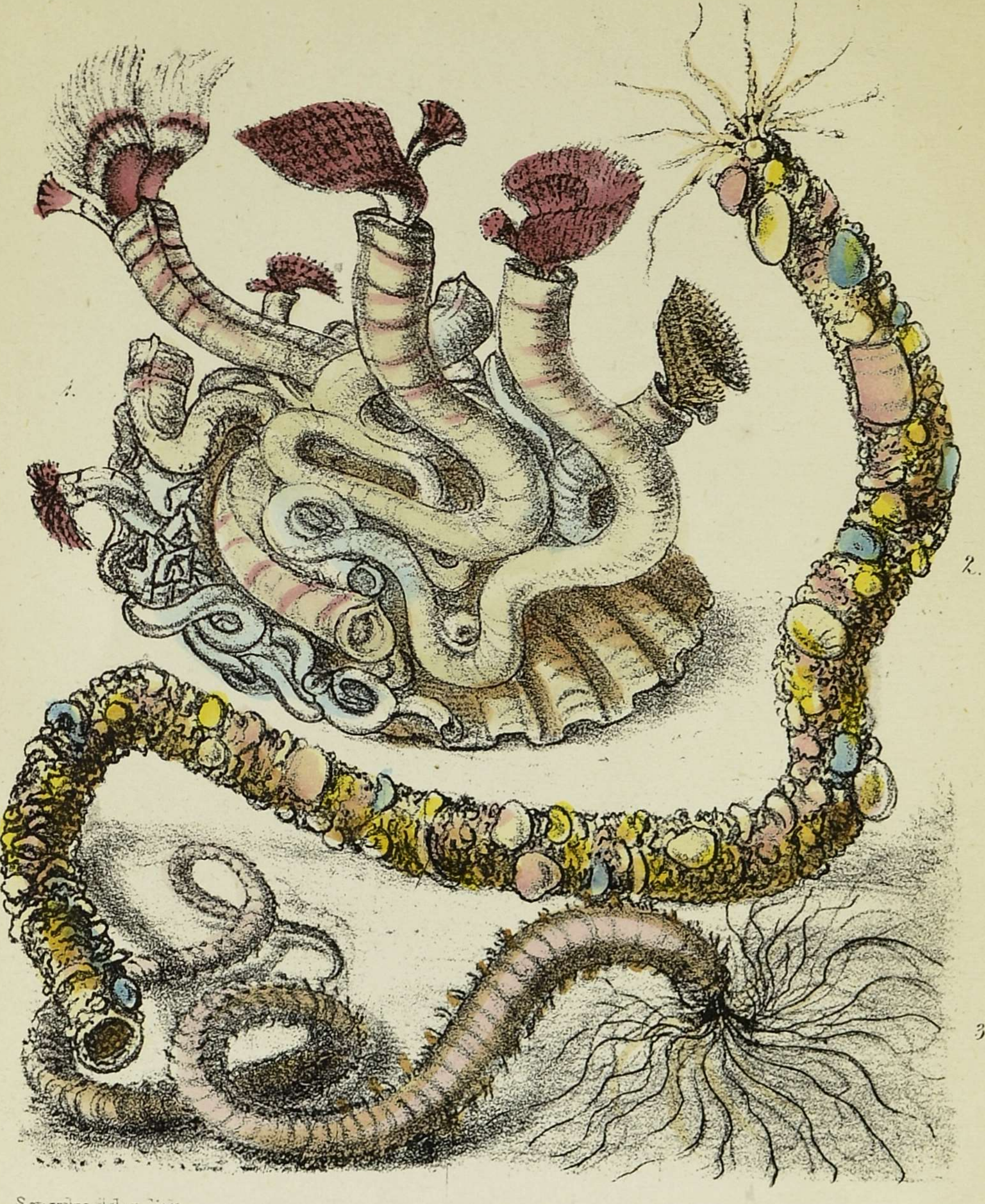
Plate I.



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1. Group of Serpula contortuplicata. 2. Case of Terebellum conchilega, formed of shells, pebbles and sand. 3. Worm withdrawn from case.

POPULAR HISTORY

OF

THE AQUARIUM

OF

MARINE AND FRESH-WATER ANIMALS
AND PLANTS.

BY

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LONDON:
LOVELL REEVE, HENRIETTA STREET, COVENT GARDEN.
1857.

JOHN EDWARD TAYLOR, PRINTER,
LITTLE QUEEN STREET, LINCOLN'S INN FIELDS.

PREFACE.

In the Introductory Chapter of this little Work will be found some general observations on the nature and uses of the Aquarium. These are accompanied by a few practical hints for the guidance of those who wish to possess such receptacles. The greater part of the volume, however, is occupied by descriptive accounts of such animals as have been, or may be, observed in Aquaria to greatest advantage. They are arranged in the order of their respective classes; and while the greatest attention has been given to observations of their functions and habits, their physical structure and the places they occupy in the system of Nature have not been forgotten.

The Writer's personal observations of *Hydroid Zoophytes,* treated of in the Second Chapter, as well as some animal organisms detailed in the Third and occasionally throughout the Work, being very limited, he has not hesitated to introduce passages from the pens of those who have studied in detail the classes to which they belong.

Other parts of the Work contain more original observations and opinions, many of which will be new to the Reader.

As every Work on this subject must however bear, to a greater or less extent, the character of a compilation, the Writer has been less anxious to produce an original book, than to bring together, in an available manner, a large number of facts which will prove interesting to his readers: and whether in his own words, or from the pens of others, he has endeavoured to introduce these facts in an attractive form. Sea Anemones, the flowers of the marine garden, and Madrepores, which may be termed Anemones with coral skeletons, are sure to attract attention for their beauty and curious habits. Then come the Star-fish and Sea Cucumbers, with their strange self-mutilating propensities. The

Crustacean scavengers, Crabs, Lobsters, and Prawns, from the Hermit in his movable cell, to the Common Shrimp burrowing and skipping in the sand, present a strange variety of facts, in their premature changes, their periodical exuviations, and their manner of feeding and living. Mollusca and Fishes have not yet been studied as they will be: but a few notices of them are presented; such as those of the habits of the Nest-building Stickleback, and the Periwinkle with his rasping tongue.

The fresh-water department will afford many pleasing although familiar details, in the metamorphoses, exuviations, and general habits of Frogs, Newts, Water Beetles, and Water Tortoises; with the wonderfully divisible Green Hydra, and the Water Spider with his beautiful air-bell.

The Writer can only hope that enough of pleasant matter will be found to induce his readers to excuse the errors and omissions of which he is but too conscious.

Pembroke Square, Kensington,
May, 1857.

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POPULAR

HISTORY OF THE AQUARIUM.

INTRODUCTION.

"In hollow of the tide-worn reef,
Left at low water glistening in the sun,
Pellucid pools, and rocks in miniature,
With their small fry of fishes, crusted shells,
Rich mosses, tree-like seaweed, sparkling pebbles,
Enchant the eyes, and tempt the eager hand
To violate the fairy paradise."—*Montgomery.*

NATURE OF AN AQUARIUM.—EXPERIMENTS AND ADOPTION OF PLAN.—THE VESSEL.—SHAPE AND MATERIAL.—FITTINGS AND FURNISHING.—ASPECT AND ADMISSION OF LIGHT.—THE WATER.—PLANTS.—ANIMALS.—TRANSPORT OF SPECIMENS.—CARE OF THE AQUARIUM.

In tide-pools of the shore we see the most picturesque miniatures of ocean life. Surrounded by a reef of small rocks, fringed with overhanging seaweeds and branching corallines, these little nooks afford grotto-like dwellings for animated beings. Crabs are here seen half hiding in the dark recesses; shrimps are burrowing in the sand or darting across the little bay; sea-flowers are blooming; sea-worms expanding their feathery fans; and barnacles incrusting rocks. Pebbles throw out their long arms fringed with network in many a cast for food; and small fishes glitter in the brine as they seek to elude the stranger's sight.

Could we but transport this little picture to our dwellings—could we place it in our gardens—could we examine the contents at leisure—could we watch the habits of these living creatures in their native element, but far from their native retreats, what an endless source of amusement would it be! Can we do this? Can we raise the grotto, and carry it home, water, rocks, plants, animals and all? No, but we can realize the idea, by collecting the materials and imitating the arrangement, and this will be a "Marine Aquarium."

Imagine again, a section of a river, pond, or lake, with its weeds and rushes flourishing, water-snails creeping on the leaves, and fishes gliding among the stems; suppose this section enclosed within glass walls, and placed in your parlour or conservatory, and you have a "Fresh-water Vivarium."

But while the imitation of a tide-pool or pond may represent the primary idea of a Water Vivarium, yet the experiments are not all confined to those organizations which keep within shallow waters : even denizens of the deep may be provided with such accommodation as will almost make them feel themselves at home.

Nor is it only for *amusement* that such parlour oceans and lakes are prepared and stocked; they are invaluable as a means of *instruction*. The natures of living beings can never be thoroughly known but by their habits; their habits cannot be well understood unless closely and continuously observed; and if we cannot go down among mollusca, crustacea, and zoophytes to examine them in their native haunts, we can now bring them up to us, to be studied in nearly similar conditions.

The principle upon which Water Vivaria are constructed and maintained consists mainly in balancing animal by vegetable life, thus:—If a few fish were confined in a vessel of water, and the water remained unchanged, they would soon droop and die. The water would not sustain life after the animals had deprived it of its oxygen by passing it through their gills in breathing. If, by means of a fountain-jet, the water can be raised up and returned through the air into the tank, or, in other words, be aerated, a fresh supply of the vital element may thus be introduced and its power of sustaining animal existence proportionally prolonged.

But it is now found that water-plants, properly acted upon by the light and under other suitable conditions, will, instead of taking from, add to, the proportion of oxygen present, and will thus restore the balance, without mechanical aeration. Thus, tanks of water with plants and animals, as collected by the first experimenters years ago, still exist with their tenants, living and breeding healthily; and although the water has never been changed, it is as clear as when first put in, and as capable of sustaining life.

Experiments and Adoption of Plan.

Although many partial experiments may have been made with a view to keeping animals in water for the purposes of observation, and many interesting details in marine and fresh-water zoology have resulted, we may consider that the first serious and systematic attempt to keep a Water Vivarium, in its true sense, was made by Mr. Robert Warrington, of Apothecaries' Hall. That gentleman's early experiments were communicated to the Chemical Society in 1850, in a paper "On the Adjustments of the Relations between the Animal and Vegetable Kingdoms, by which the vital functions of both are permanently maintained." Mr. Warrington stated that he placed two small gold-fish in a glass jar, capable of holding twelve gallons of water. Half-filling the vessel with spring-water, and placing some sand and mud at the bottom, with pebbles and fragments of limestone and sandstone, he planted a small *Vallisneria* in the mud and left the whole undisturbed. After a time the water became thick, and a coating of confervoid vegetation obscured the glass. On introducing, however, a few water-snails, he found that they fed on the confervæ as well as on the decaying matter of the older leaves, and soon restored the water to a clear and healthy condition.

The pruning of the old leaves encouraged the growth of off-shoots; the snails flourished on the vegetable matter which they consumed; and the fishes lived healthily in the renovated water, while they grew fat upon the eggs which the scavengers deposited. I could not help regarding with some veneration the veritable tank in which these early experiments were made, with the same water unchanged, when admitted to a view, through the politeness of its possessor, only a few days since.

In the year 1853, Mr. Warrington communicated in the

'Annals of Natural History' the results of his early essays in the way of *Marine Aquaria*, commenced a year sooner. The difficulties here were greater, but have been all overcome by perseverance; and side by side with the fresh-water tank is now to be seen the first marine tank, with marine plants and animals in full health. And this, as being the first, is more interesting than many others which its proprietor has since constructed. Obtaining salt-water from oyster-boats at Billingsgate, which was taken from the middle of the English Channel, Mr. Warrington placed it in a tank, and then introduced red and brown seaweeds, which, not answering the purpose, were exchanged for green weeds, which answered better. Specimens of *Enteromorpha* and *Ulva* attached to nodules of flint or chalk were procured from Broadstairs, and several anemones, with a few periwinkles, introduced with them into a small tank, and then into a shallow pan. A few more were added, and thus a number of living specimens were kept in a healthy condition to the close of the year. The first tanks were made, for fresh-water subjects, with straight sides; and these tanks were, in the first instance, used for the marine experiments; but when these were sufficiently advanced, Mr. Warrington had a new one made for a permanent Marine Aquarium. In this new tank the back towards the light, and the sides were of slate, and only the front towards the observer was of glass; for it had been found in the first experiments, that too much direct light developed the vegetation too fast, especially that small slimy confervoid growth which obscures the water. The only direct light, therefore, entered from the top. The tank was covered with a light glass shade, to keep out the dust and check evaporation. "With the sea-water obtained in January, 1852," says Mr. Warrington in 1853, "I have been working without cessation up to the present time, agitating and aerating when it became foul during the unsuccessful experiments on the seaweeds, but since then it has been rarely ever disturbed; the loss which takes place from evaporation being made up, as before stated, with rain or distilled water."

Mr. Gosse's experiments in the same line were commenced nearly at the same time, and continued with some success until that gentleman was engaged in conducting the preparations of Vivaria on a large scale for the present magnificent exhibition in the Gardens of the Zoological Society. The popularity of this exhibition, and the interesting researches, published by Mr. Gosse in his 'Devonshire Rambles' and 'Aquarium,' have led numbers of private persons and some public institutions to follow the examples thus set. It has now become one trade to supply tanks and vases for Aquaria; and another, to collect and supply plants and animals for stocking them. In the course of my preparations for this Work I have received valuable assistance from the zeal and experience of Mr. Alford Lloyd, of Portland Road, whose extensive collections have been in the most liberal manner placed at my disposal. That gentleman is in correspondence with collectors placed at various parts of our coasts, and constantly receiving new specimens for the supply of private tanks. Those who apply to Mr. Lloyd's establishment will receive information, which may be fully relied upon, respecting the mode of proceeding in the formation of Marine or Fresh-water Aquaria. The following, however, are a few observations which may serve in some degree to assist those who are desirous of commencing so pleasing an occupation. The first thing to be attended to is

The Vessel.

Shape and Material.—Bearing in mind the idea with which we started, of imitating a tide-pool, and desiring to keep as near to nature as possible, I have no hesitation in recommending for marine-shore objects, the form of tank with a sloping back. The bottom of the vessel should be flat only for about a third of its width, and from that line it should gradually rise towards the back; the front being perpendicular, and of clear glass. The back and sides should be opaque. If in a room near a window, let the back be towards the light, which will then enter only from above, just as it would in a basin of rocks on the shore. Slate is good for the back and sides, and plate-glass for the front. Mr. Warrington is now trying deep rectangular tanks, shaded with green coatings to modify the light, and suited for animals and plants accustomed to deep water. Rectangular tanks are also suitable for fishes, if of any size; and as fresh-water tanks will bear more light than marine, they too may be straight-sided.

Vases and shallow glass pans are also used both for Marine and Fresh Vivaria, and will, for many purposes, answer as well as the more complicated and expensive forms. An Aquarium should be covered either with muslin or a plate of glass.

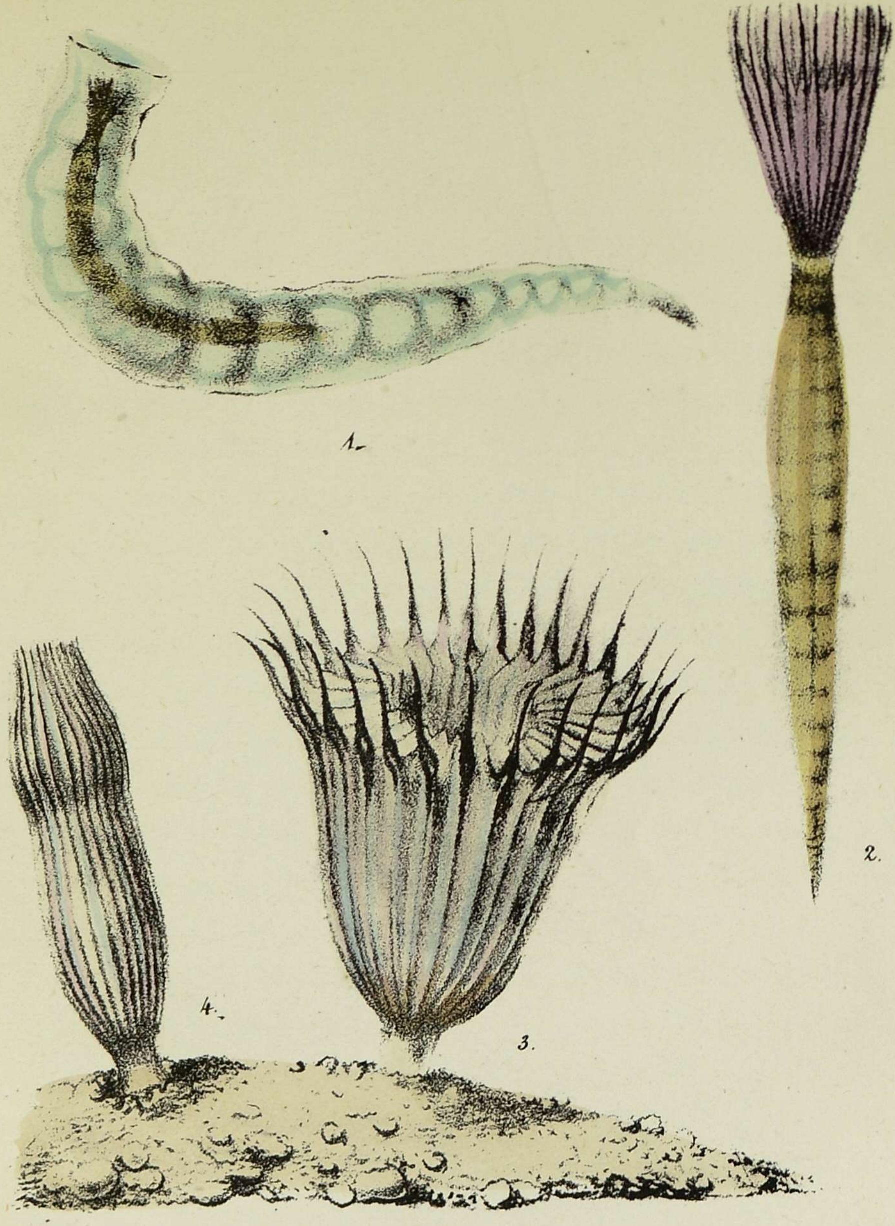
Fittings or Furnishing.—The bottom should be laid in with sand or gravel suited to the condition they are intended to represent. Some marine animals burrow, and should therefore have a bed of suitable material to gratify their propensity. It is best to use sea-sand for sea-water, and river-sand for fresh-water. Then a few clean bright pebbles give a pleasant appearance, and afford shelter for minute animals. In marine tanks only is rockwork admissible. This must be made according to the taste of the proprietor. Pieces of natural rock, or large stones cemented together, and shaped by any cement that hardens under water, may be used; they should be set up with projecting ledges, and forming hollows and arches, so as to give shelter to those animals which seek it, and present a variation in the position of various growths. Too much formality should be avoided; but, as a rule, the tank would best represent a shore-grotto, if the larger rockwork were placed at the sides and in a half-circle at the back. In a fresh-water tank, a few large stones laid down on the pebbles and sand is all that will be desirable. The ornamentation in this case must consist principally in the plants.

Aspect and Admission of Light.—In visiting the Zoological collection the eye is pained in some instances by the foul and stagnant appearance of some of the tanks. A green opacity pervades them, which renders them not only unpleasant to the observer, but unwholesome to the living beings confined in them. This arises from the too rapid development of vegetation; germs of confervoid growth accumulate throughout the water, besides what settles down in green and slimy incrustation on the rockwork and glass. When this happens, it is a sign that the light has been admitted too directly and too freely; for this growth is developed by light, and when that is shut off it soon disappears. Light, therefore, in marine tanks should be admitted sparingly and indirectly, and it has recently been found that it is best to pass it through a coloured medium. Thus, by far the best construction and position for a shore-vivarium will be that already indicated,—a sloping back towards the light, and a top of *bluish-green* glass. To represent the comparative darkness of deep water, Mr. Warrington's deep rectangular tank has the top and sides darkened with a deepish blue. This gives a rather ghastly appearance to the objects, but not more so than might be expected from a visit, if we could pay it, to the same creatures in their homes. Fresh-water Aquaria will admit more light with impunity.

The Water.

The great object is to get the water pure: if marine, it should be taken at a distance from the mouths of rivers; that dipped in mid-channel is preferred by professed Aquarians, although I cannot tell exactly why. I should have supposed that water taken from the shore, whence the greater part of the specimens are procured, would be most likely to contain those materials which were most suitable for their support. Artificial sea-water is now much used, and the formula for its preparation is given by several authors. But I do not advise the uninitiated to experiment in its composition. Aquarium dealers sell the necessary powders, mixed in proper proportions, and will give full directions for its use.

It is evident, however, that the artificial water must be at first totally deficient in one very important element, namely, the animalcules with which water in its natural state abounds, and which are necessary for the sustenance of many marine animals. These must be introduced by the insertion of seaweeds, and time must be given for them to act beneficially on the water. Bright and clear river-water is best for fresh Aquaria.



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Amphitrite Egeana. 1, in its transparent case (reduced.) 2 Worm out of its case
3 Head expanded. 4. Head closed.

Plants.

Marine Plants for an Aquarium should be taken attached to the stones or pieces of rock on which they grow. When once the root is detached the plant is dead. The stone should be as clear as possible from sponges; and many other living incrustations are likely to die, and their decay will prove injurious to the water. *Rhytiphlœa pinastroides, Corallina officinalis, Delesseria alata, Chondrus crispus, Polysiphonia, Phyllophora rubens* (Plate XIII.), *Griffithsia,* and *Callithamnion* are recommended for red seaweeds; species of *Codium, Cycladophora, Bryopsis,* and *Ulva* are suitable for greens. In ordinary tanks, the green weeds are decidedly the most healthy, but the deep sea tank on trial by Mr. Warrington is partly contrived to encourage the growth of reds, which are very pretty objects, to the discouragement of the greens, which flourish in the light. It is found that weeds of any kind may be used more sparingly than was at first supposed. After a time the stones in a tank will be found covered with a brownish confervoid growth, which throws off a considerable amount of oxygen, as may be observed by the little quicksilver-like bubbles about it. When a tank is in this condition, larger weeds may be dispensed with. For fresh-water Vivaria, *Callitriche* or Starwort, *Stratioides* or Water Soldier, *Vallisneria spiralis*, *Anacharis* or New Waterweed (Plate XVIII.), some Water-lilies, and *Eriocaulon* or Pipewort, the Water Ranunculus, *Hydrocharis* or Frog-bit, *Alisma* or Water Plantain, are among the most popular.

Animals.

Fishes.—For private collections at least, the larger kinds of vertebrate animals will not be convenient, but most of the smaller species of *fish*, both marine and fresh-water, will live and breed freely in tanks well supplied with oxygen, and there is no way in which the beauties of their form and markings can so well be seen as through perpendicular, even-moulded glass. Here we see them undistorted by refraction, and can watch their graceful movements without disturbing them. Most of them appear to enjoy their dwellings, if we may judge from their lively, yet not restless bearing. We must remember, however, that they are generally animal feeders, and if put into a vessel with other animals weaker than themselves, they will not live with them quite in the same peaceable manner that cats do with mice in "*the Happy Family.*" Some species are more voracious than others, and more dangerous. Thus, a friend of mine had a tank with a few small fresh-water fish, and among them was a young pike, only two inches long, which attacked, and in fact destroyed, other fishes half as large again as himself.

Reptiles.—Water Tortoises, and Newts, live well in tanks, and are very interesting. They should be supplied with mud at the bottom of their pond; and also, by means of floating boards or pieces of stone rising above the surface, should have the opportunity of leaving the water at their discretion. Frogs do very nicely in Fresh-water Aquaria which are surmounted by a fernery, where they paddle in and out, and dive in the water or hide among the ferns.

Mollusca.—Beginning with the Tunicate order of Mollusca, which are very simple in their composition, we find very pleasing objects presented by several species of *Ascidia*, one of which I have represented (Plate XIII.), probably *A. hyalina.* It is curious to see these apparently lifeless bottles with two necks every now and then shut the openings and jerk out the grosser particles of food, which they have admitted, in the current. Those of the more compound nature are more interesting to the microscopist than to the observer of outward forms. *Conchiferous Mollusca*, or those furnished with bivalve shells, such as the fresh-water Mussels, or marine Oysters and Scallops, lie very quietly in their burrows, or hang attached by their byssal cords, agitating the water that surrounds them, and filtering it as it passes through from the oral to the anal opening of the tubes; thus exercising a cleansing influence on the surrounding fluid. *Gasteropoda*, or Crawling Molluscs, either with or without shells, give variety and animation to a tank; while Periwinkles in salt-water, and Water-snails in fresh, are useful as scavengers, eating away the vegetable crust which obscures the glass; other Molluscs, such as *Purpura*, *Buccinum*, and *Nudibranchs* (Plate XIV.), feed on animals, and must not be put in the way of any choice living morsels which you may wish to preserve. Cephalopodous Mollusca, or the Cuttle-fish tribe, are too *oceanic* to live long in confinement.

Polyzoa and *Rotifera* are of microscopic interest.

Insecta.—The Water Beetle (Plate XIX.) and Water Spider (Plate XVIII.) are very interesting in their habits, as described hereafter, and seem to live as well in the tank or jar as they would in their natural localities at freedom.

Crustacea are among the most amusing objects in a marine collection. Many of them are useful in picking up scraps of decaying animal-matter from between the stones.

The Hermit Crab (Plate XI.), in his shell surmounted by the parasitic Anemone; the Lobster, moving out of his hole, with a forest of green weeds growing upon his shell; the Prawn (Plate XII.), with his splendid livery and delicately-contrived organs, are all fine objects; while their changes and habits, wonderful as they are, can all be observed freely by means of the Aquarium. Even the common Shore Crab, in its earlier stages of growth, is a good acquisition, if care be taken not to give it too much opportunity for displaying its pugnacious qualities.

Cirrhipedes as yet have only been represented in marine tanks by the common little Acorn Balanus (Plate XI.), which is common enough, living on the outsides of living and dead shells incrusting pebbles and rocks. It is very interesting to observe the way in which they open their opercular valves to throw out their network of cirrhi to envelope the animalcules which come within reach.

Annelida (Plates I., II., IV.) with shelly or pebble-formed tubes and branching ferns of gills, give great variety and beauty to the miniature ocean.

Echinodermata, Starfishes (Plate XVII.), Sea Urchins or *Echini,* and Sea Cucumbers (Plate X.), are very pretty objects, but not generally long-lived in Aquaria.

Acephala.—Jelly-fish will not live well in confinement when full-grown; although some of them, in their early *hydroid* stages, are interesting, and even when mature can be kept living for a few days. They are too oceanic for permanent tenants.

Zoophyta.—The *hydroid* forms, consisting of branched polypidoms, with numerous polypes, are many of them pretty objects, but their chief interest is microscopic: not so the *Actinoid* forms,—the Anemones, or Sea-flowers (Plates VI., VII., VIII., IX.), and the no less flower-like Madrepore (Plate III.); their beauties are palpable, and they present the chief ornaments of our water-garden. Most of them will live in water so turbid as to destroy other animals; and they reproduce in numbers, and transplant themselves at will without interference from the gardener's hand. They will live upon Infusoria without being fed, occasionally seizing a prawn or small fish that may happen to come in their way; but it is well to feed them occasionally with pieces of dried meat, dropped down within reach of their tentacles: they will be likely to flourish all the better for being fed, and it is a very amusing process to feed them.

Porifera.—Sponges, when dragged from their native position, are pretty sure to die speedily; and as their decay is injurious to the water, it is best to clean off all spongy matter from marine stones on inserting them. *Alcyonium digitatum* (Plate V.) is very pretty, but soon dies.

Transport of Specimens.

Most small animals suited for the Aquarium may be, and constantly are, brought to London from any part of the seacoast, in jars of sea-water, with bladders tied over them; or packed up in bundles of wet seaweeds gathered from the beach. Dealers obtain them in this way. I have been at Lloyd's when many Anemones and other things have been brought in, unpacked, and immediately placed in their proper receptacles, where they have soon made themselves at home, apparently not having suffered from the journey. I think, as a rule, that persons living near London had better let the dealers get their specimens for them: it is a cheaper and safer plan.

Care of the Aquarium.

When the Water-Vivarium is first established, there will naturally occur during the few first days some deaths among animals so recently introduced. It is very important to watch for these occurrences, and to remove the bodies before putrescence takes place; but if many of them have escaped detection by falling into hollows, or by their minuteness, they will putrefy the whole body of water, to the great danger of the remaining animals. This will be seen by a milky appearance pervading the whole. In such a dilemma, the only way of proceeding will be to draw off and filter all the water, removing the animals, for the time, in temporary vessels. The drawing-off can be effected by means of a siphon, so as not to disturb the sediment. Then, taking out the pebbles and sand, rinse them and wipe out the tank; return the water through a filter, which may be made with a piece of sponge placed at the top of the tube of a funnel. The sponge must not be pressed so closely in as to prevent the water running in a gentle stream. In passing through the air in a very thin column, every drop is brought into contact with it; and this will tend to destroy putrefaction, by chemical combination of the animal matter with the oxygen of the air. After this the probability is that the water will remain clear, and care must still be taken to remove bodies of animals that occasionally die. An occasional partial filtration is a good habit, and a floating piece or two of charcoal may give still further security.

If a green turbidity arises in the water, it is the result of a too rapid growth of green vegetation, induced by the action of light. This may be corrected by depriving the vessel of light for a few days. I have seen a tank at Lloyd's restored to perfect clearness by being covered over for a short time with dark cloths.

For the purpose of occasional aeration a drip-glass is recommended. A bell-glass perforated, with a piece of sponge lightly put into the hole, is suspended over the tank, and water taken from it is put in and allowed gradually to drip through. A Fountain-Aquarium, with apparatus for drawing the water up into the reservoir, would be a very good contrivance. This would save all the trouble of baling the water out of the tank, at the risk of disturbing the living organizations within it. A small pump, drawing the water through fine holes from near the bottom, would effect the purpose. The unsightliness of the apparatus could be disguised by rockwork, and the fountain, assuming the form of a cascade, might be so placed as to present an elegant object.

In conclusion, it is hardly necessary to recommend this new and popular method of studying Nature, as a prolific source of amusement and instruction. But although I have not in these pages followed the fashion of making Natural

History an occasion for diving deeply into abtruse doctrinal subjects, I may point out the legitimate effect of such studies in the words of Coleridge's 'Ancient Mariner.'

"Oh, happy living things! no tongue
Their beauty could declare;
A spring of love gushed from my heart,
And I bless'd them unaware.

"Farewell, farewell; but this I tell
To thee, thou wedding guest,
He prayeth well that loveth well
Both man, and bird, and beast.

"He prayeth well that loveth well
All things, both great and small;
For the dear God that loveth us
Made them, and loveth all."

CHAPTER II.

SPONGES AND HYDROID ZOOPHYTES.

"New buds and bulbs the living fabric shoots
On lengthening branches, and protruding roots,
Or on the father's side from bursting glands,
Th' adhering young its nascent form expands;
In branching lines the parent-trunk adorns,
And parts, ere long, like plumage, hairs, or horns."—*Darwin.*

NATURE AND HABITS OF SPONGES.—PROPAGATION.—APPEARANCE WHEN LIVING.—GRANTIA BOTRYOIDES.—GRANTIA CILIATA.—EUPLECTELLA ASPERGILLUM.—ZOOPHYTES DEFINED.—CLASSIFICATION.—HYDROID ZOOPHYTES.—HYDRACTINEA ECHINATA.—CORYNE PUSILLA.—CORYNE SESSILIS.—EUDENDRIUM RAMEUM.—TUBULARIA INDIVISA.—SERTULARIA POLYGONALIS.—SERTULARIA ARGENTEA.—ANTENNULARIA ANTENNINA.—PLUMULARIA PINNATA.—LAOMEDEA DICHOTOMA.—LAOMEDEA GENICULATA.—LAOMEDEA GELATINOSA.—CAMPANULARIA VOLUBILIS.—EUCRETIA CHELATA.—ANGUINA SPATULATA.—CELLULARIA CILIATA.

THE term *Zoophytes,* or *Animal Plants,* usually applied to Corals, Sea Anemones, etc., might be applied with greater propriety to a Sponge than to any other being. With its skeleton, as used for domestic purposes, we are all familiar; and when informed that every fibre of this porous texture is covered with a filmy, gelatinous, and apparently little-organized coating when the Sponge is living, we know nearly all that is to be known of its external character.

Growing fixed to various substances, but most frequently to the roots of seaweeds, the plant-like body seems to vegetate and to hold its place between the animal and vegetable kingdoms. It belongs more properly to the former, but very low down in the scale. There are many species and genera, Dr. Johnston enumerating between fifty or sixty species inhabiting the British coasts. The structure and mineral composition of the skeleton differs as much as the forms, which are well known to be very sportive and variable. Globes, semiglobes, cones, cups, funnels, branches, and flat spreading masses, with different degrees of porousness and flexibility, characterize the various genera and species. The spongy body consists of a horny, or even stony, network, with innumerable interlacing fibres, so woven together as to leave many small openings and a few larger ones. These openings, running into each other, form passages for the free circulation of fluids throughout the body. The jelly-like film which covers all the fibres when the creature is living, is the seat of all the animal life which the Sponge can boast. It secretes and deposits the substance of the skeleton, and keeps up some kind of action exerted in every part of the body, which, although scarcely perceptible, serves to produce a continuous succession of currents in the surrounding fluids. The living Sponge can be seen, if placed in a glass and examined by a microscope, to imbibe and expel currents of water, which appear to pass into the smaller meshes of network, carrying nourishment into all the recesses of the body, and then to be ejected by the larger holes appearing on the surface; and this is all the creature shows of animated existence, for the filmy flesh does not contract when touched, or show any other sign of sensibility.

The propagation of Sponges is curious; for at the proper season many minute buds may be found adhering to the sides of the passages or openings. These buds are the embryos of the Sponge, gradually increasing in size they become clothed with movable cilia, and when fully developed fall off, and, becoming detached, enjoy a locomotive freedom unknown to their parent. Their motion is effected by means of the cilia, which continue vibrating and produce a current round the little body, which impels it forwards. It is not long a wanderer in the "world of waters;" and whether it chooses, or drops accidentally into, a suitable position for its future growth, when once fixed it becomes a permanent tenant of the spot.

No doubt can be entertained that the Aquarium, assisted by the microscope, is destined to be the means of greatly increasing our hitherto limited knowledge of these half-animated beings. Mr. Bowerbank's researches in the natural history of the family have already been rewarded by the discovery of many new forms, and by the elucidation of parts of their economy. The large, spreading, fleshy *Pachymatisma Johnstonii*, with its thick skin studded with pores few and far between, has been examined, and the curious spicula (or stars and needles) of flint submitted to the microscope. Mr. Bowerbank has also pointed out that the currents observed as entering the small pores and leaving the large ones are produced by the motion of long fine cilia on the inner surface of the cells, which are constantly vibrating in the required direction, so that the means used for locomotion during the extreme youth of the Sponge are the same as those used for maintaining the principal functions of vitality in the middle life and sedentary old-age of the same creature. It appears too that as the horny skeleton of the Sponge is the support of the very loose, gelatinous animal substance which covers it, so, in its turn, it is supported by a branched and interlaced crystalline network of flinty stars and needles, which make the framing of the channels and passages composing its mass.

The living masses present various colours to the eye. Some, such as *Cliona*, which lines the inside of some shells, are of a bright yellow colour; others, such as *Halichondria sanguinea*, are of a brilliant crimson hue.

Grantia botryoides,

An extremely minute Sponge, consisting of branching tubes, has been carefully examined under a lens by Mr. Gosse, who thus describes what he saw:—"I immediately transferred it to a glass cell, and applied it to the stage of a compound microscope, with a power of 220 diameters. To my astonishment, a mass of starry crystals met my view, entangled among each other almost as thick as they could lie, by scores, nay by hundreds. For a moment the eye was bewildered by the multitude of slender needle-like points crossing and recrossing in every possible direction; but soon the curious spectacle began to take some kind of order, the crystals were seen to be all of one form, though varying considerably in length and thickness; they are three-rayed stars, diverging at an angle of 120 degrees; the rays, straight slender needles, perfectly cylindrical, except that they taper to a fine point, smooth and transparent as if made of glass, and highly refractive.

"These spicula appear to me to be held together only by their mutual entanglement and interlacing; their points, in the process of formation, have shot through and among each other, so that it would be almost impossible to extract one from any point without either breaking off its rays or tearing away a considerable portion of its whole surface. The rays shoot in the same plane, and in that plane the stars lie, not quite at random as to their direction, for the great majority have one point directed lengthwise from the mouth of the tube towards the base. There are not wanting however many which point in the opposite direction, and several at intermediate angles. Of course it requires but little divergence from the first-named direction to produce the second; still however the prevalent order appears to be this.

"I cannot trace any fibrous or gelatinous matter in which the spicula are set; but beneath the layer formed by their interlacing points there is a surface composed of round granules of transparent or pellucid matter, set as close as possible, which are plainly seen between the cross-

Sowerby del. et lith.

Vincent Brooks Imp.

Corals 1. Skeleton of Fungia or Mushroom Coral. 2. Caryophyllæa. Smithii, animal expanded. 3. Animal closed. 4. Compound specimen. 5 Dissected skeleton 6. Tentacles 7. Oculina prolifera.

ing needles. This appears to be the interior lining of the tube,—in fact, the tube itself, around which the spicula are arranged as a loose outer coating, giving firmness to the whole. I could not detect spicula of any other form than the three-rayed stars; but several of these had one or more of their rays broken short; for from their composition they are very brittle, as I have often proved in other species. The form of this specimen was so irregular that but a poor idea can be conveyed of it by words; it may, however, be roughly described as an elliptical mass, sending forth from one side several tubes, which divide or branch into others."

Grantia ciliata

Is a very minute Sponge, shaped like a bottle; the neck consisting of a dense fringe of spicula set round the opening so as to form a crown. A stream of water, passing always in the same direction through the aperture, gives the form to these neck-spicula, and it has even been found that if these latter are displaced by accident, so as to bruise and distort the crown, the current will restore them to their natural direction after the specimen has remained for a few days in a vessel of sea-water.

Of all the varied forms of Sponge, or rather Sponge-skeletons, with which we are acquainted, no one approaches in elegance of appearance, and delicate regularity of texture, the unique specimen dragged up, on a hook, among weeds by Mr. Cuming in the Philippine Islands. Professor Owen has given it the name of

"EUPLECTELLA ASPERGILLUM,"

Deriving the first name from words signifying "*well plaited*," and the second, from a wonderful resemblance to a well-known shell, commonly called the "Water-pot." The shell, named *Aspergillum*, is a tube tapering at one end, and having at the other end a disc with holes, like the rose of a garden water-pot, and surrounded by a fringe of small tubes. It is formed by an acephalous mollusc, which, in its early stage, possesses the nuclei of a bivalve shell, the edges of which increase in every direction so as to form the tube spoken of, and in which these nuclei are only seen afterwards, as forming a portion, looking as if they were glued into its side. The *Euplectella*, which measures eight inches in length, bears so near a resemblance in form to the shell, that Mr. Cuming imagined, on first taking it, that he had found a wonderful new species of *Aspergillum*. Of course, as the nuclei of valves could not be found, and as the whole texture of the tube was an open network of sponge, instead of a tubular lamina of shell, the illusion was soon dissipated. The tube is gently curved, like a horn, but not coming to a point, and at the base it is two inches wide. Here it is covered by a disc of very open network, outwardly convex, and surrounded by a thin projecting frill or plate of plaited fibres. In the wall of the tube there are supporting fibres placed lengthwise, and forming the upright framing upon which the cross fibres are woven. There are three sets of cross-fibres in different directions; two spiral, opposing and crossing each other diagonally, and the third, horizontal. These cross each other in such a manner as to form circular holes, between the upright supports, at regular intervals. Between the diagonal rows of holes, the paries is further strengthened and beautified by diagonal frills resembling that which bounds the terminal disc; at the smaller end the longitudinal supports separate into the minute fibres of which they are composed, and meeting round the orifice blend into a wool-like fluff. A figure of this beautiful object is published, with Professor Owen's description, in the 'Transactions of the Zoological Society.'

The engraving occupied three months of the artist's time. No other specimens have yet been found, but there must be others, and the time may yet arrive when we may see *Euplectellæ* living and flourishing in our zoological tanks!

Hydroid Zoophytes.

The word "Zoophyte," as most of our readers are aware, has been used in a very extended and general sense, to signify those numerous and varied beings which were supposed to occupy a middle position between the animal and vegetable kingdoms. It was applied to many things which were pretty well known in their external characters, but whose real natures were little understood. It was the name of a great miscellaneous group of things which were thrown together, not because they were found to possess qualities in common, but because it was doubtful whether they were animals or vegetables. It is now used in a much more limited sense; so limited indeed that it will scarcely apply to the objects for which it is alone retained by British Naturalists, excepting in the appearance of some. Many of the original group, as well as of the present, bear so great a resemblance to shrubs, mosses, and seaweeds, while showing some signs of animal life, that it is not surprising that a name should be used significant of both ideas; but at present, those only are retained in the assemblage whose natures have been ascertained to be strictly animal, and not to partake in any degree of a vegetable character. All the true Zoophytes are polypiferous in their structure, and are thus defined by Johnston, who is the great authority on the subject.

"Zoophytes are all aquatic, avertebrate, inarticulate, soft, irritable, and contractile, without a vascular or separate respiratory or nervous system. The alimentary canal is very variable, but the aperture to it is always superior, circular, edentulous, and surrounded by tubular, or more commonly by filiform tentacula. Many are asexual, and it is doubtful whether any species has distinct sexes. The individuals, polypes, of a few families are separate and perfect in themselves; but the great majority of Zoophytes are compound animals, viz. each Zoophyte consists of an indefinite number of individuals, or polypes, organically connected, and placed in calcareous, horny, or membranous cases or cells, forming, by their aggregation, corals, or plant-like polypidoms."

The most simple form of polype is that presented by the *Hydra, Clava,* and others, in which the body of the animal is a simple sac, open at one end, and having the opening surrounded by contractile threads or filaments, called tentacles; while the other end has a sort of sucking disc, by which it adheres to other substances. The cavity of the sac is the stomach; the orifice of the sac represents a mouth; the tentacles surrounding it act as arms; and the sucker at the opposite end may be called a foot, since it secures adhesion when at rest, and acts as an organ of locomotion when the animal requires it. Many of the Zoophytes, including the *Actiniæ,* a few Corals, and the *Hydra* before mentioned, live singly, and throwing out their young through their mouths leave them each to find an independent mode of existence; but some bud out at the sides and form branches, in such a manner that each Zoophyte is a branched shrub, with a common stem, composed of a large aggregate number of individual polypes.

Mr. Gosse divides the Polypiferous Zoophytes into two Orders, thus:—

Internal cavity simple, increasing by germs growing out from the sides,—"*Hydroida.*"

Internal cavity enclosing the stomach, and divided into compartments by radiated partitions, which have reproductive functions; germs ejected through the orifice of the cavity,—"*Actinoidea.*"

It is with the "*Hydroida*" that we shall have to do principally in this Chapter; and instead of going more deeply into their general description, I shall give the history of a few of the most interesting species, which have been the objects of special observation.

It will be necessary however to premise that, in common with the Actinoid Order, the tentacles of the *Hydroida* are furnished with a kind of stinging weapon, in the form of very minute poisoned darts, which can be projected from capsules embedded in the tissues. By means of these the *Hydroida* can not only make their tentacles adhere to the victims, but also benumb and paralyze the latter so as to diminish their chances of escape.

Hydractinea echinata.

A little creature, about one-third of an inch in length, with a club-shaped head and a ring of tentacula, living on old shells in deep water. Each *Hydractinea* is independent; but they live in numbers on the same shell. They are said to be partial to the same shells, such as *Buccinum undatum,* *Fusus corneus*, *Natica glaucina*, and *Nassa reticulata*, which are also inhabited by Hermit Crabs. It is also said that, unitedly growing on the rim of the aperture of the shell, they form an extended or overhanging ledge, which enlarges the cavity in which the hermit dwells, and if so, prolongs the period before he will be obliged to seek a fresh and more commodious home.

Coryne pusilla.

This is a minute branching Zoophyte, with a bright red star-like polype at the top of each branch. It is found on stones and seaweeds between high and low water, but the branches are so thin and the star-heads so small that it would only be seen under favourable circumstances. It creeps along the surfaces of the stone or seaweed to which it adheres. Its motions are slow; but it can at will bend any one of its horny, wrinkled, transparent branches, or coil any one of the tentacula which surround the polypes at their heads.

Coryne sessilis

Resembles an upright club, with circles of ball-shaped heads, on slender stems, projecting from it at intervals: these are the polypes, each about the sixteenth of an inch in length, fixed to the central stem, which is fixed by creeping fibres to the surface to which it is attached. They are transparent, narrow, and terminate in a ball, on which the tentacula are very numerous, as many as forty-five having been counted on a single head. The neck to each head is glassy and wrinkled; they stand out from the stem in six circles, at nearly equal intervals; and the whole Zoophyte, as figured in the 'Marine Zoology,' would form an elegant design for a circular hat-rail.

Eudendrium rameum.

Of the genus to which this tree-like Zoophyte belongs, Mr. Johnston gives the following technical description:—

"Polypidom rooted by creeping fibres, erect and variously branched, the fibres cylindrical, tubular, filled with a soft pulp. Polypes hanging from the extremity of every branchlet, non-retractile, roundish, somewhat pedicled, naked and fleshy; the body encircled with a zone of filiform tentacula; the mouth central and sub-tubular.

"Eudendrium" is from two Greek words signifying the adjective *well* and the noun *tree*.

E. rameum is found on shells and stones in deep water, at Shetland, Scarborough, Northumberland, Whitehaven, Dublin Bay, Cornwall, Aberdeenshire, and near Liverpool. It is so exactly like a leafless tree in appearance, that, until closely examined and the polypes seen, it would be taken for a plant by any one not thoroughly acquainted with the nature of Zoophytes. It grows from three to six inches high, and is thus spoken of by the late Sir J. G. Dalyell:—

"This is a splendid animal production, one of the most singular, beautiful, and interesting among the boundless works of Nature. Sometimes it resembles an aged tree, blighted amidst the war of elements, or withered by the deep corrosions of time. Sometimes it resembles a vigorous flowering shrub in miniature, rising with a dark brown stem, and diverging into numerous boughs, branches, and twigs, terminating in so many hydræ, wherein red and yellow intermixed afford a fine contrast to the whole.

"The glowing colours of the one, and the venerable aspect of the other, their intricate parts often laden with prolific fruit, and their numberless tenants, all highly picturesque, are equally calculated to attract our admiration to the Creative Power displayed throughout the universe; and to sanction the character of this product as one of uncommon interest and beauty.

"A very fine specimen of the *Tubularia ramea* (*Euden* *drium rameum*) was recovered from among the rocks of a cavity in the bottom of the Frith of Forth, at about one hundred and fifty feet from the surface. It had vegetated in such a direction that it was detached quite entire. Being transferred to a capacious vessel of sea-water, I found it rising seven and a half inches in height, by a stem about nine lines in diameter near the root, then subdividing into several massy boughs, besides many lesser branches. Numberless twigs, terminated by thousands of minute hydræ of the palest carnation, clothed the extremities, which were ten inches apart. The root diffused itself irregularly, by a multitude of mossy-like fibres, which might be circumscribed by a circle two inches in diameter. It is to be observed, that the stem and higher rigid portions consisted of irregular bundles of tubes; but about two inches of the highest were in verticillate arrangement. Though composed of bundles of tubes below, the absolute extremities, bearing the hydræ, resolve into single tubes, each with its animal.

"Many parasites invested this splendid specimen. Masses of the pure white and deep orange *Alcyonium digitatum* hung from the boughs; *Sertulariæ*, *Sponges*, and *Algæ* were profusely interspersed, all proving, by their obvious successive generations, the great antiquity of the *Eudendrium*.

"Other specimens have occurred, of a similar aspect and conformation, chiefly from four to six inches high, but none above nine. One beautiful and luxuriant specimen, four inches high and diverging four inches, might have been circumscribed by an ellipse two inches and a quarter across. By gross computation, 1200 hydræ, deeper coloured than peach-blossom, decorated this latter specimen. The head, or hydra, of this Zoophyte is deciduous."

> "Full many a gem, of purest ray serene,
> The dark unfathom'd depths of ocean bear!
> Full many a flower is born to blush unseen,
> And waste its sweetness on the desert air!"

Tubularia indivisa.

In this Zoophyte, the polypes are fixed at the end of tubes which do not branch, but each one, or nearly each one, of which proceeds directly from the creeping fibre by which it is attached.

The genus *Tubularia* is thus defined by Johnston:—"Polypidom horny, fixed by a creeping fibre, erect, fistular, and unbranched; the tube filled with a semifluid medulla. Polypes placed at the extremities of the tubes, non-retractile, fleshy, furnished with two circles of filiform, smooth tentacula; one row surrounds the middle of the heads, and the other is placed round the mouth. Bulbules clustered, shortly pedicled, placed within and at the base of the lower tentacula; embryo not always the same, being sometimes in the form of a *Beroë*, sometimes of a hydra."

This *Tubularia indivisa* is the largest of its tribe in Great Britain. The tubes, on which the hydra-heads are placed, grow some five or six inches long on shells and stones in deep water. They look like scarlet flowers on the ends of long twisting worms. They congregate in clusters of thirty or forty specimens, and make a splendid nosegay of living and moving flowers. The tubes are horny and transparent, showing the reddish liquor through them, and the polypes at the end have two rows of tentacles."

We must again hear the eloquence of Sir J. Dalyell:—

"The yellow, fistulous stem, full of mucilaginous pith, is rooted on a solid substance below, and crowned by a living head, resembling a fine scarlet blossom, with a double row of tentacula, and often with pendent clusters of grapes, embellished by various hues, wherein red and yellow predominate. Fifty, or even a hundred and fifty, are at times crowded together; their heads, of diverse figures, shades, and dimensions, constitute a brilliant, animated group, too rich in nature to be effectively portrayed by art."

The *Tubulariæ* may be kept for observation in sea-water, and a very wonderful and beautiful provision be watched. In a few days, dispirited by captivity, the flower-heads will generally drop off, and the observer naturally expects the straw-like pipes, on which they were placed, to wither and droop. It is not so, however; but the wound, caused by disseverment, heals at first, and afterwards a new head, formed no doubt principally of the pith which fills the tube, rises to the top, assumes the globular form and bright colour, puts forth its first and second row of tentacles, opens its mouth, and is ready for anything that Providence may place within its reach. In this way several successive heads may fall, and a fresh one will supply its place.

If, then, we see with admiration the flowers of the field and garden, which, beautiful as they are, still give no signs of sensation or voluntary movement, how much more shall we be delighted with these no less beautiful objects, endowed as they are with sentient vitality, and adding the grace of motion to those luxuriant charms which meet the eye! And, if we add to this the exhibition which they afford of the restorative power of Nature, we must be destitute of feeling, if our praise of creative wisdom fall short of enthusiasm.

Sertularia polyzonias,

Or *Great Toothed Coralline.* The following is Dr. Johnston's definition of the genus *Sertularia*: "Polypidom (or Coral-house) growing in the shape of a plant and fixed by its base, variously branched; the divisions or branches formed of a single tube, denticulated or serrated with the cells, and jointed at regular intervals: cells alternate or paired, biserial, sessile, urceolate, short, with everted apertures; ovarian vesicles scattered. Polypes hydraform."

The general appearance of this Zoophyte, is that of finely serrated, and variously branched, minute sticks or straws; and it is only on minute examination that we find that one being pervades the whole; that the notches are cells; and that each cell is filled by an arm or branch of the animal ending in a polype, furnished with a bunch of tentacula. In this species the cells are short, smooth, and truncated; while here and there appears an ovarian vesicle of a rounded form, and spirally grooved, much larger than the ordinary cells. In *Sertularia rugosa*, on the contrary, the cells and vesicles are similar in shape and only differ in size. The cells of some *Sertulariæ* are in pairs, some alternate, some at irregular intervals.

SERTULARIA ARGENTEA

Is a fine, feathered, bushy polype, sometimes called the Squirrel's-tail Coralline, which is found growing on the rock-oysters at Sheppey and Sheerness. The ramifications are in tufts, arranged spirally round the stem; an arrangement which gives a peculiarly graceful air to the whole polypidom, which sometimes reaches several feet in length. But when its upper branches reach this length, much of the vitality of the under branches is impaired through age, and these earlier parts die and become worn; in this state they fall away and leave the lower part of the stem bare.

The following experiment on the dead and dry polypidom of a *Sertularia* will be found interesting, showing a degree of elasticity in the horny substance of which it is composed :—

"About two years ago I detached two specimens of *Sertularia* from an oyster-shell: they were about 1¾ inch high, the side branches being from ½ to ¾ of an inch in length.

Plate IV.

1.

2.

Sowerby del. et lith. | Vincent Brooks Imp.

1. Edwardsia vestita, clothed with its leathery coat. 2. Edwardsia withdrawn.

Having broken off with the *Sertularia* a piece of the shell to form a base for it to stand upon, I placed it within the doors of a bookcase to keep it from the dust; about two or three months afterwards I took it to a tub of rain-water for the purpose of washing off the saline incrustations, and, after rinsing it several times, I observed the branches begin to assume a more rigid appearance, and the stem, which had been previously lax and drooping, became perfectly upright and rigid. If any part was drawn aside, it immediately regained its position, and in this state it remained nearly a day before it began to droop again. I repeated the experiment a few weeks back, with the same results."—*J. Bladon*, 'Zoologist,' i. p. 34.

Antennularia antennina.

This is a pretty Coralline, the branches of which are finely serrated and ciliated, and have a beautiful feathery appearance.

The genus is thus described by Johnston:—"Polypidom plant-like, horny, simple, or branched irregularly; the shoots fistular-jointed, clothed with hair-like, verticillate branchlets; cells small, sessile, campanulate, unilateral; vesicles scattered, unilateral. Polypes hydraform." *A. an-*

tennina "grows in clusters in the sand, or on stones lying in the sand, rooted together by numerous fibres matted with a mixture of broken shells and sand, pretty generally distributed. We have not found it on the Ayrshire coast, if it is distinct from *A. ramosa.* It has however been got by the Rev. Mr. Urquhart, at Portpatrick; and we have remarkably fine specimens from Dr. Beverley Morris, from the coast of Yorkshire; from Dr. Scouler, from Dublin Bay; and from Major Martin, from Lough Swilly. These last were very handsome, but the stems smaller and more compact than usual, and the branchlets shorter."—*Landsborough.*

It often grows to the height of a foot, and it appears jointed in rings like the long antennæ of the Lobster. "Each articulation is surrounded by short capillary branches, which when magnified have the appearance of sickles, and bend towards the main stem. Along the inside of these are placed minute sockets, which support small open denticles (cells) of a cup-shape, which are of so tender a nature that they are scarcely visible but in recent specimens. Between the minute hair-like branches we have observed, on some specimens, small egg-shaped vesicles, fixed on footstalks, with their openings, or mouths, on the side of the top of each, looking towards the middle stem."—*Ellis.*

PLUMULARIA PINNATA,

Belonging to another genus of feathery Corallines, which is thus described by Johnston:—"Polypidom plant-like, rooted, simple or branched, the shoots and offsets plumous; cells small, sessile, unilateral, usually seated in the axillæ of a horny spine; vesicles scattered, unilateral. Polypes hydraform."

Mr. Gosse has made this beautiful Zoophyte the subject of some interesting observations, which will be best detailed in his own words, nearly entire. "A tuft of weed, that I had pulled off from the side of one of the rock-pools, and brought home screwed in a bit of paper, was almost covered with the elegant plumes of *Plumularia pinnata*. I put it into sea-water as soon as I arrived at home, after it had been out of the water about eight hours, carried within my hat. When I came to examine it, many of the polypes appeared alive, though contracted. Many of the lower stalks were nearly denuded of branches, except at their tips; but were densely crowded for the most of their length with ovigerous vesicles. These are placed in a single series, on the upper side of the arching stems, as thickly as they can stand, about twenty-five on each. By a single series I mean that they are all seated on one side of the stem, and all point the same way, with an occasional exception, for they are two, three, or four abreast. Their substance is hyaline, but the contents are opaque and flesh-coloured. Their shape is sub-oval, larger at the tip; but the sides are fluted, so as to form about six rounded angles, and as many furrows. Near the tip, several divergent tubercles or blunt spines are given off. The tuft alluded to I put in a glass vessel made of the chimney of an ordinary lamp, with the bottom closed by a plate of glass: this was about half-full of sea-water. In three or four days, examining cursorily with a lens, I was surprised to see the bottom crowded with young polypes growing erect from every part; they were there by hundreds. I detached a few for more particular examination. Each consisted of an irregular, dilated, glossy plate, adhering to the bottom; from some point of which sprang up, erect, a slender tube, with one or two joints, and terminating in a cell of the same form as those above described. The medullary core permeated the tube, and was developed into a perfectly-formed polype inhabiting the cell and freely expanding from it. The tube, the cell, and the polype, were of the same dimensions as in the adult. Some of the cells already showed, in the form of a tubercle budding from their bases, the commencement of a new joint of the lengthening polypidom.

"Along with these, on the floor of the glass vessel, were many minute animalcules, of an opaque-white hue, somewhat *Planaria*-like, which crawled slowly and irregularly, protruding the anterior portion of the body in a blunt point, but often contracting the whole outline into a subglobose form. These worm-like animalcules I found to be the primal form of the young polype; and though I have not been able to trace the metamorphosis through every stage in the same individual, the facts I have observed leave it indubitable.

"I took two thin plates of glass, and suspended them by threads in the vessel, near the bottom, horizontally, with a view to obtain some of the embryos rooting themselves thereon, which I might afterwards take out, to watch their progressive development under the microscope. Meanwhile I secured the first step in the inquiry, by opening with needles some of the crowded vesicles of the adult polypidom, from which I obtained some of the minute white worms. In two or three days I drew out the plates of glass and put them in shallow cells of sea-water, fit for the stage of the microscope: I found upon them the young animals in various stages. Some of the worms were yet vagrant, and crawled freely about the surface; others had selected their position and were adherent, but still retained their power of

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motion to such a degree as enabled them to change their form by protruding certain portions of their outline; others were contracted into a globule, fixed and changeless, with the matter produced in the form of a creeping rootlet."

"The next stage that I observed was that in which the adherent mass had become shelly, as I presume; for the marginal portions were perfectly transparent and colourless, and the opaque granular matter had retired to the centre, where, irregular in form, it had given rise to a tube. This tube had already formed one joint: its extremity was closed and rounded, and had not yet begun to dilate into a cell. The medullary matter proceeding from the granular mass at the base, passed through the lower portion of the tube as a central cord, but completely filled the terminal moiety. Another specimen had proceeded so far as the formation of the cell, the bottom of which was filled with the granular matter, as yet amorphous, no trace of the polype being yet discoverable. This was the most matured phase of the development that appeared on the experimenting plates of glass; but the transition from this state to that of the young polypes, already described, at the bottom of the vessel, is short and obvious; and the progress from one of them to a perfect polypidom is a matter of increase and aggregation.

There is however a hiatus in this chain. I should have particularly wished to see one or more specimens between the condition of the adherent globule, and that of the formed and growing tube; but of this intermediate stage my glass plates presented no specimen. And whether the water in the shallow stage-troughs, to which I removed the plates for microscopic examination, afforded insufficient nutriment, I know not; but I could not find that any individual specimen continued to grow after removal from the larger vessel; and they shortly gave evident tokens of death and decay."

Laomedea dichotoma.

The genus *Laomedea* is thus described by Johnston:—"Polypidom rooted by a creeping fibre, plant-like, erect, jointed at regular intervals, the joints ringed, incrassated, giving origin, alternately from opposite sides, to the shortly-pedicled cells; cells campanulate; vesicles axillary; polypes hydraform."

L. dichotoma rises to the height of a foot, or even two feet. The stem bends angularly, and gives off a short branch at each bend. The cells are shaped like bells, and their stems ringed, three times as long as the bells. The polypes are of a red colour. "This Coralline," observes

Ellis, "is found in great abundance on the south-west coast of England, and seems most curiously contrived, from its structure, to resist the violence of the waves, all its joints being furnished with springs. Its vesicles are formed so as to yield easily to every violent impulse of the water, without injury, from their being placed on footstalks like screws."

Laomedea geniculata.

This *Laomedea* is a numerously branched polypidom, bearing on its fronds the most beautifully delicate, cup-like polypi, which, by means of their cilia, move about in a very rapid and playful manner. Each polypus is like a tiny shallow glass vase, with a foot by which it is attached to the frond, and fringed with threads all round the disc. *Laomedea geniculata* is interestingly described in the 'Devonshire Rambles:'—"The little creatures [*i. e.* the cup-shaped polypi] are very active and lively, making their way rapidly through the water by a sort of flapping motion of all the marginal threads together; an action which, when viewed in profile, could not fail to remind the observer of the flight of a flagging-winged bird: but so exquisitely delicate is the tiny creature, so transparent, so shadowy, that a friend to whom I showed it aptly called it the soul of the Zoophyte.

There is something in it also which reminds me of the pappus of a dandelion floating on the breeze."

This Zoophyte has the power of throwing off the polypi; or rather, the little polypi are able to detach themselves and still to dance merrily in the water. "Immense numbers of these tiny sylph-like creatures were successively produced from the *Laomedea* in the glass jar, so that the water at length seemed quite alive with them; but I could not find that a single individual either became stationary, or changed its form, or grew. In the course of a day or two they all died."—Perhaps a salutary example to young people in too great a hurry to become independent of parental care.

To describe one of the polypes more particularly, it seems most to resemble an inverted umbrella with a netted disc across its diameter; on the convex side is a central fleshy protuberance forming the foot. The flatter disc is divided by four angles, between each of which are six thread-like tentacles,—twenty-four of them altogether,—which play about in all directions. Placed at equal distances, on the margin, between the tentacles, are four pairs of very eye-like globes, which however, from their structure, are believed to be rather organs of hearing. Altogether, these little polypi have the appearance of miniature *Medusæ* or Jelly-fish.

Laomedea gelatinosa.

This polypiferous animal is, like the former, provided with cup-shaped cells placed on ringed, springy necks, protecting the polypi which fill them. As the cups are very transparent, a favourable opportunity is given for observing the economy of the structure. A slender and transparent tube springs up from creeping, thread-like roots, sending out branches at intervals on both sides. These branches are ringed, or constricted in such a manner as to appear tied in as it were by very fine threads, at places close to each other, so as to make the rings very narrow. At the end of each branch is a miniature wine-glass, or hyaline cell, perfectly transparent and beautifully shaped, containing the polype, in which each branch of the fleshy centre terminates. The flesh is jelly-like, hollow in the centre, and runs like an inner pipe through the stem and branches of the polypidom, until it reaches the cell at the end of each. In the hollow part of the fleshy pipe is a fluid containing moving granules, the precise nature of which is not accurately ascertained.

When the fleshy tube reaches the end of each branch, and arrives at the neck of the cell, it passes through a perforation which exists in a partition which runs across, near the bottom of the cell: it now thickens out into a polype, dilated at the bottom, and dividing, on arriving at the rim of its cup, into a star of many rays, hanging over its sides all round its aperture. In case of irritation, alarm, or discontent with the fluid in which it is placed, the polype can collect its star-rays, or tentacula, into a bundle and withdraw them into the cup.

Campanularia volubilis.

"This very minute Coralline," says Ellis, "arises from small irregular tubes, which adhere to and twine about other Corallines, particularly the Sickle Coralline. Exceedingly small tubular stalks go out from this tubular stem, which supports little bell-shaped cups with indented brims. At the bottom of each, where they join to the stalks, the microscope discovers to us a very minute spherule or little ball, as in some drinking-glasses."

Eucratea chelata.

A minute, irregularly branched polypidom of very interesting structure, formed by the continual addition of cells, springing each one from the upper and outer rim of its predecessor. The formation of a new branch, however, commences in a spinous projection from the lower rim, and this afterwards expands into a cell to which others are added. The polype in each cell is protected by an elastic membrane, which retracts into its very depths when the polype is projected, but, when that is withdrawn, forms a projecting rim, or lappet, beyond the edge of the cell. The polype is protruded in through an opening in this membrane, in three circular slides, like the joints of a telescope. The top, or head-joint, is crowned by twelve ciliated arms; the second, edged by a scalloped frill, and the third, or basal joint, has a projecting point. The whole is most exquisitely formed, and of a most delicate, filmy transparency.

To observe the course of the digestive system in very minute animal frames is very difficult, requiring the adjustment of a high power, to the medium in which, to produce the continued actions of life, the object must be placed. In order to assist in the observations, a colour has been introduced into the element, which, being readily imbibed by the polype, is seen in circulation through the body.

There is a continued motion of cilia going on, which enables the polype to bring a current of nutritious substance within its power, as well as to throw off any disagreeable intruding bodies. When the ciliary action is insufficient to effect this, the little filmy creature will succeed in getting rid of the offensive object by suddenly withdrawing and jerking itself sidewise, or by bending in one of its ciliated arms, and sending it out with a fillip-like motion.

Anguinaria spatulata.

Snake-headed Coralline.—This little Zoophyte winds up a seaweed as the ivy does the oak. It consists of a stem with cells thrown out at intervals on bended stems. They are of a flattened, oval form, and not unlike the head of a snake, open at one side. Each "snake's head" forms the habitation of a polype, which, when it throws out its own head, presents a circular crown of tentacula. The neck of the cell-stem is marked with rings, while the swollen head is dotted. The mechanism of the cell is very curious, being furnished with a little door, which, closing when the polype is retracted within its cavity, and held firmly down by muscles, gently opens on its hinges and turns back as the living film passes out and spreads its crown of feelers. All the time it keeps out, the door is folded back, again gradually closing as the animal retires. If a piece of bladder were stretched over a half-circle of bent cane or wire, it would give the idea of the door or valve we are describing, only on a very large scale; the bladder answering to the almost impalpable membrane, and the circular frame answering to the horny rim of the door. Sometimes, however, patient observers have seen the polype retreated far within his cell, and still holding the door wide open, so as to permit the free circulation and inhibition of the watery element, but with the spring ready to be drawn back on the approach of danger. The *Anguinaria spatulata* is found not uncommonly twining like a "gentle evergreen," about small sea-weeds at low water, near the Devonshire coasts.

Cellularia ciliata.

The Ciliated Cellularia is parasitic in its habits, like the *Anguinaria.* There is a kind of tubercle on the outside of the cell, which is open at one end, with a movable valve, presenting an appearance in form resembling that of a flower of *Calceola.* It has also been compared to the head of a bird, the valve answering for the lower mandible of the beak. This valve opens and shuts with a sudden, snapping motion; and the edges of the upper and lower mandibles are both armed with tooth-like points.

It seems not yet to be ascertained what is the nature of these excrescences; what functions they perform, or what relation they sustain with the polypi, or their house. In truth, from the fact of *not all* the cells being provided with them, and of other polypidoms having generic characters in common with this species, showing no signs of possessing or requiring these excrescences, a doubt is justly suggested, whether they may not, after all, be independent and distinct, although parasitic organisms, consisting of what would look like an animal, all head and mouth, swaying to and fro, snapping its jaws and seeking what it may devour. On the other hand, its occupation *may* be that of a useful member of the polypidom, auxiliary to the seizure and imprisonment of wandering animalcules for the purpose of feeding the polype in its cell.

All these interesting forms, to be appreciated, require the most careful observation by means of the microscope, with the objects in a living state. The day for dried specimens has now gone by, and it may soon be a common every-day amusement to examine this class of Zoophytes in glass vessels, and trace their admirable structures in the same manner in which only the Ellises, the Johnstons, and the Gosses have hitherto been privileged to do.

CHAPTER III.

SEA-FEATHERS, SEA-PENS, AND SEA-FROTH.—PENNATULA PHOSPHOREA.—VIRGULARIA MIRABILIS.—PAVONARIA QUADRANGULARIS.—GORGONIA VERRUCOSA.—KINGFISHER'S NEST OR MERMAID'S GLOVES.—ALCYONIUM DIGITATUM.—ALCYONIDIUM HIRSUTUM.—INFUSORIA AND FORAMINIFERA.

THE three families—*Pennatulidæ, Gorgoniadæ, Alcyoniadæ*—are included by Gosse in the sub-order *Alcyonaria*. The family of *Alcyoniadæ*, which contains *Alcyonium digitatum*, of which we shall speak presently, appears to partake much of the nature of Sponge, only that the fleshy masses of which it is composed, send forth distinct and beautiful polypi. It differs from the other two families, *Pennatulidæ* and *Gorgoniadæ*, in not having, like them, a central axis; but instead of that axis, the flesh contains scattered calcareous spicula, similar to those Sponges.

In the Hydroid Zoophytes, it was observed that the horny skeleton formed, as it were, a case, or external support to

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Vincent Brooks Imp.

Alcyonium digitatum 1. A two lobed specimen with polypes expanded. 2 Young of the same. 3. A polype magnified. 4. Internal spiculæ.

the fleshy part of the animal and its polypes; while in the Asteroid groups, included in the families of *Pennatulidæ* and *Gorgoniadæ*, the skeleton consists of a central horny or calcareous axis, around which are arranged the polype-bearing fleshy parts.

Pennatula phosphorea.

Dr. Johnston thus describes, in technical terms, the genus:—"Polype-mass free, plumous, the shaft subcylindric, naked beneath, pennated above; pinnæ two-ranked; spreading, flattened, and polypiferous along the upper margin."

"Nature," observes Lamarck, "in forming this compound animal, seems to have desired to produce a copy of the exterior form of a bird's feather."

And truly, if you imagine a bird's feather four or five inches long, but of a fleshy substance, plumed broadly at the feather end and naked at the quill end, very elegant in form and of a delicate pink colour, you have before you an image of our *Pennatula*: yet this also is a living animal. Along the upper edges of the pinnæ are placed the polype-cells, in rows, containing the polypes. The pinnæ are obliquely curved backwards, and each one is capable of an independent action. All the external part of this Zoophyte is fleshy, including the central stem; but through the centre of the latter runs a calcareous column, which serves to strengthen and support the whole. This forms the rudiment of a true Coral, and constitutes a bond of union between the Sea-Feather and the Asteroid which forms that beautiful Coralline known in commerce as the "Precious Coral," of which red ornaments are made.

Cock's-Comb, Sea-Pen, Sea-Feather, are the names by which the *Pennatula* is known; the former, on account of the colour and general appearance of the upper pinnæ; the latter, because of the resemblance which every one must see on glancing at the object.

Pennatula phosphorea is unattached: it does not grow fixed to any object, like *Gorgonias*, etc., but is planted in mud, with its pinnæ exposed. And now comes the question, whether it is capable of moving from place to place through its bed, or of raising its body and swimming through the water. Some naturalists have held that it is capable of both motions; others say that it cannot move voluntarily at all. Its general habits certainly appear to be very stationary; and we have no direct evidence, derived from actual observation, that the animal is provided with locomotive power or instinct. Yet some authors assert that it swims about freely in the sea, using its pinnæ in exactly the same manner as fishes use their fins; others say that the motion is effected by alternate contractions and expansions of the thick part of the central mass, as well as by a combined action of the polypes.

When placed in a basin of sea-water, as many specimens have been by acute observers, they have never been observed to exercise this supposed power of swimming, but have remained quietly lying, polypes upwards or downwards, just in the same position in which they were placed. In this condition however the whole body has become very considerably distended with water, increasing to several times its natural dimensions; and that is the only approach to motion betrayed by the *Pennatula* when in captivity. Sir G. Dalyell remarks that the distension that takes place does not reduce its specific gravity sufficiently to produce an equilibrium with the water; "thus the animal cannot swim."

It seems to me that the appearance of the body is such as to favour the notion of a creeping movement, which could be easily effected by a slight action of the lower edges of the pinnæ; and this is just the motion which would most probably be missed by observers watching for it, in the case of animals confined in a narrow basin. For it is doubtful whether they would be provided with exactly the same kind of bed which they had been accustomed to, and which was most suitable to any movements they might desire to make.

On one subject there is no question. There is no doubt that, when irritated, Sea-Pens throw out a strongly phosphorescent light. When the animal is touched or pressed it gives a luminosity, commencing at the point of contact and proceeding up towards the pinnæ. If the upper part of the specimen be irritated, all parts below the contact remain unaffected, while those above it emit phosphorescence.

A beautiful result is obtained, although perhaps cruelly, by throwing a *Pennatula* into fresh water, when it emits and scatters brilliant sparks in every direction.

Virgularia mirabilis.

Very nearly allied to *Pennatula*, but very much more slender and elongated in form; sometimes growing to the length of five-and-twenty or thirty inches. It is of a straw-colour, and growing all along on each side of the long stem are polypiferous masses, each divided into six or seven lobes or fingers, and at the end of each finger a most beautiful eight-rayed star polype. The pinnæ are not placed on each side of the stem exactly opposite to each other, but each one against the space between the two on the other side. They are beautifully transparent, and have the power of contracting, so as to lie up closely imbricated upon each other, pressing the stalk; but they can also expand and lie out, so as to leave open spaces between. Mr. Harvey says, "The polypes are objects of great beauty, and their form may be very well seen after death; for though capable of retractation within the cell, the tentacula have no contractile power, and may be made to expand in their full extension by merely pressing upon the cell. The polype thus displayed is an eight-rayed star, the rays curved backwards, channeled and elegantly pectinated along each margin. In the centre is the mouth, with prominent lips."

The same question occurs as to the habits of this Asteroid as arose respecting those of *Pennatula*. But one curious motion has been observed in the former when captive, which does not take place in the latter: it is that of the animal twisting itself spirally round its central axis, and afterwards relaxing again into a straight line. The bone running through the central axis is very slender,—said to be not a thousandth part of its length in diameter. "Each organ," remarks Dalyell, "of this remarkable object has a distinct action, free of all the other parts. Each lobe, each hydra, each of the pectinate tentacula, and each of their prongs, can move at will, while the whole of the rest of the Zoophyte is quiescent; therefore, in a specimen with the bone extending eighteen inches, above a million of separate fleshy parts are under the common control of the Zoophyte." It is of course very difficult to understand where can be the seat of this common control, or in what manner the central power of volition can be exercised. But when we reflect that the only motions of which this animal is known to be capable are a kind of excentric twist round its own axis, and a certain amount of puffy inflation of its parts, it does not present a very favourable view of separate government. It is rather calculated to remind us that too much independent action among individual members of a body politic is unfavourable to the development of corporate power: we will not point to practical illustrations of this.

Pavonaria quadrangularis.

This is another of the living rods of the ocean. It is invested with a fleshy skin, and has rows of polypes along its sides; those at the lower part of the rod are in a single row on each side, but higher up they come in twos and threes, until at the thicker and more bulbous part they form oblique rows of four, five, or six in a transverse row. The flesh is of rosy hue. Each polype is a flower of eight petals or tentacula. This, like *Pennatula*, gives out a phosphorescent light when irritated.

Gorgonia verrucosa.

The generic characters of *Gorgonia* are thus described by Johnston: "Polype-mass rooted, arborescent, consisting of central axis barked with a polypiferous crust; the axis horny, continuous, and flexible, branched in coequality with the polype-mass; the crust, when recent, soft and fleshy, when dried, porous and friable; the orifices of the polype-cells more or less protuberant."

We should much like to see this Zoophyte, whose central stem is composed of beautiful branching red coral, growing in the Zoological tanks. Those fair beings, who in ancient pastoral numbers were courted by lovesick swains with promises of

> "Coral clasps and amber studs,"

might then see the living founders of a favourite ornamental production gathered round and concealing the coveted centre, but displaying in themselves beauties greater than any they could hide.

Or even if we could transport the branching and netted *Gorgonia flabellum*, or "Venus's Fan," from its native haunts in the West Indies, and see its branches incrusted with animated fibre and lively polypes waving in the rippled waters, and crowning the rockwork of an Aquarium, we should be adding a desirable variation to the already varied picture. But notwithstanding the fact of broken pieces being dredged up near our coasts, it appears certain that Venus's Fan has never been seen living in this country. Those species that we can point to as our own, although interesting, are not so beautiful as those which are met with abroad. The same principle however may be observed throughout,—a branched, tree-like form rooted to the rock by a spreading disc; through the stem and every branch a horny or bony central axis; axis covered with a fleshy incrustation; flesh containing, at intervals, polypes in cells.

Gorgonia verrucosa

Is shrub-like. It grows to the height of a foot, and spreads out like a fan to an equal width. It is branched; but as the branches do not cross into each other, as in *Gorgonia* *flabellum*, it is not netted. The axis is horny, black, smooth, and shining. The living flesh incrusting the axis is flesh-coloured and soft, but when dead dries into a brittle crust. The polype-cells are numerous; they form, at least in dried specimens, those wart-like excrescences from which the species derives its name "*verrucosa*," from *verruca*, a wart. These warts, when their crust is dissolved, are found to contain the contracted remains of eight-rayed polypes.

As *Gorgoniæ* are deep-sea Zoophytes, it will be long ere we can arrange the admission of light, and other circumstances, in our tanks, so as to suit their habits: ultimately it will no doubt be done. We may yet hope to see both foreign and English Sea-Fans making miniature forests in limited allotments of their native element.

Alcyoneæ.

The following definition of the family, from one of the Cyclopædias, may serve to convey a general idea of the economy of these curious Zoophytes. "*Alcyoneæ*, a group of marine productions somewhat similar to the Sponges, but more distinctly belonging to animated nature. We are indebted to Pallas, Gärtner, Savigny, Spix, and Lamouroux, for what is known of their singular structure. Both in the fresh and dried state they are of much greater specific gravity than the Sponges, and frequently emit a disagreeable odour. They vary much in form, some being in a shapeless form or crust, and others lobed, fingered, branched, or with rounded mushroom projections. The interior substance is spongy or corky, surrounded by tube-like rays enclosed in a leathery sort of membrane. The tentacles or arms of the animal inhabitants of these productions are eight or more. The cells in which the animals lodge are round, unequal in diameter, and about a sixth of an inch in depth.

"The *Alcyoneæ* are found in all seas and at various depths, subsisting, it would appear, on marine plants ; they do not however seem to like places which are often left dry by the ebbing of the tide, and hence we have never met with them recent, except about the low-water mark of spring tides, and they seem to delight in places sheltered by rocks from the sweep of currents or the agitation of the waves, and where the light is rather obscure. They are found therefore to be more numerous in deep water."

Alcyonium digitatum.

The Alcyon, or Kingfisher,—fabled to have formed its nest of the foam of the sea, and to have been favoured by Neptune so far as to be permitted to hatch its eggs while the waves were kept unmoved for the purpose,—gives its name to this Zoophyte (Plate V.). It is a curious-looking spongy substance, growing attached to the rocks, in lobes of a buff or fleshy colour. When taken fresh from its element its surface is nearly even, but an attentive examination shows it studded with star-shaped depressions. But if a specimen can be taken living and placed in salt-water with the piece of rock on which it has been growing, it will presently put forth polypes from these depressions, which project from the surface in the form of beautiful little flowers with star-like petals. Its appearance in this condition is very elegant, and a microscopic examination of the polypes and of the interior presents new beauties to the view. Each polype is a delicate white tube, nearly transparent,—at least sufficiently so to render visible the interior organs: each is enclosed in a cell, from which, when fully protruded, it is seen to taper gradually towards the opening, where it is expanded into a flower with eight petals; very slender filaments, arched outwards and with ringed circumferences, fringe the edges of the petals. The truncated stomach, the bended and twisted threads edging the divided septa of the surrounding part and connecting the stomach with the interior of the polype, the vibrating cilia covering every part of the inner lining, the current of globules passing up and down along the pellucid skin, and the curiously arranged coral-shaped spicula, not unlike those of more decidedly spongoid bodies, are all admirably and minutely described in the 'Naturalist's Rambles on the Devonshire Coast.' As, in nature, the polypes on a mass are never all exserted at the same time, we have shown in one part of the figure (Plate V. fig. 1) the polypes fully exserted; in another part some of them partially withdrawn, others only showing the starlike petals; and in other parts of the specimen its appearance when the polypes are withdrawn and the edges of the cells closed over them.

Mr. Gosse, speaking of *Alcyonium*, says, "Darkness is more essential to its comfort than constant immersion. It is more careless of exposure to air than of exposure to light. The size and development of the masses are in proportion to the obscurity of their residence. Even in these cavernous recesses we only see half-grown specimens, and those consisting of one or two lobes. When left by the tide these hang down to a great length, the base shrunk to a slender, skinny column, with a white fleshy lump at the tip, from which depends a large drop of clear water; but no sooner does the sea return to their level than they retract themselves, their bodies become plump and pellucid by the absorption of the sea-water into their system of aqueducts, and the numerous little pits that had appeared on the surface swell and protrude into transparent star-like polypes, rendering the aspect of the whole as beautiful as it was before repulsive." (*Gosse, Tenby.*)

Alcyonidium hirsutum.

"All round the margins and smooth sides of the basin, under water, grow numerous specimens of the Stag's-horn Sponge-polype. These are so characteristic of the pool, and so remarkable, as at once to claim attention. They have much the aspect of a Sponge, being downy, growing in irregular rounded masses, and of a subpellucid yellowish-olive hue; but to the feel the substance is more solid and fleshy, something between jelly and cartilage. It is frequently three or four inches in length, springing from a minute point of attachment, and much branched or lobed, resembling a deer's horn." (*Gosse, Tenby.*)

Plate V. represents *Alcyonium digitatum* with two young lobes, a single polype magnified, and some of the spicula.

Infusoria and Foraminifera.

Since the great work of Ehrenberg on the 'History of Infusoria, Living and Fossil,' a great number of these infinitesimal creatures have been discovered to be the young of other animals, and others proved to belong to the vegetable kingdom, although gifted with a kind of spontaneous motion; and as many of the others are yet undetermined, it seems possible that the *Infusoria,* as a class, may come to be dispersed over various parts of the system. As affording food to many marine animals whose habits and organization render them entirely dependent on such provision, they are indispensable parts of the mighty scheme of Providence; and in the Aquarium their existence will be duly appreciated, although scarcely perceptible to the eye.

Every current drawn towards the patient *Anemone,* or agitated by the ever-repeated ciliary action of other marine animals, brings into the proper channels many tiny and almost invisible living creatures, which afford rich nourishment to the fortunate recipients, many of which have no means of securing more tangible objects, or of devouring them if secured; and many others live mainly upon the *Infusoria,* although quite capable of seizing and enjoying a Shrimp or a Mollusc, once in a way, for a *bonne bouche*.

Foraminifera, as a class, differ from *Infusoria* in this respect, that they are a defined group in themselves, not distinctly connected with any other, but possessing characters which are recognizable and distinguishing. Formerly indeed they were considered as belonging to the very highest class of *Mollusca*, namely *Cephalopoda*, for, although very minute, the shells in many instances take very exactly the forms of Nautilus, Ammonite, etc., and are divided like those shells into chambers. They are now believed to be much lower down in the scale, and in recent systems take their humble place among the *Polypi*.

They are all microscopic, glutinous animals, divided into segments, arranged either in a line or rolled spirally; they are clothed with a shell having numerous orifices, through which pass contractile filaments, which are very long, branched, and used for locomotion. The recent species, although few in our seas, are numerous in warm climates; yet all those living now are insignificant in numbers compared to the enormous multitudes of them which crowded the ancient seas. Large mountains are formed almost entirely of their fossil remains. The great stratum on which

Paris is built is composed, to a great extent, of their shells. Hundreds of thousands of specimens may be counted in an ounce of sand!

The *Foraminifera* may be seen in a living state by taking up seaweeds and branching Zoophytes, in favourable parts of the southern coasts, at or near the edge of the tide. If these are shaken over a vessel of water, the *Foraminifera* will first drop to the bottom, but will afterwards be found—by help of a lens—crawling about or sticking to the sides of the vessel. Many of them may also be picked up by careful research among the patches of drifted sand and shells which the tide will sometimes leave upon the shore. Some of them are like flasks or bottles, and others like twisted *Serpulæ;* some are like *Nautili,* others like jointed branches of coral. The principal genera are,—*Lagena,* the flask-shaped form with a neck; *Entosolenia,* also bottle-shaped, but the neck doubled back as it were within the body; *Rotatia,* whose shell consists of a spiral arrangement of swelled lobes; *Polystomella,* shaped like a Nautilus; and some others.

According to Dujardin, who has rather minutely examined the history of the *Foraminifera,* they have not any distinct organs of locomotion, although the film-threads thrown out

Snake-headed and Clubbed Anemones. 1 Sagartia anguicoma. 2 The same extended. 3 The same closed and flat. 4 Bunodes clavata.

through the pores serve that purpose, and even the means of respiration are indistinct or non-existent.

The life and death of these myriads of tiny, insignificant, and lowly-organized beings, in past ages as well as in the present, have no doubt fulfilled important functions in the general economy of Nature. Certainly the great results, visible and tangible, presented to us in the shape of mountain masses,—composed, not of grains of sand, but of what were once living creatures infinitesimally small,—strikes us with wonder at the strange contrast; while the profusion of life continually supplied and expended in supporting life in higher forms, by giving food to many a larger animal, whose

> " Restless tongue
> Calls daily for its millions at a meal,"

may well give rise to reflections of a serious kind, painful perhaps, though not unprofitable.

> " 'T was wisdom, mercy, goodness, that ordained
> Life in such infinite profusion,—Death
> So sure, so prompt, so multiform."

CHAPTER IV.

SEA-ANEMONES, OR ACTINIADÆ.—TENACITY OF LIFE.—REPRODUCTION OF PARTS.—DOUBLE-HEADED SPECIMEN.—POWER OF STINGING.—FOOD.—MORALIZATION, OR PURPOSELESS EXISTENCE.—CHANGES OF FORM.—CLASSIFICATION.

"Pray, Mr. Stanhope, what's the news in town?
Madam, I know of none; but I'm just come
From seeing a curiosity at home;
'T was sent to Martin Folkes, as being rare,
And he and Desaguliers brought it there:
It's called a Polypus!—What's that?—A creature,
The wonderfullest of all the works of Nature.
Thither it came from Holland, where 't was caught
(I should not say it came, for it was brought.)
Tomorrow we 're to have it at Crane Court."*—*Sir C. Williams.*

The first and only Marine Aquarium possessed by many is the basin of sea-water in which they have, perchance, while young, placed that wonderful polypus which they have taken

* Where the Royal Society held its meetings and kept its Museum, from 1710 to 1782.

on the rocks, and which they have heard called a "Sea-flower." Probably it is the commonest of common species, which has been named *Mesembryanthemum*, from its resemblance to the many-petalled flower of that name. It is well for the early Aquarian, if, when he first takes the living flower from the rock, he is unacquainted with its nature; but seeing only a round leathery hemisphere fixed on a stone, and puckered in at the centre, he has just conjectured that it might be a living animal. In that case his delight and wonder will be great when his captive, little by little, expands before him, and exhibits one after another of its curious characteristics. Every alteration in shape, attitude, and dimensions, will excite astonishment, and create a desire to know more of this surprising creature.

A first view of the common *Actinia* in its contracted state is not particularly inviting. It is generally of a dull liver-colour, or fading green, and presents nothing to the eye but a raised half-circular mass, with a puckered hole in the centre. This is the outer covering of the polypus. It is of a leathery substance, and capable of contraction and expansion at will. Presently this mass will be seen gradually to rise a little, and the puckered folds at the central hole to smooth out. The next things to be seen, when the hole is wide enough, are the tips of delicately-coloured petals, which, on examination, are found to be rounded, cylindrical, and transparent. These continue to be more and more fully seen, until they separate so as to disclose a small inner surface in the centre; and we find that this inner surface is part of a rounded disc, and that the petals are arranged in several rows so as to fringe the outer edge of the disc. Here we have the flower fully expanded; and on looking at the now visible edge of the outer coating, we find that it is studded, behind the petals, with a row of bright rounded tubercles, like blue beads. The central hole is of course a mouth, leading to a central stomach; the cylindrical petals are tentacula, or arms, by which prey is seized; and the exact use of the blue beads, which exist only in the *smooth anemone*, is not yet fully ascertained.

Now if, with this flower before him, with its petals out, the observer will put a small water-insect, or piece of meat, within reach of one or two of the outer tentacles, he will see that they adhere to it as it were by a kind of electric touch; and there is an agitation among a few tentacles in its immediate vicinity, which bend towards the object and try to reach it, in support of those which first had hold of it. Meanwhile a firmer purchase is obtained by those tentacles which touched the morsel first, till it is completely surrounded, and if living, overpowered. It is passed along from hand to hand (if the expression may be permitted) among the tentacles, until that side of the disc coils over towards the mouth, into which it is soon sucked and disappears. If on the contrary no food be given to the *Actinia*, and he become hungry and dissatisfied with his situation (as is very likely to be the case) he will probably turn his stomach inside out, just as a man may turn out his pockets to show that he has nothing in them. I remember being immensely astonished when from the mouth of my specimen appeared several balloon-like inflations, which gradually enlarged and presented a most beautiful appearance, a kind of transparent bladder, delicately ribboned. After this happens the poor creature will not live long.

When we have specimens of *Actiniæ* in glass tanks, they sometimes fix their basal disc against the inner surface of the sides, so as to show its structure to the observer from without. This disc may be regarded as the animal's foot, for he uses it just in the same manner as Gasteropods use their crawling base, and effects his very slow movements by stretching out a portion of the rim and drawing the other after it, little by little. Its disc form and sucker-like character, enables it to cling firmly to rocks and other surfaces; while amid boisterous tempests agitating the waters, his extended body bends to the waves, and his many arms are active in search of food. The edge of the outer covering will be distinguished by a darker colour and more opaque texture, from the rest of the disc. From it, radiating towards a common centre, are opaque white lines; some reaching the centre, and others, shorter, between them. If at any height in the body of the animal a cross section be made, these same lines will appear; showing them to be edges of vertical plates, of a different substance from the rest of the body. The spaces between these plates and the central stomach are filled up with translucid jelly-like flesh, which is capable of being greatly swelled with water. If a section were made of a Single-starred Madrepore, such as *Căryophyllea Smithii*, or the Mushroom Coral of the Pacific, the same arrangement of radiating plates would be observed; only in these instances they are hard and calcareous,—in short, *coral;* while in *Actiniæ* they are only a kind of gristle, and, being of a firmer texture than the flesh, give support and firmness to it. This is the essential difference between *Actiniæ* and Single-star Corals. The latter however are fixed, while the former, as we have seen, are locomotive.

Let us inquire what is the difference between this group of polypes called "Helianthoid" and that which contains the Hydra and the other "*Hydroid*" polypes. It is this: that while the former are composed of all the distinct parts which we have been enumerating,—the outer covering, the basal and upper discs, the vertical plates, the fleshy substance between them, the central stomach, and the lipped mouth; the latter is a simple bag, open at one end and fringed with tentacula,—mouth, stomach and all in one,—so simple indeed that it may be turned inside out and yet perform the same functions.

When describing the fresh-water Green Hydra, we shall have occasion to speak of experiments made on that wonderful creature, in the way of cutting up in pieces to observe its power of reproducing parts. Similar experiments have been made, although not to so great an extent, with *Actiniæ*, and with a similar result. An *Actinia*, for instance, has been cut across the centre, and instead of forming, as might be expected, a new basal disc, it put forth, at the severed part, a new set of tentacula, surrounding a new mouth, so that the creature seized and devoured food at both ends. New tentacles are soon supplied for any that are accidentally or designedly mutilated.

At Mr. Warrington's I saw what appeared to me a very curious phenomenon,—an *Actinia mesembryanthemum* with a double head, both heads on the same plane; the body seemed to be entirely one, with an oval basal disc, and no sign of separation up to the very edge of the leathery covering; but the upper disc formed two complete circles, surrounded each by its proper set of tentacles, and each with its central mouth. It is observed, that when a considerable morsel of food is presented to an ordinary *Actinia*, some slight agitation may be observed even among the most remote tentacles, as if they were in some degree conscious of what was going forward, and held themselves in readiness to give assistance if required. But in order to show the complete duality of the upper part of his two-headed specimen, Mr. Warrington fed first one, then the other, in my presence. When the morsel was brought near the tentacles on the outer part of one circle, and they were busy securing it, the other tentacles of that circle showed some degree of alertness; but not a feeler of the other circle stirred. When the twin head received its *bonne bouche*, we could then see both independently engaged in securing and devouring their meal. We have heard of twin babies turning out to be a capital speculation in the family of some working man, by exciting a kind of admiring sympathy, productive of charitable contributions; and I more than suspect that the twin *Actiniæ* make a very good business of their peculiarity; for of course every visitor must see both heads fed, and by this means, by the kindness of their possessor, they get many and many a morsel which but for the happy partnership they would not have enjoyed.

Much has been said respecting the power of stinging possessed by these animals, and by Polypiferous Zoophytes in general, in consequence of which they are called "Sea-Nettles," and by the French "Orties de la Mer." The experience of those who have handled them differs greatly; and of course the power will differ in different species under different circumstances. Thus the *Anthea* possesses it in a greater degree than most others of the family. It is exercised by means of fine darts pervading the body, and is connected with a great power of adhesion. In the 'Manual of Marine Zoology' it is remarked that "most, if not all, of these polypes have the power of arresting, by a touch of their bodies, other animals much higher in rank than themselves, and of instantly benumbing them, so that they may be sucked in and devoured without resistance. This power resides in the highly elastic threads or wires, which are doubtless connected with a subtile poison, and are ordinarily coiled up in oval capsules, but are, at the will of the animal, projected with surprising force: these capsules are lodged in vast numbers in the flesh of the body, but especially in the tentacles."

There is an old stanza referring to the common terrestrial stinging-nettles, which will not apply to these "Orties de la Mer:"—

> "Tender-handed stroke a nettle,
> And it stings you for your pains:
> Grasp it, like a man of mettle,
> And it soft as silk remains.
> 'T is the same with common natures:
> Use them kindly, they rebel;
> But be rough as nutmeg-graters,
> And the rogues obey you well."

But the case of polype stinging-nettles is different; for being sheathed in their cases, ready to dart forth on irritation, pressure does not break the polype-stings, but only causes them to be shot out in greater force.

In general, the "sting" is not felt by the human hand, although a sensation of "stickiness" is produced. Those wonderful little threads which dart out of their capsules and penetrate with surprising subtlety many objects of contact, perhaps find the skin of the human hand too tough to wound. Mrs. Pratt, in her 'Seaside Chapters,' observes that the touch of the very same *Actinia* will affect different persons in a different manner. Having placed a specimen in a vessel which she often touched, she found the tentacles crowding round the finger and producing a very slight sensation. The same specimen being touched by another person communicated a tingling which was felt up the whole arm! Some persons felt nothing; others felt as if stung by a nettle.

Altogether the Anemone must be a formidable tenant of the sea, and is a rather dangerous inhabitant of the tank. Firmly adhering by its base, it puts out its arms in quest of prey. Nothing, once in contact with an arm, can escape its deadly touch. Small *Mollusca*, *Radiata*, and *Crustacea* are drawn to the central vortex, and swallowed in spite of the most vigorous resistance. Small fishes and crabs are seized and devoured. Creatures larger than the natural extent of the Anemone's body are pressed down into the same accommodating and extensile carpet-bag. If you have any choice specimens belonging to other tribes, endowed with powers of locomotion likely to bring them into thoughtless contact with the foe, do not place it in a tank with Sea-Anemones.

Foreigners boil many kinds of *Actiniæ* for the table, and find in them a very pleasant dish. The texture is something like calf's-foot jelly; taste and smell resembling that of crab or lobster. Eaten with sauce, they are savoury. The author of 'Devonshire Rambles' gives an amusing account of the manner of his first becoming acquainted with Actinian dainties. "The next morning," remarks that gentleman, "I began operations. As it was an experiment, I did not choose to commit my pet morsels to the servants, but took the saucepan in my own hand. As I had no information as to how long they required boiling, I had to find it out for myself. Some I put into the water (sea-water) cold, and allowed to boil gradually. As soon as the water boiled, I tried one; it was tough, and evidently undone. The next I took out after three minutes' boiling; this was better; and one at five minutes was better still, but not so good as the one which had boiled ten. I then put the remaining ones into boiling water, and let them remain over the fire boiling for ten minutes, and these were the best of all, being more tender, as well as more inviting in appearance. I must confess that the first bit I essayed caused a sort of lumpy feeling in my throat, as if a sentinel guarded the way, and said, 'It shan't come here.' This sensation, however, I felt to be unworthy of a philosopher, for there was nothing really repugnant in the taste. As soon as I had got one that seemed well cooked, I invited Mrs. G. to share the feast; she courageously attacked the morsel, but I am compelled to confess it could not pass the vestibule; the sentinel was one too many for her. My little boy, however, voted that 'tinny was good,' and that 'he liked tinny,' and loudly demanded more, like another Oliver Twist. As for me, I proved the truth of the adage, 'Ce n'est que le premier pas qui coûte;' for after the first defeat my sentinel was cowed. I left little in the dish." Afterwards, frying them with egg and butter-crumbs, they were found far superior to the others, "all prejudice yielded to their inviting odour and appearance, and the whole table joined the repast with evident gusto." Thus, eating or being eaten, the sea-flowers fill up their appointed place in the world's economy.

Active, fearless, and powerful as the *Actiniadæ* are in the means adopted to secure their food when it comes within reach, they are but sluggish creatures and show but little instinct in their general habits. They will remain for hours, and even days, in the same position; and when they do move, it is at an almost imperceptible pace; perhaps an inch in an hour. When removed from their site and placed at the bottom of a vessel, they take a good while to consider whether they shall fix themselves on another; and a still longer time in effecting their purpose. When on the look-out for prey, they never lengthen their tentacles to reach it unless it come in actual contact with them. Dr. Hamilton, a pastor of the Scotch Church, in a little work called 'Life in Earnest,' has happily seized upon this apparent laziness of the Zoophyte, in rebuking those who are satisfied with living in the world without a definite object.

"Those of you, who are familiar with the shore, may have seen attached to the inundated reef a creature, whether plant or animal you could scarcely tell, rooted to the rock as a plant might be, and twirling its long tentacula as an animal would do. This plant-animal's life is somewhat monotonous, for it has nothing to do but grow and twirl its feelers, float in the tide, or fold itself up on its foot-stalk when that tide has receded, for months and years together. Now, would it not be very dismal to be transformed into a Zoophyte? Would it not be an awful punishment, with your human soul still in you, to be anchored to a rock, able to do nothing but spin about your arms or fold them up again, and knowing no variety, excepting when the receding ocean left you in the daylight, or the returning waters plunged you in the green depths again, or the sweeping tide brought you the prize of a young Periwinkle or an invisible Star-fish? But what better is the life you are spontaneously leading? What greater variety marks your existence, than chequers the life of the Sea-Anemone? Does not one day float over you after another just as the tide floats over it, and find you much the same, and leave you vegetating still? Are you more useful? What real service to others did you render yesterday? What tangible amount of occupation did you overtake in the one hundred and sixty-eight hours of which last week consisted? and what higher end in living have you than that polypus? You go through certain mechanical routines of rising, and dressing, and visiting, and dining, and going to sleep again: and are a little roused from your usual lethargy by the arrival of a friend, or the effort needed to write some note of ceremony. But as it curtseys in the waves, and vibrates its exploring arms, and gorges some dainty *Medusa,* the Sea-Anemone goes through nearly the same round of pursuits and enjoyments with your intelligent and immortal self! Is this a life for a rational and responsible creature to lead?"

We may say to the last question, "Perhaps not;" but it is nevertheless a very good sort of life for an Anemone to lead, for it is that in which God has placed it, and it fulfils the end for which it was created.

I have not yet alluded to the habit of elongation possessed by most of the *Actiniæ*, and consequent great variation of shape. We have seen specimens of *A. anguicoma*, for instance, vary from a flat closed disc, scarcely thicker than a penny in the centre, to a worm-form three or four inches in length, with an open flower at the top. *A. bellis* is very apt, after elongating its body till near the top, to spread the upper disc so as to give the appearance of a trumpet. The habit of elongation is more frequently practised at night or in darkness; but may often be observed in the daytime among specimens in Aquaria.

One circumstance remains to be noticed; it is the manner in which the young are produced. They are thrown out from the mouth of the parent, one at a time. They glide about its body for a little while, or float freely in the water, but soon come to an anchor, and may be seen growing in groups not far from the secondary author of their being. Young *Actiniæ* are very beautiful objects, showing the characteristics of the species to which they severally belong, with more transparent delicacy than is seen in older

Plate VII

1.

2.

3.

Sowerby del. et lith.

Vincent Brooks Imp.

1. Plumose Anemone Sagartia dianthus expanded.
2. Variety of the same, closed. 3. Young of the same.

specimens. In the newborn young of *A. gemmacea,* the beautiful markings of the tentacula are distinctly conspicuous. Young Sea-flowers, jerked from the parent's mouth and colonizing near it, are among the most exquisite objects of an Aquarium.

Actiniadæ, as a family, are not however exclusively confined to creatures of the form I have described in this and the preceding chapter. There are considerable variations among different members of the group. There are some which have no adherent bases, but which possess other characters in common with true *Actiniæ;* some with tentacles scarcely retractile, others with knobbed tentacles. Other variations distinguish the different genera of the family, of which the following is a summary.

All *Actiniadæ* are divided into those which are *adherent* and those which are *not adherent.*

Adherent Actiniadæ are divided into those whose tentacles are retractile, and those which have non-retractile tentacles.

Adherent Actiniadæ with non-retractile or scarcely retractile tentacles are divided into two genera:—

1. With a simple circular base.—*Anthea.*
2. With a lobed and annular base.—*Adamsia.*

Adherent Actiniadæ with retractile tentacles have the tentacles knobbed, truncated, or conical, and are divided into the following genera :—

1. Tentacles knobbed.—*Corynactis.*
2. Tentacles truncated.—*Capnea.*
3. Tentacles conical.—
   Emitting filaments.—*Sagartia.*
   Not emitting filaments :—
   Warted : *Bunodes.* Smooth : *Actinia.*

Non-adherent Actiniadæ are divided into the following genera :—

1. Body tapering downwards; tentacles simple, equal, retractile.—*Hyanthus.*
2. Body cylindrical, with a rounded base; tentacles non-retractile, those of the outer circle long and those of the inner circle short.—*Arachnitis.*
3. Body worm-shaped; animal forming a protective sheath.—*Edwardsia.*
4. Body pear-shaped, with a posterior orifice.—*Peachia.*

Each of these genera will be more fully described when studying their representative species in the following Chapter.

CHAPTER V.

SEA-ANEMONES.—THEIR DIFFERENT KINDS.

SEA-ANEMONES, CONTINUED.—DIVISIONS INTO GENERA.—SAGARTIA.—BUNODES.—ACTINIA.—ANTHEA.—ADAMSIA.—ABNORMAL FORMS OF ACTINIADÆ.—CORYNACTES.—HYANTHUS.—CAPNEA.—ARACHNITIS.—EDWARDSIA.—PEACHIA.

If Sea-Anemones were all of one kind, one colour, one form, one uniform habit, however exquisite that one colour and form might be, its constant repetition would tire the senses, and having seen one or two specimens we should soon cease to admire the rest. It is so with flowers: it is so with beauty of every kind. If our ladies were uniformly fashioned after the strict model of beauty as set forth in the statues of Venus, it is doubtful whether they would find so many admirers as they do now, with their charming variety of feature, complexion, and expression. No tiresome sameness marks our sea-flowers, but every one presents some variation from others of its class. Each individual varies in itself; assuming now one shape, then another; now displaying one tint, then setting forth another in a different part of his body. Each specimen shows some slight peculiarity by which he may be known from others of the same variety. Each species has a range of variation, reaching perhaps from pale green to dark purple. Each genus presents distinct forms and characteristics in its species; and the genera differ from each other in striking peculiarities. Clustered in crowded colonies on sea-rocks and in pools on the beach; enriching the sands and pebbles with starry flowers, bright and variable, as rich and varied in form and tinting as any terrestrial flowers that can be produced for prizes on a gala day; there are the *Anemones*. The more we know of them, the more we shall admire their structure, economy, and transcendent loveliness.

We will now pass in review a few of the most remarkable and interesting species of true *Anemones*.

They are divided by modern writers into three distinct genera, namely, SAGARTIA, BUNODES, and ACTINIA. The latter name is retained for the genus containing our common species; it being a rule in nomenclature, when it is found necessary, on account of an increased number of species and increased knowledge, to divide a genus, that the original generic name should be attached to the first species to which it was applied.

There is one peculiarity in those species which are now placed under the generic name *Sagartia,* which is not observed in the others, and which forms a fair line of separation: it is that they have long threads or filaments contained in the soft parts of their bodies, which, when irritated or frightened, they throw out through pores in their skin. I have seen these threads thrown out to the length of an inch or more, and coiled up together at the ends. They contain filiferous capsules of the same kind as those contained in the tentacles.

The genera *Bunodes* and *Actinia* are separated upon less important grounds; namely, that the outer covering of the former is rough and warty, while that of the latter is smooth.

SAGARTIA ANGUICOMA.—(Plate VI. fig. 1, 2, 3.)

The "*Snake-locked*" *Anemone* is one of the most pleasing objects of a Aquarium collection, on account of the extreme gracefulness of its numerous, long, transparent, twirling tentacula, which have the appearance of a number of delicate worms, clustering and twisting about each other. It is very remarkable, even among the changing sea-flowers, for the extent of its changes in form. Now it is an almost flat button fixed to a piece of rock; now it is an upright cylinder, with a many-threaded head; and now it is a narrow worm three or four inches in length. It has been observed that its greatest tendency to elongation is in the dark. Its body is of a light buff colour, marked with irregular lines of brown, or interrupted light bands running down lengthwise. The disc, when expanded, is wide, mottled, and speckled with brown and white, with one or two dashes of pure white reaching from the mouth to the edge. The tentacles are in about five rows, of which the outermost are shortest and most numerous. They are all very long, flexible, and tapering; each with a delicate line of brown on each side. The longitudinal plates are conspicuously seen, on account of the general transparency of the flesh, and the filaments are seen twisted up in the spaces between. It is very pleasing to see in some dark corner of the tank, against a dingy background of rock, a specimen of this, with its Medusa's head displayed. Perhaps it is a rather young specimen, of the lighter and almost white variety; the darkness of the background beautifully setting off its pellucid feelers.

Sagartia troglodytes.

It is so named from its habit of choosing holes suited to its size, in which it lives, and into which it withdraws when disturbed; or it will bury itself in sand, producing and displaying its head above the surface, or at the head of its hole. The people classically known as *Troglodytes*, reported to have lived in caves and burrows, near the Gulf of Arabia, have suggested the name of this interesting species.

Sagartia bellis.

The *Daisy Anemone* also delights in hollows and fissures, into which it can withdraw and defy the collector who approaches it in its native haunts. The body of this *Actinia*, when fully expanded, is generally thinner in the middle than towards either extremity. In that condition, its sucking disc is expanded, and its oral disc spread out like the mouth of a trumpet. Sometimes the body is formed into a kind of cup at the upper end, and the disc hollowed into it. However deep the hole in which the *Daisy Anemone* lives, he must stretch out his body to reach the surface, so as to expand his disc beyond it, and he does so, sometimes, to the extent of three or four times the diameter of the body. The disc, being very thin, is sometimes extended in different directions, so as to vary considerably from a circular form, and has sometimes been described as *lobed*. The tentacles are very numerous and small; they are arranged in five or six rows; the innermost rows are the largest and least numerous; they are generally erect; the successive rows declining more and more, till the outer row lies nearly flat on the edge. Beginning at twelve tentacles in the inner circle, the number in each circle doubles, so that the whole would amount to between seven and eight hundred. Those on the outer rim only form a short fringe of minute feelers, not the sixteenth of an inch in length. From between each tentacle runs a radiating line to the centre, which gives a beautiful starry radiation to the whole. The colours of *Actinia*, or *Sagartia bellis*, are as follows. The lower part is white; a little higher, it becomes pink, which gradually assumes a purple hue. The upper part of the body and the disc are palely spotted. The surface of the disc is brown, sometimes mottled with grey. The tentacles partake the same colour, but are variegated with bands of white or grey, and sometimes speckled.

Mr. Gosse has given the following account of his examination of the tentacles of this species. "I cut off, with a fine pair of scissors, the tips of one or two, and submitted them to the microscope upon the compressorium. As soon as the pressure began to flatten them, it became apparent that the tentacle was composed of rather thick gelatinous walls surrounding a tubular centre. The wall was filled with a vast multitude of very minute granules, of a rich sienna-brown hue, and almost globular in form; all being quite alike in shape, colour, and dimensions. These escaped by thousands, on the increase of the pressure, from the tip of the tentacle, where was evidently a natural orifice forced open by the pressure, but ordinarily, as I suppose, kept firmly closed by muscular action. The gelatinous walls of the tentacle contained, imbedded in their substance, a goodly number of those highly curious organs known as filiferous capsules. They are in this case very minute, being about one twelve-hundredth part of an inch in length, almost linear and slightly curved. The pressure being continued, each of these little organs suddenly shoots forth from one end, to a great length, a slender, highly elastic thread, which had hitherto been coiled up spirally within its cavity. The expulsion of this thread is effected by a proper organism, excited by the pressure on the tissues of the tentacle, but not forced out by the compression of the capsule itself. It is supposed that the adhesive touch of the tentacles resides in these little organs, and that poisonous fluid accompanies the emission of the thread, since the mere contact of a tentacle with any small animal appears at once to paralyze it, however lively it may have been but a moment before."

Sagartia nivea.—(Plate IX. fig. 3, 4.)

The *Snow-white Anemone* is one of the most exquisite tenants of the sea or the tank. It grows in tidal pools under the weeds. The body is of a yellowish-brown colour, the disc pale, and the tentacles of the purest white. A variety occurs, however, in which the outer coating assumes a bright orange complexion, while the disc is chocolate-coloured, and the tentacles pure white. A fine specimen of this variety, seen floating in one of Mr. Lloyd's Aquaria, presented a splendid object. The specimen was transferred to the gardens of the Zoological Society.

Sagartia rosea.

The *Rosy Anemone* has the same habit as *S. bellis* and

S. troglodytes, of ensconcing its body in a hole, and spreading out its disc beyond its edges. The body contracts into a globe, wrinkled and studded with white glands; its general colour is brown, sometimes inclining to red. The fringe of tentacles is of a bright rose-colour. The mouth is four-lobed, and forms a cross; the edges of which are crenated with white. The disc is pale fawn, or olive, slightly silvered.

Sagartia candida

Is white in every part, excepting a rosy line round the rim of the outer coating, and pinkish spots at the base of the tentacles.

Sagartia parasitica.—(Plate XI.)

The habits of the *Parasitic Anemone,* in connection with the Hermit Crab, are so interesting that in spite of his comparatively small share of beauty, he secures a fair share of attention. It is a large species, attaining the height of three or four inches without diminishing the bulk of its cylindrical column. Its outer covering is rough and warty; it is of a dull greyish sandy colour, with stripes of brown or purple running down lengthwise, which are wider than the spaces between. The disc is expansive, and sometimes hollowed. It has numerous rather small tentacles, which are marked with cross brown bands.

Such is the Anemone which loves to ride on the back of a crustacean bearer. Although *S. parasitica* will sometimes fix himself on a stationary stone, or an empty shell, he more generally chooses a *Buccinum*, inhabited by the *Pagurus Bernhardus* or Hermit Crab, which blunders along among stones, rocks, and seaweeds, with his double burden, the uppermost of which does not seem daunted by the dangers of his passage. The Anemone generally keeps his disc expanded when he receives a concussion which would make most of his brethren "hide their diminished heads." No species throws out with more readiness than the *parasitica* those long adhesive threads which are characteristic of *Sagartiæ*. In his case they appear to be particularly tenacious and offensive, and the author of the 'Aquarium' relates an instance in which a single thread, although detached from the *Actinia*, adhered to a little fish on which it had been darted, so firmly, and appeared to cause so much agony that it died. The thread was probably detached from the *Actinia* by the fish's action; for, as a rule, the threads are withdrawn through their pores, and remain coiled up ready for use on the next occasion.

Sagartia dianthus.—(Plate VII.)

The arrival of a large number of magnificent specimens of this *Plumose Anemone* at Lloyd's establishment while I was there, tempted me to figure them as well as I could in one of our Plates. There were two varieties; one all orange; the other pinky-white with pale orange tentacula. It is a very large species, of a smooth, transparent, jelly-like texture, and remarkable for the beautiful manner in which its disc coils and puckers up into lobes, fringed with overhanging feelers. At a distance, it looks not unlike a cauliflower-head, and presents an object that may be admired, but scarcely portrayed. The young are very pretty, and show all the characteristics of their progenitors.

Bunodes crassicornis.

We now come to those *Actiniæ* which do not jerk forth filiferous threads, but which differ from the true *Actiniæ* in being rough and warty. The *Thick-horned Anemone* is remarkably so. It is a remarkably fine species, and one of the largest, if not *the* largest, of the British species. Sir J. G. Dalyell says:—" No species is equally diversified in colour and aspect. Red is usually predominant. The surface of many, however, is variegated, red and white, like a rose, or with orange and yellow intermixed. One occurred almost totally white, another wholly primrose-yellow. It may be truly affirmed that the diversities baffle enumeration and description." The variety which has the thick tentacles white, with bands of pink, is a very splendid sea-flower. *Bunodes crassicornis* sometimes agglutinates to its outer coat an extra coating of sand and gravel as an additional protection.

Bunodes gemmacea.—(Plate VIII.)

The *Gemmaceous Anemone* is remarkable for the rows of gem-like and pearly warts, which are arranged down the body, and the strongly marked white bands which cross the tentacles. The warts are round, well-defined, larger on the upper part, diminishing downwards towards the base. There are some rows of principal ones, and between them are rows of smaller ones. Generally about half-a-dozen rows at equal distances are white, so as to produce a conspicuous radiation when the animal is closed: it is then globular. The ground-colour is sometimes delicately rosy pink, sometimes of an ashy grey; altogether, unlike the generality of *Actiniæ*, it shows almost as much beauty when closed as when open. We can hardly, however, exaggerate its beauty in the latter condition. Every tentacle is a series of gems; their upper side has a dark ground-colour, across which are pearly white, bluish, and greenish bands. And even the very youngest displays all the characters of its parent, excepting that the tentacles are fewer in number.

Bunodes clavata.—(Plate VI. fig. 4.)

Nearly white, with sulphur markings; tubercles outside, with a pink spot in each.

Actinia mesembryanthemum.

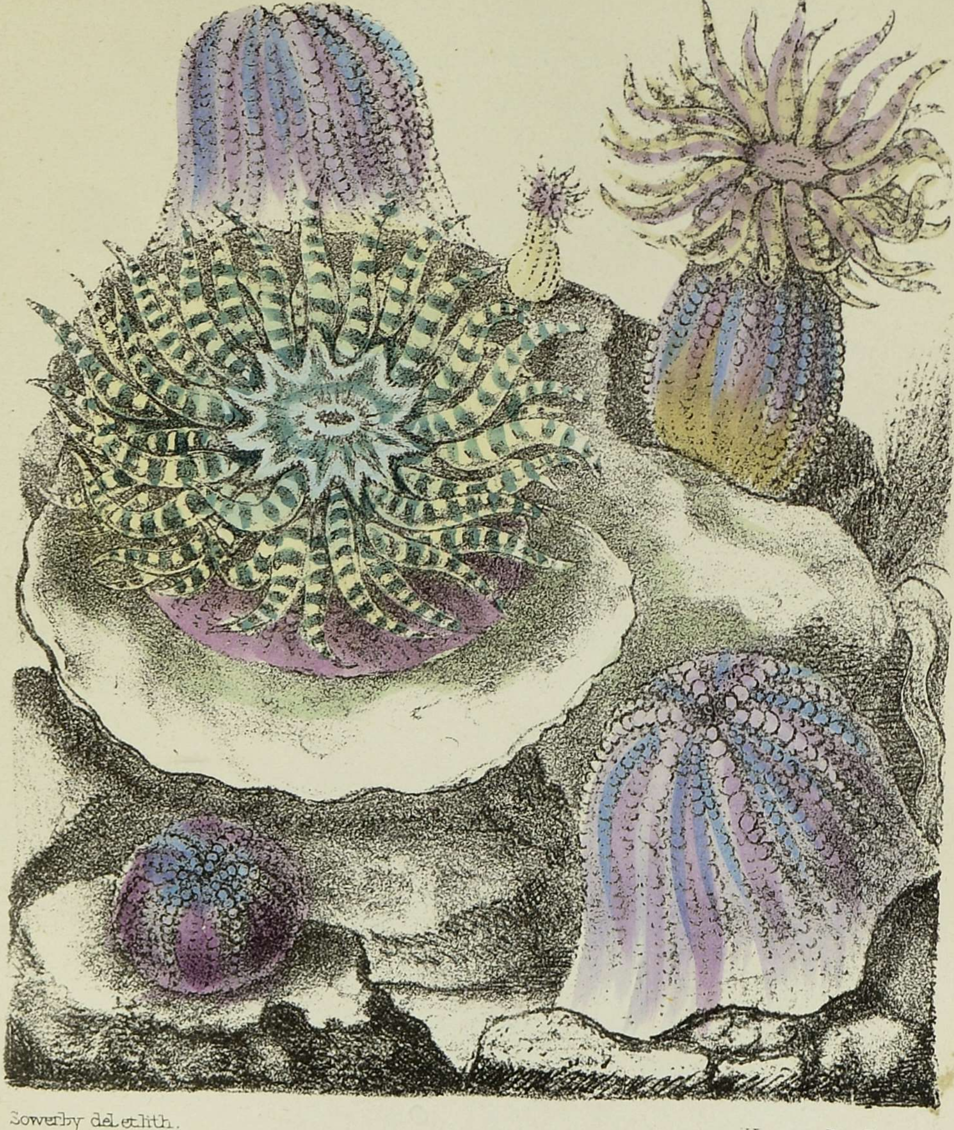
In the last Chapter but one, speaking generally of *Actiniæ*, we had occasion to describe some of the characters of this species, which is the commonest on our British shores. It is smooth outside, and is remarkable for having a row of beads on the inner edge of the outer coating, or between it and the tentacula.

In Plate VI., *Sagartia anguicoma* is represented in three forms, including extreme extension and extreme depression. *S. clavata* is fig. 4; *S. dianthus* occupies Plate VII., showing the two most beautiful varieties, and young. Varieties of *Bunodes gemmacea* fill Plate VIII. *Sagartia parasitica* is seen on the *Buccinum*, with the Hermit Crab, in Plate XI.

Anthea cereus.—(Plate IX. fig. 1.)

The genus *Anthea* is thus described :—"Body adherent, cylindrical ; tentacles numerous, scarcely retractile within the body, their bases united in clusters."

This Actinoid Zoophyte does not appear to differ very materially from the ordinary form of his order ; but its long tentacular arms are united in clusters on the disc, and seem incapable of being wholly withdrawn into the body. Although Mr. Gosse relates an instance in which a specimen in his possession did retract his tentacles, so far as only to show the tips on one occasion, the rule appears to be that they are not withdrawn. And as they had never, previously to this instance, been seen withdrawn, it was assumed by observers that they could not be so. In the instance of which I shall speak presently, in which an *Anthea* allowed his tentacles to be "held in suspense" by air-bubbles, I remarked to the keeper that it would be inconvenient if the animal wanted to "shut up shop." The man



Sowerby del et lith.

Vincent Brooks Imp.

Gemmaceous Anemone Bunodes gemmacea.)
expanded and closed.

seemed rather to pity my ignorance, and told me that such a thing never occurred. In fact, at that time, I had seen very few Zoophytes, and had never read Johnston.

The manner in which these long and slender purple-tipped arms coil and recoil, spread themselves out, and feel about for a passing *bonne bouche*, is very amusing. They are exactly like a great number of snakes confined by one extremity and free to move about at the other. Each tentacle is about an inch and a half long in specimens of medium size, although I have seen them considerably longer in fine specimens. They have great power of adhesion, easily holding anything they touch. They are said to possess a stinging power, but this does not appear to be well authenticated; indeed those who have tried them with their fingers have not experienced any sensation, excepting that of adhesion. *Antheas* are very voracious, and very clever in securing prey. Many a beautiful Prawn in the tanks has fallen a victim to the handy use of their long arms. If but a small part of a limb be but touched by one of them, and the smallest purchase obtained, the other arms soon crowd round to help the first in securing the prey, which is soon entangled among them, and, in spite of all it can do, is drawn irresistibly into the fatal gulf.

The Antheas in the tanks of the Zoological Society are numerous and fine, particularly that variety of *Anthea cereus* which has its tentacles very long and slender, of a greenish tint, or buff with pink or purple tips. These tentacles do not seem to be arranged in symmetrical circles, but hang in a kind of irregular bunch, turned and twisted in all directions. It is but rarely that they are seen apparently motionless, and even then a near and steady gaze will detect a slight action in the extreme tips of a few of the most distant. In general there is a slow, graceful twirling among all the anthers, excepting when some living animal swims, or is pushed sufficiently near to attract attention. Then all the anthers twirl and coil in the most grotesque combinations, and look like a twisted knot of small snakes engaged in mortal combat. In the sea, attached to the rocks, these Antheas would appear as fixtures, and on being removed, the rock beneath them presents a hollow, as though they had corroded or eaten away a space corresponding to the size of their foot, like the limpets and some Cirripedes. This would appear to indicate a very sedentary, stationary life; but the habits of the creature when in captivity do not well correspond with this indication; for, in the tank, he shifts his position rather frequently, and although, when observed, the motion is not quite perceptible, yet in the evening you may leave him seemingly fixed at the bottom of one end of the tank, and, in the morning, find that he has crawled up to the top of the glass sides at the other end. When seen through the glass a curious view is afforded of the broad circular disc which constitutes the base of his stem, and which corresponds with the foot of the Gasteropodous Mollusca,—in fact, it is his organ of locomotion. It is generally nearly white, or partaking slightly of the body tint, as seen through its transparent, jelly-like substance. From nearly the centre to the circumference, radiate opaque thread-like lines which increase in number near the outer edge. Those who have seen sections of Star-corals would at once recognize the resemblance of these fibres to the bony plates constituting the skeleton of the latter.

The *Anthea* has the power of swelling out parts of its body into lobes, which assist it in crawling. In doing this it spreads out a portion of the disc on the side towards which it is travelling, gets a firm hold by that portion, and then draws up the rest to it; repeating the process until the distance is accomplished. It will sometimes come to the edge of the water, and keeping its attachment by part of its foot to the sides of the glass, turn over the other portion to a plane with the surface of the water; so that half the body and anthers are suspended by a dry portion of the disc from the air, and the other half by the more solid attachment to the glass; but it cannot, like the Water-snails, float on the surface wholly in this inverted position. The tentacles present a very beautiful and animated appearance when the body is partly suspended. They are moved about in the most graceful curves, and while each separate tentacle seems to have a will and spirit of his own, yet a harmony of motion, and unity of purpose, is seen to pervade the mass.

In watching the tanks at the Regent's Park, I noticed a circumstance showing the very quiet and patient habits of the *Anthea*. A very large, healthy specimen, fixed to a piece of rock near the bottom of the water, with his tentacles beautifully tinted, lay twirling some of them with a gentle and graceful motion, quite active enough to show that the Zoophyte was alive and wide awake. Several disengaged threads of confervæ had been drawn up from the bottom by means of numerous bubbles of air. On their way up, some of them being attached to the bubbles at both ends, had looped round some of the longest of the

Anthea's tentacles, whose dead weight, apparently without any voluntary resistance, was sufficient to arrest any further progress of the rising shreds. Thus, suspended in mid-water, were the globules of air holding up the loops of conferva, and these loops keeping the tentacles of the *Anthea* suspended in an unnatural position above the body,—a position very similar to that of the arm of a rider passed through one of the looped bands hanging by the side of a carriage window. The least effort, or contraction of the limb, would either have broken the loop, or have drawn it down, and released the air-globules which suspended it; but no, our *Anthea* preferred "taking it easy," and, although his tentacles were awkwardly bent, he seemed inclined to rest them as they were. Well, I watched a little while longer then, but no movement. Leaving the tank for a while I returned after two or three hours. There were the same tentacles, of the same *Anthea*, hanging by the same threads, in the same position. Well, surely when the Zoophyte shuts up for the night, he will burst his bonds. Oh no, I forgot! The *Anthea* must be supposed never to shut up, for Johnston says, "tentacula . . . incapable of being retracted within the body." On returning the next morning, there were still, in the same relations to each other, the bubbles, the green threads, the *Anthea* and his arms. Shortly after, however, the animal managed by slow degrees to shift his entire position, and take his place in another part of the tank.

ADAMSIA PALLIATA.

The "*Cloak Anemone,*" although of the same nature as *Actinia,* is very different in form. Instead of being a symmetrical body with upper and lower circular discs, it is an enveloping body with linear and one-sided aperture. Like the *Parasitic Anemone,* it attaches itself to empty shells of *Buccina,* or "*Whelks.*" Taking its place on the body of the shell opposite its mouth, its disc spreads out at each side; one lobe reaching towards the notched part of the mouth, and the other towards the spire. Passing the notch on one side, and the spire on the other, it begins to invest, at each end, the outer lip of the shell's mouth. Continuing to spread round, the two ends meet and become united by a cicatrix, or seam. Having spread broadly in investing the mouth, it has very considerably retracted the opening. On the side where it first settles, remains the mouth, which is long and narrow, and fringed with a row of short, scarcely retractile tentacula. As a broadly expanded disc could not rest at angles with the vertical edge of the aperture, the *Adamsia* forms an incurved ledge, or bent extension of the edge, of a horny substance secreted by itself, thus making its own bridge and passing over it at the same time,—a very surprising instance of instinctive adaptation of a creature to its circumstances, which will be made further interesting when we find that there is another creature, whose convenience is greatly cared for in the arrangement. The shell thus enlarged in volume, but decreased in its opening by the *Adamsia* and its horny ledge, forms a most happily contrived case for the dwelling of a Hermit Crab, *Pagurus Prideauxii.* These two tenants of the old deserted mansion are generally found in company, and probably contribute to the supply of each other's wants. The Hermit supplies the deficiency of locomotive power in the Anemone, by travelling about in search of food for himself. Small fragments of his food may also fall to the share of his humble house constructor; and it sometimes happens that, a large morsel being seized by the latter when the former is in want, the Hermit, acting upon the principle that "might is right," may compel his weaker companion to divide the spoil. *Adamsia* is generally of a reddish-brown colour, becoming pale and cream-coloured near the mouth. It is striped with bluish lines and marked with purple spots.

Anthea cereus is figured in the position described above, at the top of Plate X.

Abnormal Forms of Actiniadæ.

Corynactes Allmanii.

This curious little animal differs from the more normal *Actiniæ* in having the tentacles short and headed with bead-like globes. It is very beautiful and very variable in the position and shapes it assumes. *Corynactes* are found in tide-pools in great numbers, and displaying a great variety of colours, and hanging from overhanging ledges with their coronets of knobbed tentacula.

Being of a very thin substance, they are capable of contraction to a very small flattish button. When extended and expanded, the edge of the disc is seen to be crenated and brightly coloured ; but when more fully expanded, the disc spreads beyond the diameter of the body so as to bring the tentacles over the rim. The tentacles, like those of the British Coral, *Caryophyllea Smithii,* are short cylindrical bodies, with round heads ; they are arrayed in two circular rows near the edge, and two other circles, less complete, towards the centre; in all the rows amounting to eighty or ninety to above a hundred.

In *Actiniæ* generally, a morsel of food is laid hold of by the tentacula and brought towards the mouth; but when the *Cornyactes* feeds, the lips of the mouth expand until their circle reaches the morsel held by the tentacula. The opening sometimes extends to the whole width of the body, so as to show the very bottom of the stomach; and as soon as the lips reach their prey it is soon drawn into the basin, and sunk into the vortex.

Corynactes Allmanii is commonly of a pale roseate hue, with the rim of bright scarlet, or bright green, and the tentacles are generally white.

The thread- or sting-darting capsules are large in the *Corynactes* compared to those of some other *Actiniadæ*. They are oval, and the thread, infinitesimally thin, is coiled up in its cell, ready to be unfurled or jerked forwards when required. Its extreme thinness may be imagined when we find a thread the eighth of an inch in length, coiled in more than a dozen spiral folds.

They have also a smaller set of capsules, the threads of which are furnished with a brush of minute hairs.

Capnea sanguinea.

The genus is described as having the body invested in a lobed skin, the base of which is very much dilated; it is reflected so as to form a kind of frill near the upper edge. Tentacles truncated, in a single row, short, and, when expanded, shaped like the embattlements of a tower. *C. sanguinea* is of a bright vermilion colour. It changes its proportions as to width and depth, but generally preserves a tubular or cylindrical form.

Iluanthus Scoticus.

Iluanthus is thus described by *Forbes*:—"Body cylindrical, tapering to a point at its extremity, free? Tentacula simple, retractile, surrounding the mouth." It is a free *Actinia*, about an inch and a half in length, fixing itself in the mud by its narrow end: from this habit it is called the "Mud-flower."

Arachnitis albida.

This is another very curious abnormal form. The genus is thus described:—"Body adherent, or free at will; cylindrical with a rounded base; mouth surrounded by non-retractile tentacles (about sixteen) in two series, the outer ones very long, the inner short: it either swims like a *Medusa* or adheres in deep water." The tentacles of the outer row are very worm-like and long, like those of *Anthea* and *Cereus*, and probably enable the animal to swim through the water.

EDWARDSIA VESTITA.—(Plate IV.)

In a communication made in 1841 by the late lamented Professor Forbes, and published in the 'Annals and Magazine of Natural History,' an account is given of two interesting marine animals found in the Ægean Sea.

One is the animal now before us, and the other, a curious Annelide. "The depth of the bay," says the Professor, "is generally from seven to ten fathoms, the bottom sand and seaweed, chiefly *Zostera*. At the entrance of the bay there is deeper water, from seventeen to thirty fathoms, with a bottom of Corallines. The animals different according to the bottom and depth. . . . There are also a number of sandy bights, which, in places where streams run in, are crowded with *Cerinthia;* in others, are inhabited by great numbers of *Testacea* and *Foraminifera*. In these sandy nooks live two animals, the one an Annelide, the other a Polype, so remarkable on account of the peculiarities of form and habit, that I have thought it might prove interesting to transmit this short notice."

The Polype was afterwards described as *Edwardsia.* It is a free, worm-shaped *Actinia,* which constructs a leathery tube to live in. The cylindrical body terminates obtusely at one end, and in a flower-like disc at the other. In the centre of the disc is a circular mouth surrounded by numerous short tentacula springing from its inner margin. Round the outside of the disc is another row of larger tentacula, very much like those of an ordinary *Actinia.* The tentacles are never withdrawn into the mouth, but are often reduced by contraction to very small dimensions. Mr. Forbes observes, that the body can be greatly lengthened so as to assume the form of a tapering worm, or *Holothuria;* and that it is protected by a membranous tube, which is itself strengthened by an incrustation of gravel and shells in the manner of a *Terebella.* It can move freely up and down in this tube, and sometimes, leaving it altogether, construct another. When out of the tube, our *Edwardsia* crawls along very much in the manner of a worm, but with the disc expanded, and perhaps using the tentacles at its margin as organs of locomotion. It soon secretes a quantity of glairy matter, to which shells and sand adhere, and which soon becomes thickened and opaque. It is a very voracious feeder. Mr. Forbes further remarks, that "In the habit of protecting itself by sand and gravel, it resembles *Actinia viduata* and some other species, none of which, however, construct a regular tube. In its being free and having no adhesive disc at its posterior termination, reminds us of *Iluanthus*, a genus of *Actiniadæ*, which I discovered three years ago on the Scottish coast, and which I described and figured in the 'Annals of Natural History.' It is evident the animal I now describe fills up an important gap among the polypes, and leads to analogical consideration of the greatest interest to the philosophical zoologist."

The Annelide, found at the same time, will be described in its place, under the name applied to it by Chénu, of *Amphitrite Ægeana*. But it is a very curious fact, that both these forms, differing from all other forms in their respective classes, discovered at the same time and place, by the same illustrious naturalist, as presenting each a new link in the chain of beings, should both prove to be natives of our coasts, and find their way at the same period into our own collections. The Annelide did so by accident, having appeared spontaneously growing among the pebbles of a central tank in the Zoological Gardens, at about the same time that Mr. W. A. Lloyd procured the Zoophyte in some numbers from the coast of North Wales. Specimens of the latter may now be seen at the Zoological Society's fish-house, and at the establishment of Mr. Lloyd, in the Portland-road. My figure is taken from one of that gentleman's finest specimens, which had made its covering under his own observation. The worm had been removed, and, after a few days, was found secreting its slime, which gradually became opaque and thick. It is of a dull greyish-purple colour, and looks like very ragged leather hanging in shreds in many places. It is open at both ends, and it appears to be the habit of this Zoophyte to leave the hinder extremity uncovered: I noticed this in all the specimens. Mr. Forbes remarks that the creature is very voracious, crawling about, when divested of its covering, and attacking everything it came in contact with. I do not know whether it was an instance of this that we witnessed at Lloyd's. There were a number of specimens in a shallow pan, some in and some out of their *blankets;* one fellow in the latter state had been crawling slowly about round the pan, when presently we noticed that he had come in contact with an *Actinia:* their tentacles were all engaged, but which was the aggressor, it was difficult to say. However this might be, the *Edwardsia* was evidently getting the worst of it, and appeared evidently in danger of being swallowed by his more sedentary antagonist. They were parted, when the *Edwardsia* lay on the bottom of the vessel apparently very much exhausted, with his tentacles shrivelled up. Unfortunately the final result was not known: whether it died or recovered, I am unable to say.

PEACHIA HASTATA, *Gosse.*

This is another abnormal form of Actinoid Zoophyte, approaching, in form and appearance, the character of the Sea Cucumber, and differing from all other Actinias in having a posterior opening. It is unattached, and lives buried with its body upright in the sand, the tentacular disc being aboveground. It was found by the Rev. Charles Kingsley in the neighbourhood of Torquay, and described by Mr. Gosse in the 'Transactions of the Linnæan Society.' The body is pear-shaped, transparent, very pale red, with white longitudinal lines running from one end to the other, at equal distances. It is protected partly by a very thin epidermis, which is apt to burst and hang in shreds when the animal distends itself. The upper disc is oval, surrounded with twelve tentacula, which are ornamented with arrow-headed brown markings on a white ground; they are bent outwards and backwards. From the mouth protrudes a fleshy proboscis, the top of which spreads into a clubbed head, divided into papillæ. Mr. Kingsley gives the following observation on the habits of this Zoophyte:—"They lie (or rather stand) in wet, ribbed, clean sand, at low-water mark, the disc just out of ground. On digging carefully (for the animal retracts on the least shaking of the sand) you find that he is buried bolt-upright to the depth of nine inches, where his extremity stops; the whole animal tapering gradually from stem to stern. On being taken out (no easy matter, since its power of retraction, if irritated, is far more springy and rapid than in any of the class, as far as I have tried them), and put into a vase of salt-water, he swells himself out with water like a *Holothurian*, disclosing longitudinal septa. All his motions are rapid and spasmodic; betokening, as does his whole make, a higher muscular organization than that of the *Actiniæ*."

Sowerby del. et lith. Vincent Brooks Imp.

1. Anthea cereus, with two tentacles suspended by confervæ and air-bubbles.
2. Bunodes miniata. 3 and 4. Sagartia nivea.

CHAPTER VI.

SEA-BELLS AND CORALS.

LUCERNARIA.—ZOANTHUS.—MADREPORES.—COMPARED WITH ANEMONES.—THEIR BEAUTY.—FEEDING.—BALÆNOPHYLLEA.—TURBINARIA.—OCULINA.—CORALS AND CORAL ISLANDS.—MUSHROOM CORAL.

THE *Lucernaria* is very closely allied to the *Sea-Anemones*, and may be termed a *Sea-Bell.* It differs greatly in form from the family of *Actiniadæ,* and presents a set of characters which place it sufficiently apart from all other forms. The genus *Lucernaria* is thus described :—"Body bell- or goblet-shaped, adherent or free at pleasure: mouth quadrangular, in the centre of a membranous expanded disc; tentacles knobbed, clustered in groups on the projecting angles of the disc."

LUCERNARIA AURICULA.

This little bell, hanging on the stems and branches of seaweeds, and expanding its web-like disc in the transparent water, presents one of the most beautiful objects that can be conceived. It has been found on *Fuci*, on the coast of Devonshire, by Montagu and Fleming; and at Weymouth, by Gosse. From its elegant form it suggests a variety of comparisons, such as the flower of convolvulus, the expanded mouth of a trumpet, a hanging bell, and a small *Medusa*.

It has a short knotted stalk, which is capable of adhering to the stems on which it hangs, or of gliding along it and shifting its position. The narrow end of the bell is attached to this stalk, and is divided by eight beaded or knotted ribs. The bell expands rather suddenly towards the outer extremity, where it attains the form of an octagonal disc. The disc is thin and filmy, and at each angle of the octagon is a little cluster of thread-like tentacles, which are, like those of *Caryophyllea*, globular at the ends. Mr. Gosse thus describes his examination of some young specimens:—"Collecting a basketfull of tufts at random, I brought them home; one by one I waved them to and fro, in the tank of water, between my eye and the light, whereby the animals became distinctly discernible, and were easily detached. Sometimes four or five were scattered over one tuft of the parasitic plant, and it was rare to find a *Rhodomela* of any size without one at least."

"The specimens were evidently the young of the season: but many were no larger than I have named; but some were as much as one-third of an inch in diameter. They were very beautiful, closely resembling a bell or trumpet-mouthed monopetalous flower, with a short flexible foot-stalk, and a small, expanded, sucking disc at the base. The substance was clear, transparent, gelatinous; the flower-like expansion thin and filmy, with the margin projecting into eight equidistant points. From each of these points radiated about twenty slender tentacular threads, bearing at their extremities orange or yellow globules. The ovaries radiated in eight irregular bands from the centre of the flower to the marginal points, and from the centre itself projected a little, protrusile, four-cleft mouth, closely like the peduncle of a *Thaumantias*. Indeed I was strongly struck with the resemblance which the entire creature bore to a small *Medusa*, and I consider it as a link that connects the normal *Actiniæ* with the *Acalephæ*."

Lucernariæ are found at low water on the under sides of floating leaves of *Zostera*, mouth downwards, seeking for prey. Here, in their natural situation, they are believed to be very active, throwing out their threads in various directions, moving from one spot to another, and easily holding and devouring any small shrimps or other marine animals that its long-reaching tentacula bring near enough to its mouth. In confinement they are very difficult to keep alive, and even while still surviving they seem to lose much of their strength and activity; in short, not taking kindly to their confinement, they soon become weak in all their functions and die.

Zoanthus Couchii

Resembles a cluster of small *Actiniæ* united together by a creeping, root-like, fleshy band. Each *Actinoid* body is capable of contracting into a half-globe, like the true *Actiniæ*, or of extending its trunk and expanding its tentacular disc like them; while its connection with others of its race by means of a fleshy band which unites many individuals, takes it out of simple, and places it with compound Zoophytes. Thus it presents one of those anomalous forms with which every part of Nature's great series is studded, and which shows that the God of Nature will not be restricted in the fashion of his works by wise rules of uniformity invented by man. Man would have had all Hydræ or all *Actiniæ*. God varies his productions by giving us a Zoophyte partaking some of the characters of each.

Corals.

(Plate III. and Plate XVII. fig. 4.)

On seeing one of the beautiful specimens of white branching Madrepore, or of hemispherical Brain-stone, which are brought from the South Seas, we are told that this elaborate structure is the work of minute animals existing in those seas in countless myriads, and that whole islands are composed of similar structures in large masses. We are astonished at the intelligence, if we have not heard it before, but find it difficult to form a clear conception of the fact, or of the manner of its production. The English coasts afford no examples of coral reefs or rocks, excepting in a fossil state; and we can scarcely hope to see the aforesaid animals engaged in the process of building a coral island in one of our tanks, however large its dimensions. The few species of Coral-forming Zoophytes which can at present be brought within actual observation in a living state, are so simple in construction, and so small in size, that they appear almost unworthy of being considered by the side of the magnificent and varied specimens brought from foreign seas, which yet dwindle to insignificance compared to the immense masses from which they have been torn. Yet if we examine our own British species, it will not be difficult to trace the line that leads from them to the more complicated forms of their wonder-working brethren in distant oceans.

Caryophyllea Smithii.—(Plate III. fig. 2 to 7.)

Some of the *Actiniæ* are very fond of crawling upon the glass sides of a tank, so as to present their basal disc to the observer. It is of an irregular circular form, and a transparent whitish substance; but from the centre may be seen numerous opaque white threads radiating to the circumference. These threads must be the edges of folds or plates running through the body of the animal lengthwise. In the *Actinia* the plates, although more opaque, and consequently more dense, are yet soft, and essentially composed of the same substance with the other parts of the body. If we cut the body across in any other part, so as to form another disc, the same radiating white lines would appear, indicating a continuation of the vertical plates. But if, instead of being soft or gristly, these plates were hard and bony, we should be presented with exactly what occurs in the case of our little Coral: *Caryophyllea Smithii* might, in fact, be described as a Sea-Anemone with a bony skeleton; and the description would be almost correct.

In the Aquarium, with their scalloped scarlet fringes, their delicate salmon-tinted filaments and membranes, their purple-bodied and white-headed tentacles, and their symmetrical skeletons, they present very pleasing and flower-like objects when viewed in themselves; but they become far more interesting when we see in them the simple and humble representatives of those wonderful structures to which we have alluded. Mr. Gosse, in detailing the circumstances under which his first living specimens were obtained, observes that they were all fixed either on upright or overhanging surfaces, and in no case with their faces upwards. This might have afforded a lesson to the keepers of Aquaria, who should have fixed their specimens in a similar manner. The specimens might have been brought attached to their pieces of stone, and the pieces fixed in the required position. Perhaps, if the habits indicated by Nature were followed more faithfully in Aquarian arrangements, we might see the characters of these and many other water-animals more fully developed. The following is Mr. Gosse's account of his Coral-gathering.

"I searched some time without success for the Coral, and had begun to despair of finding it; for the tide was almost at its lowest; when suddenly I caught sight of one projecting from under the surface of one of the slanting ridges of rock. The water would not allow me to reach it with any hope of detaching it uninjured, but presently I peeped into a small cavern formed by large masses of rock piled one against another, in which there were nearly a score of them. By a little manœuvring, I managed to squeeze my body between the stones, so as to work with the chisel, disregardful of the water which covered my feet below, and the coating of mud, the slimy Zoophytes, and Sponges, that adhered to the overhanging rock above me. The Corals varied in size, from that of a pea to three-quarters of an inch in diameter. They were not at all clustered, but scattered at irregular distances. I observed them to be fixed to perpendicular and overhanging surfaces, but in no case on a diagonal or a horizontal one with an upward aspect; not even in the remotest part of the cavern. All that I saw were left exposed by the receding tide, though in any but spring tide they would all have been constantly covered. I afterwards found a few more on the sides of pools in the rocky ridges several feet above low-water mark."

The fleshy part of the animal is seldom evenly spread over the circular surface of the disc; for it will sometimes leave the plates apparently bare at one end while it hangs out in a mass from the other end. Sometimes it will retreat altogether, so as to be scarcely seen between the plates, and the red centre contracted into the small star at the bottom of the hollow, only showing a thread-like slit indicating the mouth; like the *Serpulæ* and other Annelides, it retreats into its shelly cave almost instantaneously when touched or startled.

I have not been fortunate enough to see the fleshy part of the *Caryophyllea* extended, as is sometimes described, very considerably above the edges of the plates; and, in fact, on looking at a specimen living in its usual quiet condition, you would hardly suppose it natural for it to assume so distended a state. As the Anemone, when placed in unnatural circumstances, will sometimes turn its stomach, as it were, inside-out, may it not be that the Coral, when so observed, is dissatisfied with its position, as when in captivity, or unexpectedly left by the spring tides without moisture?

The soft parts of this Madrepore, viewed externally, consist of, first, a thin film investing the plates on their edges and sides some distance down; secondly, of tentacula resembling those of an *Actinia*, which seem to be irregularly placed on various parts of the film, and to make the interstices their home when withdrawn between them; thirdly, the scalloped fringe surrounding the mouth; fourthly, the mouth itself, represented by a central slit. The most beautiful specimen in the Aquarium of the Zoological Society is one in which the enveloping skin is of a delicate salmon-tint, the tentacula tinged with purple, the frill in the centre bright crimson, and the mouth, or rather lips, white. The tentacula have swellings or knobs on the tips; but these are not, in the Zoological specimens, nearly so distinct nor so remarkable as represented in the 'Devonshire Rambles.'

"The feeding of the Madrepores," remarks the Author of the last-mentioned Work, "affords much amusement; they are very greedy, and the presence of food stimulates them to more active efforts, and the display of greater intelligence, than we should give them credit for. I put a minute spider, as large as a pin's head, into the water, pushing it down with a bit of grass to a Coral, which was lying with partially exposed tentacles. The instant the insect touched the tip of a tentacle, it adhered, and was drawn in with the surrounding tentacles between the plates, near their inward margin. Watching the animal now with a lens, I saw the small mouth slowly open, and move over to that side, the lips gaping unsymmetrically; while, at the same time, by a movement as imperceptible as that of the hour-hand of a watch, the tiny prey was carried along between the plates towards the corner of the mouth; the latter, however, moved most, and at length reached the edges of the plates, and gradually took in and closed upon the insect; after which it slowly returned to its usual place in the centre of the disc."

The Madrepores, however, are not undiscriminating in their greediness; for, after swallowing a morsel and tasting it, they will frequently reject it, if it does not meet their approval.

They exhibit under certain circumstances a remarkable power of reproducing parts. Thus new plates will replace those accidentally broken, and a specimen, the base of which had been partly detached from the rock on which it grew, formed a new mouth at the exposed part of the base with tentacula and all complete; so that the creature could receive food at both ends, and double all the functions of life; the new mouth stretching and gaping, and enclosing its prey, with as much regularity as the old one! It has also been observed that, when a specimen was divided perpendicularly, each half of the mouth, etc., would act an independent part without much apparent inconvenience.

BALANOPHYLLEA REGIA.—(Plate XVII. fig. 4.)

This pretty little species was discovered and described by Mr. Gosse, who ascertained that it differed in many important particulars from the *Caryophyllea*. It is difficult to say which is the most beautiful of the two; each has beauties of its own. The *regia* has a much more bright and sparkling appearance than the *Smithii*. The body is of a brilliant scarlet, and the tentacles are of a yellow tint. They are not terminated by a little globe, but are conical, and more or less bluntly pointed. Numerous warts, by which they are studded, give them at once a granulated appearance and a golden hue. However contracted the animal may be, it is always sufficiently thick over the plates to hide them completely; and the mouth, instead of receding into the central hollow, protrudes in the form of a high conical proboscis. Mr. Gosse observes, that, "if any additional evidence were wanting to show that this species approaches much nearer the *Actinia* than *C. Smithii* does, it would be found in the stony skeleton. This is very different in appearance from that of the kindred species, and is manifestly rudimentary. When the soft parts have been carefully removed by several days' maceration in fresh-water, and the gelatinous matter all cleared away from the stony plate by a slender stream of water allowed to run upon it from a height, a vertical view shows the following arrangements. First, at the very margin there is a narrow circle of white calcareous plates, small and very irregularly anastomosing, so as to resemble in miniature the honeycombed limestone-rock that we find in Torquay and elsewhere. In the centre of the cavity, there is another loose spongy mass of similar irregular plates. Eighteen perpendicular radiating plates extend between the marginal circle and the central mass, arranged in six threes, so as to make a six-rayed star. The plates are all very rough, with irregular projections and erosions. They do not rise in an arched outline above the level of the margin, but the whole surface is concave." I had noticed in the British collection of the British Museum a few specimens, marked "Ilfracombe," which struck me as extremely different from the skeleton of *C. Smithii*, before being aware of Mr. Gosse having thus completely described this species. It has since been taken in considerable numbers, and living specimens can be easily obtained.

Turbinalia milletiana.

This is a very small Madrepore, shaped like a top, with ribs or plaits lengthways, but flattened at the sides. It seems to present no point of attachment, and must therefore have a free set of plates within a moving animal, thereby taking another step towards the *Actinia*.

Oculina prolifera.—(Plate III. fig. 7.)

Here we have a branched Coral, presenting a series of radiating circles of plates united into one stem. Our figure is from a small specimen in the British Museum; but specimens of considerable size are procured occasionally, the largest specimen weighing six pounds. It was first found on the coasts of Norway. On British coasts it is rare, and has not yet been taken in a living state.

These are the British Corals. We find that they are bony skeletons of Actinia-like Zoophytes; not made by pincers and mandibles like wax honeycombs, but secreted within the body of the animal in the same manner as our bones are secreted within our own. It is the habit of the *Caryophylleæ* to live singly, not attached to each other, but to independent bodies. The young generally separate entirely from the parent, and the result is in each case a simple single-rayed Coral. But it does sometimes happen that the young *Caryophyllea* lingers about the parent until it has formed its skeleton, and then becomes permanently attached, and grows as a branch on the parent stock; or it may be that in some instances it is reproduced by budding at the sides. In this abnormal condition we have a transition from the single-rayed Coral to the branched or many-rayed Coral, which is presented, although in a humble form, in our *Oculina*. Then again, these branches may be formed on differently shaped stars on differently shaped stems aggregated together by very different rules, and at different angles, so as to form very differently shaped masses: but the same principle may be traced throughout. Branch being added to branch, and mass to mass, it is not difficult to imagine the formation, steady and certain, but gradual, of rocks, which in time may become tracts of land. It is impossible to treat of this wonderful subject without introducing the oft-repeated lines of Montgomery, although my readers must have seen them over and over again.

> "Millions of millions thus, from age to age,
> With simplest skill and toil unweariable,
> No moment and no movement unimproved,

Laid line on line, on terrace terrace spread,
To swell the heightening, brightening, gradual mound
By marvellous structure climbing towards the day.
Each wrought alone, yet all together wrought;
Unconscious, not unworthy instruments,
By which a hand Invisible was rearing
A new creation in the secret deep.
Omnipotence wrought in them, with them, by them;
Thus what Omnipotence alone could do,
Worms did. . . .

" Atom by atom, thus the burden grew;
Even like an infant in the womb; till Time
Delivered ocean of that monstrous birth,
A Coral Island, stretching east and west,
In God's own language, to its parent saying,—
'Thus far, no farther, shalt thou go; and here
Shall thy proud waves be stayed.' A point at first,
It peer'd above those waves; a point so small,
I first perceived it, fix'd where all was floating;
And when a bubble cross'd it, the blue film
Expanded like a sky above the speck;
That speck became a hand-breadth; day and night
It spread, accumulated, and ere long
Presented to my view a dazzling plain,
White as the moon amid the sapphire sea;
Bare at low-water, and as still as death;
But when the tide came gurgling o'er the surface,
'T was like a resurrection from the dead;
From graves innumerable, punctures fine,
In the close Coral, capillary swarms

Plate X.

Sowerby del. et lith. Vincent Brooks Imp.

1. Sea Cucumber, Pentacla pentactes, headless specimens. 2 & 3. Healthy specimens. 4. Phylline (Bullæa) aperta. 5. Shell of the same.

Of reptiles, horrent as Medusa's snakes,
Covered the bald-pate reef; then all was life,
And indefatigable industry;
The artisans were twisting to and fro,
In idle-seeming convolutions; yet
They never vanished with the ebbing surge,
Till pellicle on pellicle, and layer
On layer, was added to the growing mass.
Ere long the reef o'ertopped the spring-flood's height,
And mocked the billows when they leap'd upon it,
Unable to maintain their slippery hold,
And falling down in foam-wreaths round its verge.
Steep were the flanks, with precipices sharp,
Descending to their base in ocean gloom,
Chasms few and narrow and irregular,
Form'd harbours, safe at once and perilous,—
Safe for defence, but perilous to enter.
A sea-lake shore amid the fossil isle,
Reflecting in a ring its cliffs and caverns,
With Heaven itself seen like a lake below."

Yet it is incorrect to suppose that the Coral Islands, as they are called, are composed entirely of Corals from their very foundations. It has been well advanced, and almost proved, that the islands were originally volcanic mountains rising to a great height above the sea. Round the base of the mountain these Zoophytes commenced their operations, and fringed the edge at low-water mark. By degrees, the island began to sink, and the fringe of Corals would sink with it, but that it is the instinct of these animals to work upwards, so as to keep near the surface, for they do not live in deep water. They also increase more vigorously at the outward or seaward edge; so that when the mountain has sunk a little, and the Corals nearest to it have not risen in proportion, there is formed a channel or lake between the island and the outer edge of Corals; and this outer edge forms what is called a Coral-reef. As the island sinks lower and lower, the lake or lagoon becomes wider and wider, and in some cases, the island has sunk below the surface of the sea, while the surrounding reef, keeping up to the surface, and becoming in process of time covered with soil and vegetation, forms that circular kind of island which is called an *Atoll.*

Fungia.—(Plate III. fig. 1.)

While, on one hand, the simply formed *Caryophyllea* leads us to the branched masses of many-starred Madrepores, on the other hand, their rayed laminated surface presents a striking resemblance to the flat, mushroom-shaped Coral, which seems to have so little attachment to surrounding objects. Our Plate contains the representation of a very small specimen of the Mushroom-Coral, which, although being a single-rayed Madrepore, plays no important part in the construction of Coral-reefs, yet forms a pleasing object in the shallow lagoons. Another very beautiful form allied to this is constructed on the same principle, but elongated; the inner edges of the plates meeting in a longitudinal line. This species has the outside or back hollow, so that with the mouth downwards it resembles a boat. We have seen very fine specimens of this, with numbers of young individuals of the same or other species adhering to the outer surface.

Mr. Samuel Stutchbury, who went out as collector of Natural History in a voyage undertaken by a Company formed in the year 1825 for the purpose of fishing for Pearls in the Pacific Ocean, gives some lucid details respecting the growth and propagation of specimens of the genus *Fungia*. They generally lie at the hollows of reefs, where they are in some degree protected from the more violent agitation of the sea by the surrounding portions of branching Coral, which enclose the hollows, and, at the same time, allow sea-water free access through their interstices.

It appears then, although the older and larger individuals are quite unattached and present no mark of former attachment, yet that in the young state they are fixed sometimes to rocks, and frequently to the dead remains of one of their own species. In this state, they grow upon a foot-stalk, and generally remain attached till they acquire the size of nearly an inch in diameter, when they separate at the top of the peduncle. At this time, the Coral, when divested of the fleshy part, shows a circular opening underneath, through which the radiating plates of the upper surface are visible. In a short time, a deposit of Coral-matter takes place, which cicatrizes at the opening; the marks of which, however, can be traced for a considerable time: at length, the increase of this deposit, which continues with the growth of the animal, entirely obliterates all appearance of it. It will not appear surprising that this circumstance should have remained hitherto unnoticed, when it is recollected that it has very rarely occurred to Naturalists to visit the places of their growth; and that to general collectors, the smaller specimens would appear hardly worth the trouble of preserving and bringing home.

"The sheltered situations in which the *Fungiæ* are found are peculiarly well adapted to their nature, as they would be liable to injury if they were exposed to the full force of a stormy sea; and the circumstance of their being attached in the young state is a beautiful provision of Nature for their preservation at that period, as from their light weight when first developed, they would, if unattached, be exposed to great injury even by a slight agitation of the water.

"I have also to remark upon this fact, that the *Caryophylleæ*, more especially in their early state, when the radiating plates are first developed,—at this time their upper discs are scarcely larger than the stem, but they soon begin to spread, and show indications of their characteristic form. There are not unfrequently instances of smaller individuals remaining fixed to large ones in a living state; and such specimens are not unfrequent in a collection of Corals; but in all such cases that I have seen, the younger ones are attached to the under side of the old one, and I believe them to be cases of accidental attachment."

Rumphius says, "The more elevated folds, or plaits, have borders like the denticulated edges of needlework lace; these are covered with innumerable oblong vesicles, formed of a gelatinous substance, which appear alive under water, and may be observed to move like an insect."

"I observed," says Stutchbury, "these radiating folds of the animal which secrete the lamellæ, and which sink between them when the animal contracts itself on being disturbed. They are constantly moving in tremulous undulations; but the vesicles above described appear to me to be air-vessels placed along the edges of the folds; and it is some confirmation of this opinion, that the vesicles disappeared when the animal was touched.

"This arrangement of air-vessels would very materially assist in keeping uppermost the convex disc of the Coral, and be of vital importance to the young polype at the time of separation, and, subsequently, in keeping it upon the surface of its sandy bed; or if they were moved by a sudden roll of the sea, which would lift even the most ponderous, and possibly convey them a considerable distance, they would be again deposited in their natural position. That they have no power of turning themselves, I proved during a sojourn of six weeks at Tahiti, by placing a healthy specimen with its upper surface downwards, during which time it remained in the position placed, and the vitality of the points in contact with the rocks was destroyed.

"In *Fungia limacina*, I have seen instances where the Coral, having been accidentally placed, and permanently fixed in such unusual positions, has adapted itself to its new situation by increasing upon its edges and forming a new convex surface. They seem, when young, to be conical, and attached to some marine body (often their parent) by the base, which is contracted into a kind of stem. When in this state, the animal only occupies the upper surface, but when it is full-grown and free, it completely encloses the Coral.

"As long as the young *Fungia* retains the form of a *Caryophyllea*, it is entirely enveloped by the soft parts of the animal; but as the upper disc of the Coral spreads and it assumes its characteristic form, the pedicle is left naked, and the soft part extends only to the line where the separation takes place. I consider the cases where the young *Fungiæ* are found fixed to the under side of others of the same species, to arise from the accidental attachment of the young polype when detached from the ovarium of the parent, and by the motion of the water floated underneath a larger one of its own species, the edges of which were not so even as to touch the rock or Coral on which it rested, at every part of its circumference. In such cases, the soft parts of the older specimen would continue to cover the short stem of the younger individual, and hence its separation from its pedicle would be prevented."

In Plate III. is figured the skeleton of a young *Fungia* (fig. 1), and *Oculina prolifera* (fig. 7), between which, the

British *Caryophyllea* occupies a middle station. It is represented in the intermediate figures 2 to 6; fig. 2, is the empty skeleton divided perpendicularly; 3, the living Zoophyte, with its tentacles out; 4, tentacles magnified; 5, specimen with adherent young, forming branches; 6, living specimen with tentacles withdrawn.

Plate XVII. contains a *Balænophyllea* in company with Star-fishes.

CHAPTER VII.

MEDUSÆ, OR JELLY-FISH.—NOT GOOD AQUARIANS.—THEIR HISTORY.—MULTIPLICATION.—METAMORPHOSES.—CHRYSOARIA CYCLONOTA.—BEROE OVATA.—SEA-CUCUMBERS.—MODE OF PROGRESSION.—HABITS IN AN AQUARIUM.—SELF-MUTILATIONS.—PSOLINUS BREVIS.—CUCUMARIA GRANDIS.—THYONE PAPILLOSA.

Sea-blubbers, or Jelly-fish, are among the most familiar objects of the shore. Those pellucid bladders of jelly are often seen floating on the breakers, or thrown up by their violence, on the beach, where they spangle and crowd the sand and shingle, mingling with dead *Laminariæ* wrecked by the same mighty power.

They are not creatures fitted for the Aquarium, even when taken living; their part is to roam freely through the wide ocean, and, themselves almost invisible, seek for living prey. For a few days they may be kept, or even weeks, but seldom and with difficulty. In most cases they die almost as soon as they are taken, and dissolve their substance into the watery element of which it is so largely composed. I remember being much astonished and disappointed, when a child, at the strange result. Taking up from the shore a large Jelly-fish, weighing a pound or two, most beautifully formed, and still showing some slight signs of life, I put him into a large pan of water, and, after taking a good look at my prisoner, left him. On returning, after a time, to examine him more minutely, what was my astonishment to find no Jelly-fish in the pan, but an increase of water, and an empty skin! Pining at the cruelty of his situation, he had, Niobe-like, melted away his substance in tears.

Yet there are very interesting facts in the history of these evanescent animals, some of which may be observed in an Aquarium. The prevailing form of a Jelly-fish is that of an umbrella, with an upper and under disc, the space between the two being filled up with a liquid, which is in fact little more than water. From the under disc, hangs a mass called the peduncle, forming a handle to the umbrella. This generally ends in four lobes or lips, much fringed and scalloped at their edges. The mouth is in the middle of these lips, and leads, of course, to the stomach. From the rim of the umbrella hang thread-like tentacles, which are active and sensitive, and provided with minute darting threads, giving them an adhesive, and somewhat stinging power.

"*Naked-eyed*" *Medusæ* are those which have swelling coloured bulbs at the bases of the tentacula, supposed to be eyes. While "*Covered-eyed*" are those in which the organs, more complicated, are protected by membranous folds hanging over them.

Few objects can exceed the elegance of these creatures, when floating in the briny fluid. Their graceful forms, their crystalline transparence, their airy and evanescent tints, and wavy motions, combine to make them exquisite in loveliness; while many of them are luminous, giving out flashes of light in the midst of darkness.

> "Within the shadow of the ship
> I watched their rich attire;
> Blue, glossy-green, and velvet black,
> They coil'd and swam; and every track
> Was a flash of golden fire!"

The most attractive part of the history of *Medusæ* is the wonderful manner in which they multiply their species. In the course of this operation metamorphoses take place from the state of fixed Zoophytes to that of free *Acephala*.

The *Medusa* first gives birth to numbers of minute balls, or eggs of jelly covered by a thin skin studded with vibratile hairs. The action of the hairs enables this germ or spherule to swim through the water. They are nearly oval bodies but rather wider at one end than at the other, and they are propelled with the larger end foremost. After swimming about for some time, the larger end turns downwards towards the ground, and attaches itself to some submarine object convenient for the purpose. Presently the body lengthens, and at the same time becomes wider at what was before the narrowest end, and then there is formed in the centre of that end a mouth, at first a mere opening of small dimensions, but soon enlarging and becoming surrounded by four prominent lobes or lips. These, increasing in length, are changed to long thin tentacula, or feelers, between which new tentacula make their appearance, till the whole thing assumes the appearance of a kind of cup-flower with long petals, and is, in fact, a Hydra-like polype, fixed on a stalk. This is the *Medusa-bud*, from whose sides new buds of the same character and appearance grow out, each one beginning like a small tubercle, stretching out till it reaches something to which it can attach its apex, and then, detaching itself from the other bud, grows on the chosen spot, when it gets a mouth and tentacles like those of its parent. From this, new germs sprout out and establish themselves in the same manner, until a large colony is formed. The next process is more surprising; it is that by which the *Medusæ* rise from the buds. The bud begins to lengthen and become cylindrical and narrow; it is wrinkled at intervals and divides into segments. The tentacles at the apex waste away, and in place, the edge of the top segment is scalloped into eight lobes. The top edge of each segment in succession becomes lobed in like manner, and exfoliates from the next; so that a column of cups is formed one within the other. By-and-by the top cup turns over and leaves the column; then another, and another; each swimming about, a young *Medusa*. The column still grows from beneath, forming fresh cups when the top ones fall off. At last, the rising process ceases; the last young *Medusa* is thrown off, and a stump only is left of the original bud. All is not over yet; the remaining stem forms a new head of tentacula, and becomes a flower-polype again.

I have seen the beautiful little *Medusa*-cups, propelling themselves in playful activity, upwards and downwards, forwards and backwards, and slant, by means of contracting and expanding the frill of furbelows which borders their edge. They undergo several changes after this, before they assume the perfect form to which they are destined. But what a wonderful history is theirs!

"The very Jelly-fish," says Harvey, "as it swims the wave, expanding and contracting its umbrella, and thus propelling itself through the water, has its beauty; but few are aware of the singularity of its history; how its eggs are of the nature of seeds, which, sown on their rocky bed, sprout and grow, throwing out buds and suckers, each of which forms an animal stem, quite unlike the parent Jelly-fish; till at a certain time young Jelly-fish begin to be formed, and to be thrown off by the several branches, just as flowers are formed and expand on the several branches that originate from a vegetable seed. And if the abject Jelly-fish, whose body consists of little more than organized water, have a history so wonderful, shall we not expect to find, in tracing the history of other tribes of animals, matter of equal interest?"

Chrysoaria cyclonota,

A magnificent species discovered by Mr. Gosse, a pet specimen of which was kept living for three weeks in a glass vase by that gentleman. The umbrella part is three inches wide, not quite lenticular, but slightly depressed in the middle circle, very transparent, and tinged with a rosy blush, with radiating lines of pink. Long thread-tentacles hang and wave from the rim, and between them are the brown-coloured bulbs, called eyes. The peduncle is bulbous, and the mouth is surrounded by four membranous arms of great length, which are frilled and twisted in a very elegant manner. In captivity the *Chrysoaria* moved gracefully, twirling, furling, and unfurling his flounces in ever-varying undulations. His possessor, having casually touched the animal with a stick, found that the furbelows, as well as the tentacles, clung to it and wrapped themselves round it, and were drawing it towards the peduncle; and it was liberated with difficulty. This suggested an attempt to feed it. A whitebait being introduced was presently surrounded, and drawn up under the umbrella, but being perhaps too heavy, was allowed to fall. Its head had actually been for some time in the oral cavity of the *Medusa*; but when examined it was found that the process of digestion had not begun. After awhile the captive Jelly-fish changed its habits, turned over its umbrella-body, and died in the act of propagating fresh buds.

Beroe ovata.

This pretty little *Medusa* is of a different order from the umbrella-shaped Sea-jelly. Its body is shaped like a melon, from half an inch to three-quarters long, quite crystalline, and divided into gores by eight ribs. On the ribs are little plates or scales, capable of moving up and down, and acting as paddles, by which the *Beroe* can move itself freely in every direction. It has two very long pendent tentacles, to which are attached, at regular intervals, still more slender threads, which coil like the tendrils of a vine. These have all the adhesive qualities of the tentacula and filaments of *Actiniæ,* and constitute the fishing-tackle of the *Beroe.* The whole apparatus, when not in use, is drawn up into the body and lodged in sheaths.

"Though at first," says Landsborough, "we observed only one solitary *Beroe,* we had not gone far till we found them in abundance. In one little creek there was a flotilla of fifty. What life! What beauty! What happiness in that little fleet! Fifty thousand paddles, of exquisite workmanship, were in rapid, noiseless motion, twinkling with all the iridescent beauty of the morning dew. I had not before observed this lovely iridescence; and I ascribed it in part

Sowerby del. et lith. Vincent Brooks Imp.

1 Hermit Crab, Pagurus Bernhardus, in a shell of the whelk, surmounted by an Anemone, Sagartia parasitica, and studded by Balani. 2. The same withdrawn. 3 The same in a shell of the Periwinkle.

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 species 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 observation. 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.

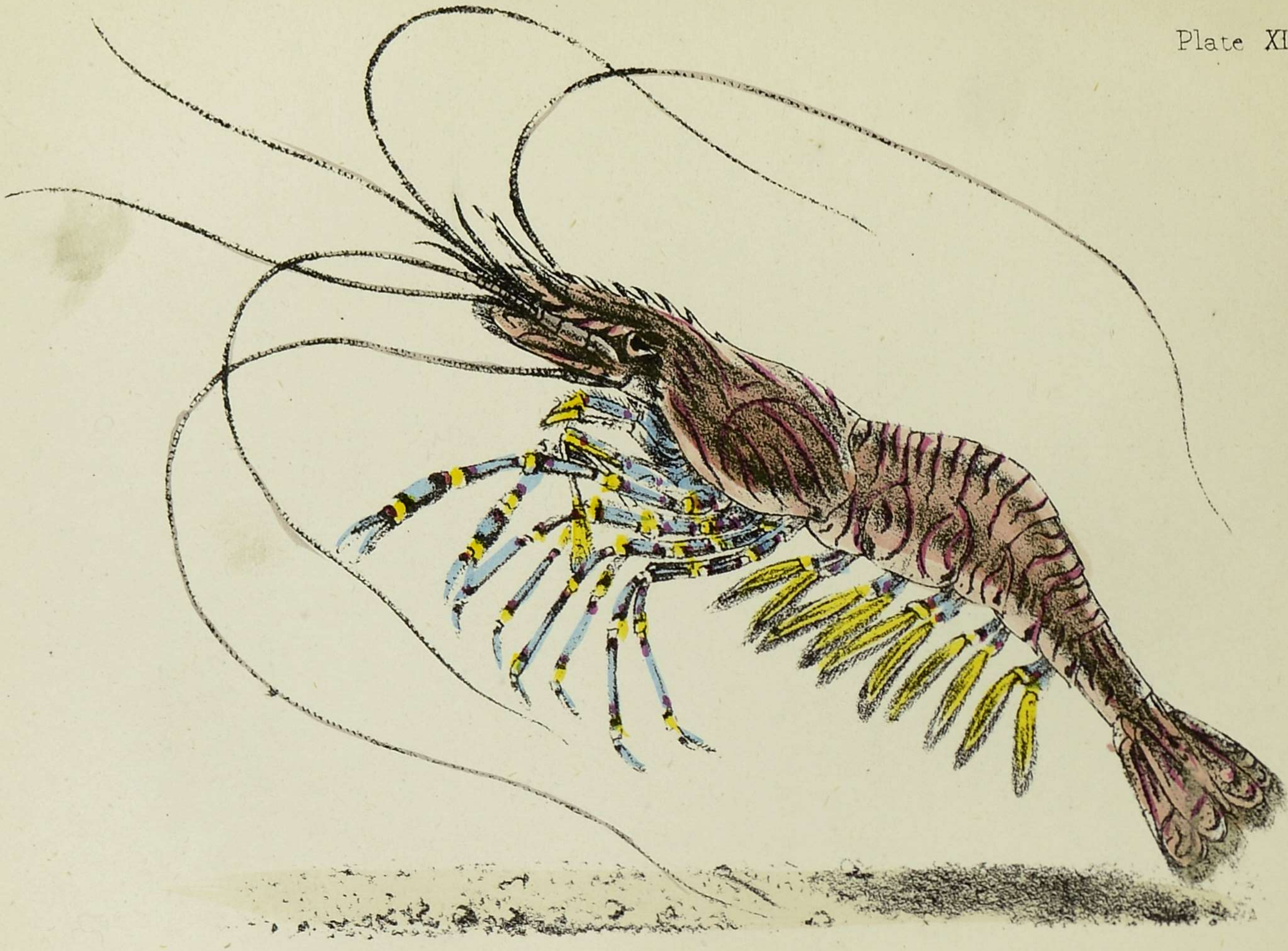
The *Rosy Feather-star* is one of the most beautiful objects in nature, and is most interesting on account of a curious feature of its animal economy. Viewed from above, it is seen as a radiating circle of ten feathers, with a smaller central circle of filiform appendages. This smaller circle hides the 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

Plate XII.



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 account 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 Ireland, 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

Plate III.

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 element, 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 *Confervæ* 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;

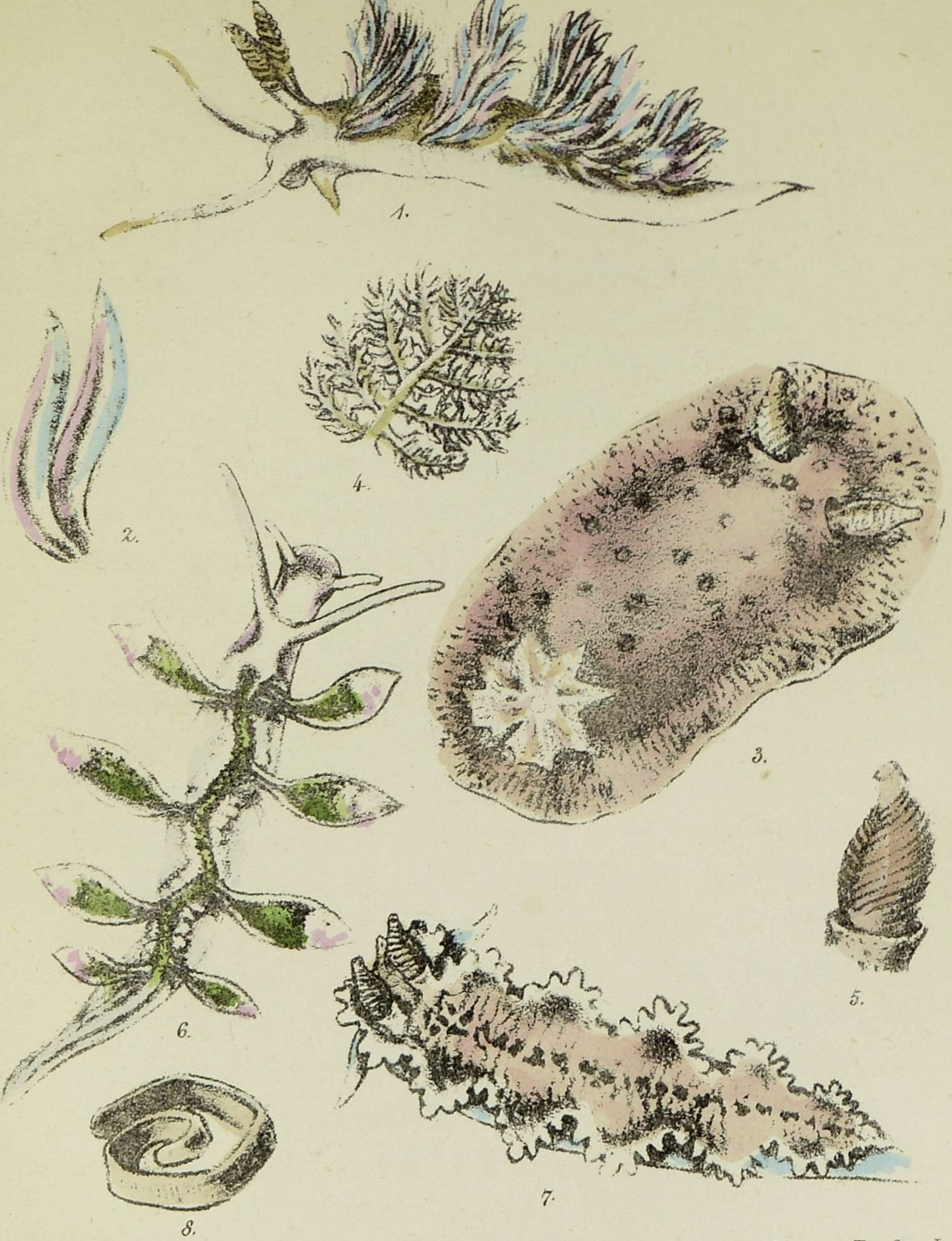
but when touched or shaken they immediately again withdraw themselves within their shell, and remain motionless. "This inability to swim is no doubt owing to the want of those pencils of long hairs or filaments which adorn the superior and inferior antennæ of the *Cyprides*, and which we have seen are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

Plate XIV.



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

Sowerby del et lith.

Vincent Brooks Imp

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 *Confervæ* 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 Zoological 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 resembling 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;

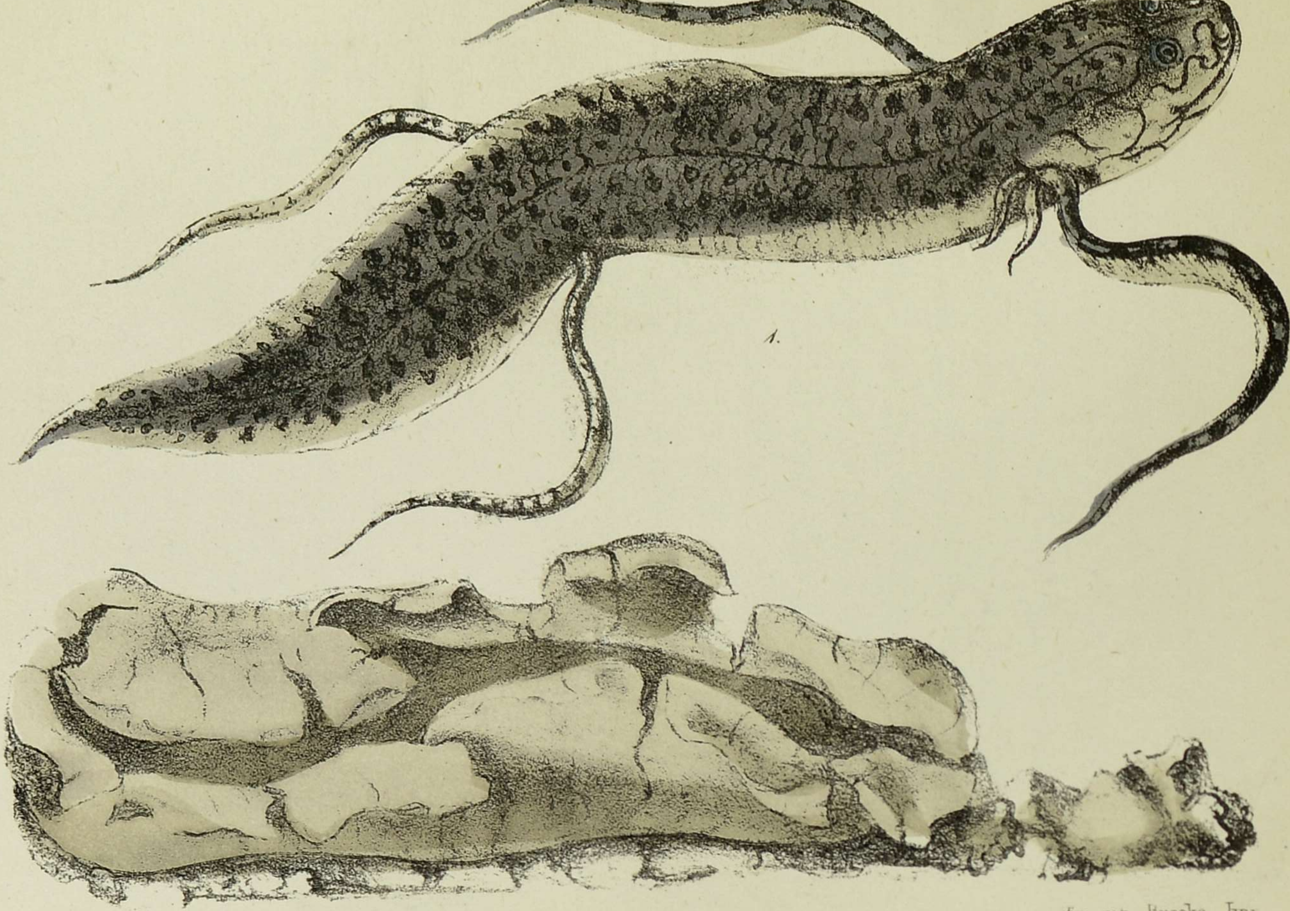
but I shortly afterwards had the pleasure of witnessing, beneath the microscope, the natural bursting and escape of one precisely similar in form to those found so abundantly in the water. Thus then there is no doubt that these grotesque-looking creatures are the young of the *Carcinus mænas*; but how 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 establish 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 aperture, 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:—

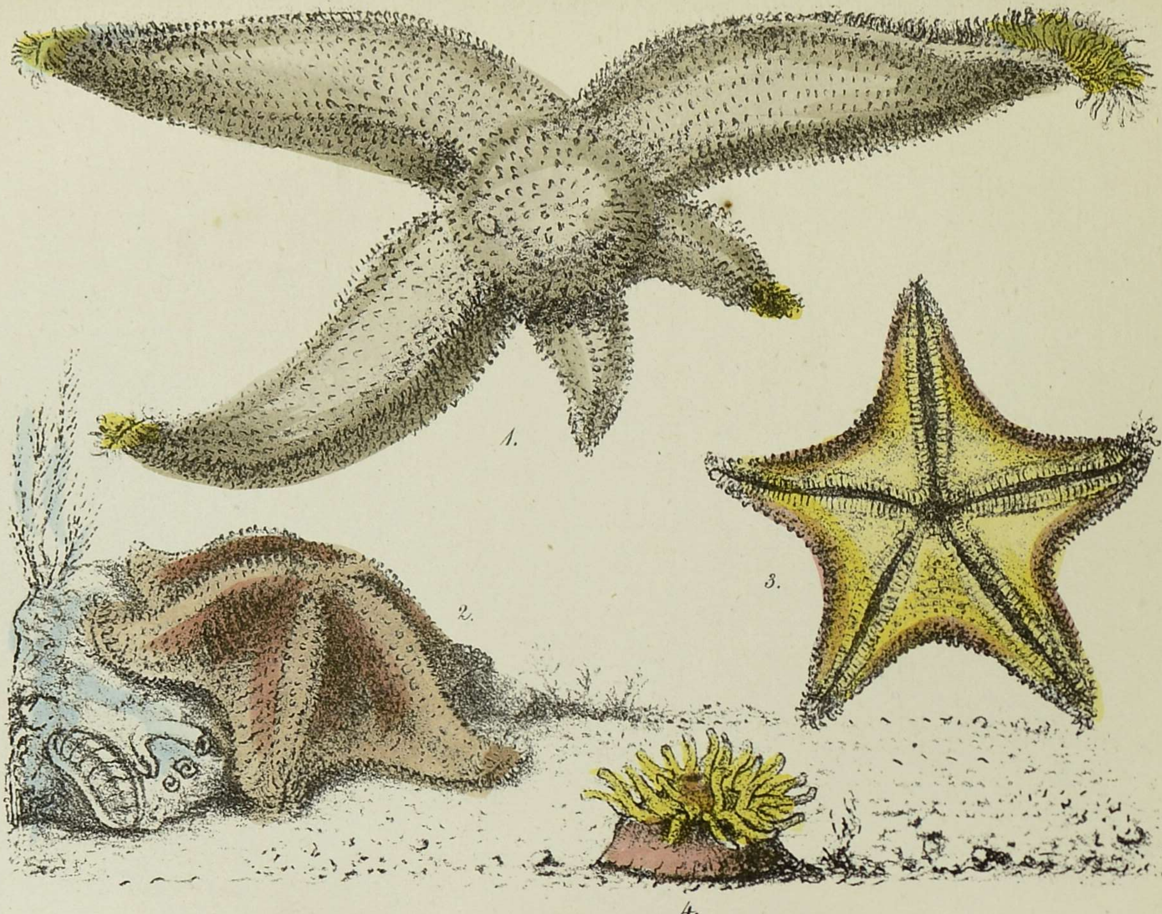
"No. 1. Placed in an upright cylindrical vessel of water, in which was a rootless plant of *Stratiotes*, on the afternoon of November 14. By the morning it had constructed a very perfect oval cell, filled with air, about the size of an acorn. In this it had remained stationary up to the present time.

"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 harmless. 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, between 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 opercularis.

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 appearance 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 commction 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.

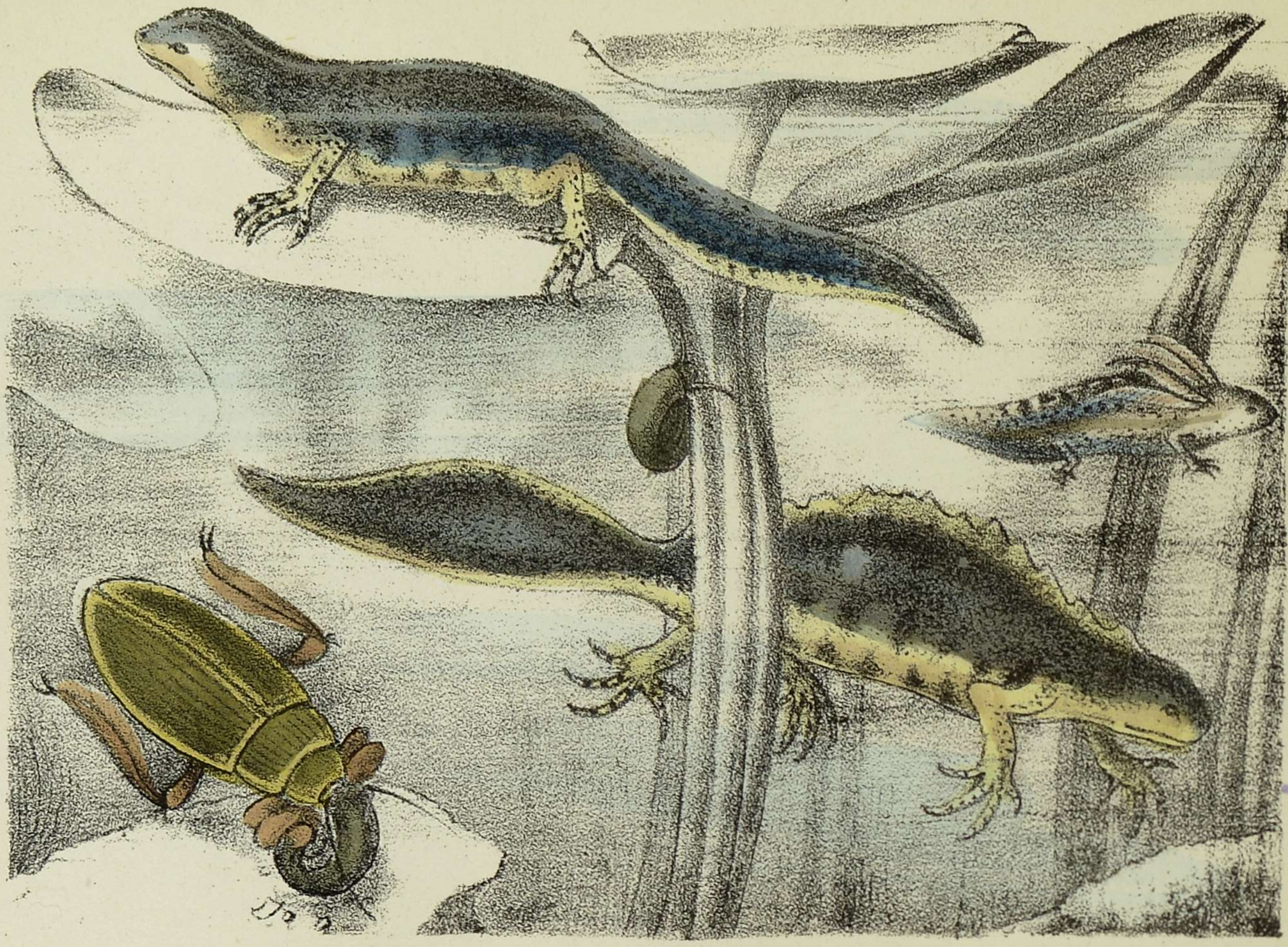
Gobius niger.

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

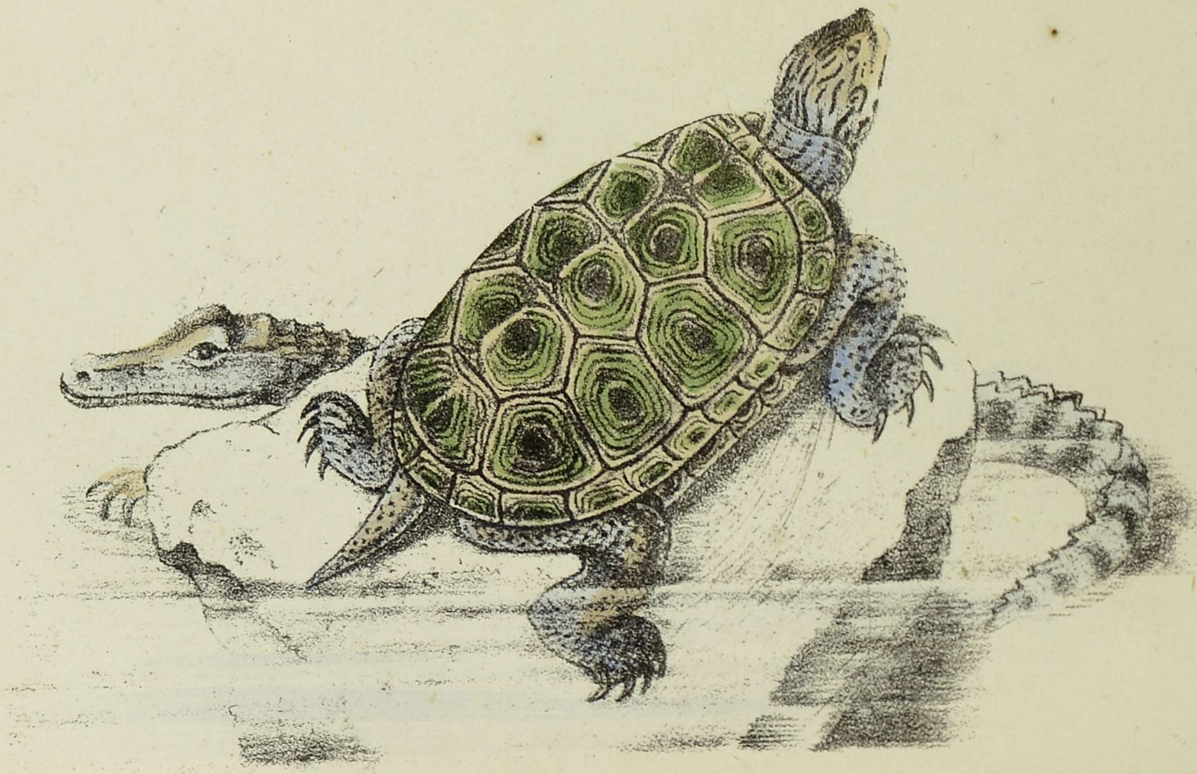
In eating fish, which constitutes a considerable proportion of the food of the carnivorous *Testudinata*, they will almost always reject the air-bag, which, floating on the surface of the water, tells its tale of the murder which has been committed. This circumstance is so well known, that those who 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

Plate XX



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Vincent Brooks Imp.

Fresh-water Tortoise, Emys concentrica, & Young Alligator

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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THE END.

JOHN EDWARD TAYLOR, PRINTER,
LITTLE QUEEN STREET, LINCOLN'S INN FIELDS.


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COLLECTANIA JUVENILIA