DENIZENS OF THE DEEP

F. MARTIN DUNCAN, F.R.P.S.

DENIZENS OF THE DEEP

OFF TO THE FISHING GROUND.

DENIZENS OF THE DEEP.

By

F. MARTIN DUNCAN

F.R.P.S., Author of "Insect Pests of the Farm and Garden," "First Steps in Photo-Micrography," etc

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DENIZENS OF THE DEEP

CHAPTER I

HINTS ON COLLECTING AND PHOTOGRAPHING

"Awhile to wait upon the firm fair sand,
When all is calm at sea, all still on land;
And there the ocean's produce to explore,
As floating by, or rolling on the shore."

A CALM, quiet morning in early summer; overhead a cloudless, deep blue sky, throwing into exquisite contrast the bright snow-white and silver-grey plumage of the gulls, as they poise and glide on graceful, outstretched wings. The air is full of the gentle murmur of a softly ebbing tide, falling in long, slumbrous waves upon the shore, where already it has left exposed a stretch of wet golden sand, that sparkles in the sunlight with glorious opalescent, rain-

bow hues. On such a morning, what could be more delightful than to set forth, armed with the collecting outfit, for a ramble along the shore and among the deep rock-pools, in search of treasures from the realm of Neptune! Few who visit the seaside for their annual holiday fully realise the joy of such an excursion, or what an absolutely inexhaustible supply of wonderful, interesting, and beautiful objects may be gathered—

"From the depths of the waters that lighten and darken
With change everlasting of life and of death."

No one who has a real love for the beautiful, and a keen interest in Nature, need ever know a dull moment while within sound of the voice of the waves. No matter what the season of the year —spring, summer, autumn, winter— each brings to the shore, and to the pools, its wealth of changing forms of life.

The apparatus necessary for collecting material from the seashore and rock-pools is neither elaborate nor costly. It

may consist of a good botanical collecting tin, with straps to sling over the shoulder ; a good supply of flat-bottomed glass collecting tubes, fitted with corks ; a large, wide-mouthed glass jar, with a string handle attached to its neck ; an old table-spoon, pocket-knife, cold-chisel, micro-forceps, set of pocket magnifying glasses, and one or two glass pipettes, or, better still, a couple of clean, unused ink-fillers, such as are sold for filling fountain pens. A small gauze net, such as is usual for collecting pond-life specimens, will pretty well complete the equipment.

For storing the treasures brought home, two or three " bell," or propagating glasses of various sizes, fastened securely to well-weighted wooden bases, so that they will not be easily knocked over, will be found cheap and most useful aquaria. Of course, owing to their rounded sides, they are not much good as permanent aquaria for keeping objects under careful observation. For that purpose, a square or oblong tank, with slate bottom, and glass front

and sides must be used. If the tank can be constructed with a gently sloping bottom, so much the better, as this will present a greater surface to the light, and also for observation.

Rockwork is of great importance in the marine aquarium, and should be built up in a series of miniature reefs and caves, some of the rocks rising above the surface of the water, so as to form little platforms on which those creatures that like for a while to quit their aqueous home can climb and rest.

The bottom of this permanent aquarium should be covered with a layer of well-washed, small, fine shingle, and on top of this should rest a layer of clean, bright sand. The sand and rocks having been placed in position, the sea-water, which must be perfectly clear and fresh, and free from all sediment, must be gently poured into the aquarium. When the sand stirred up by the incoming water has settled down, two or three small rocks, to which a young growth of the green Ulva seaweed is attached, may be carefully introduced.

The aquarium must be placed in such a position that a good light falls upon it, so as to induce the growth of the green weeds, which, if healthy, will soon be seen to be more or less covered with bubbles of oxygen, and to give off bubbles from time to time. When the weeds appear in this healthy condition, and not before, one or two forms of animal life may be put in the aquarium. This requires judgment and care, lest unsuitable creatures be introduced, who cannot tolerate each other's presence in the confined area of the aquarium. Such creatures as crabs, the blennies, or gobies, for instance, would quickly cause devastation in a small aquarium. Care must also be taken to regulate the amount of light falling upon the aquarium, too much inducing the excessive growth of Algæ, too little producing death and decomposition. As far as possible, the conditions of a rock-bound pool must be imitated, and the even balance of animal and vegetable life maintained.

To every possessor of a microscope,

the seashore and its rock-bound pools offers an absolutely inexhaustible supply of objects of the greatest interest and beauty, and a rich field of work for original investigation. Nor are very high magnifying powers, or elaborate and costly apparatus required for marine biological work. A good student's model compound microscope, with 2-in., 1-in., and ⅛-in. objectives, and a couple of eye-pieces will amply meet most requirements. Add to this some half-dozen dissecting knives and needles, a pair of micro-forceps, fine scissors, razor, glass slips, and cover-glasses, a zoophyte trough, some Canada balsam and Deane's Medium for mounting, and you will have a pretty complete outfit.

Comparatively little attention has been paid to the photographing of living marine organisms, and yet it is a field of work capable of yielding the most interesting and charming results. Certainly it is very difficult work in many respects, and requires the greatest determination and patience to obtain really successful pictures, for it is the unex-

pected that generally happens. In the first place, you must have a specially constructed photographic aquarium; then you must scrub all the rocks and sea-weeds before they are placed in position; after this you must fill your tank with carefully-filtered sea-water, for if the water contains any floating *débris*, it will help to spoil the brightness of the picture; and, last, but by no means least, you have got to wash and cleanse as well as you can the creature you wish to photograph, for all fish, and crustacea, have a good deal of *débris* mixed with the slimy coating that covers their bodies, which is likely to part company from them when they are introduced into the clear water of the photographic aquarium. To endeavour to clean some of the superfluous dirt off a lively and much excited fish without damaging it, is about as messy and temper-testing a task as anyone could well wish to attempt.

I would most strongly advise those who are inclined to turn their hands to the photographing of marine life, to

be content to begin with small subjects and a small aquarium, and then, as they gain knowledge and experience, gradually work up to bigger game. They will find that a modest beginning will save them a lot of expense and disappointment, for the larger the photographic aquarium, the greater the cost of construction, and the greater the difficulties that will have to be faced and overcome when taking the photographs. Therefore I would advise that the first photographic aquarium should measure not more than 2 ft. by 1 ft. 2 in. by 9 in. All four sides should be of glass, and the two largest sheets, for the front and back, must be of very carefully selected patent plate, absolutely free from scratches or blemishes of any kind. A sloping false bottom, painted a pale grey, is necessary, as it will act as a reflector and light the under surface of the fish. A series of metal backgrounds, painted varying tones of stone colour, to which rock work can be fastened to make as natural a background as possible, will be required. These backgrounds should just fit the

inside of the tank, and be made so that they can be let down, and then gently edged forward little by little, like the glass plate in a microscope zoophyte trough, so as to bring the fish nearer to the front of the aquarium. Great care, however, must be exercised in doing this not to cramp the movements of the fish too closely in any way, or it will begin to plunge about, and even try to leap out of the tank.

As regards the photographic apparatus, I now always use a reflex camera with a good focal-plane shutter. There is no doubt that the reflex camera is the very best instrument for all natural history work, as it enables one to watch and focus the object right up to the instant of exposure. It is obvious that the focal-plane shutter is the best, as it is the shutter that allows the maximum amount of light to reach the plate during exposure, and this is very important in photographing marine life, for exposures average between 1–25th and 1–100th of a second; and as the light forming the image on the plate has first to pass

through the water and glass of the tank, some of its actinic power must be lost ere it reaches the plate. A good lens is, of course, all-important, and a Zeiss anastigmat, working at a large aperture, *f* 5·4, or *f* 6·, should be used.

A stand for holding the camera in a vertical position will be found a most useful piece of apparatus, for it enables one to photograph the upper surface of various "ground" fish, seaweeds, worms, etc. It can easily be constructed at home, at a very small cost. Into a stout, heavy wooden base, about 14 in. by 11 in. by 3 in., two iron or brass uprights, each $3\frac{1}{2}$ ft. long, should be firmly bolted. An arm should slide up and down each of these uprights, to carry the camera and keep it quite steady when clamped in position. To prevent side-spring and vibration, a stout piece of wood, or an iron bar, should be fitted so as to be fastened by screw-nuts across the top of the uprights, when the camera has been focussed; by unscrewing the nuts, this locking bar should be easily removed,

when the position of the camera has to be re-adjusted. The whole apparatus may be further steadied by stout wire stays running from the top of the two uprights to the wooden base.

Always give the longest exposure possible without showing movement, and consequent blurring of the object. As it is important to obtain as truthful a rendering as possible of the gradation of colouring of the subject, an instantaneous isochromatic plate must always be used. It is not generally necessary, or possible, to use a screen or filter in front of the lens ; the slight yellowish-green of the sea-water in some respects helps to correct for colour rendering, and, to a certain extent, acts as an isochromatic screen. Care must be taken in developing the plate to avoid excessive contrasts, and to try and obtain a soft negative, full of delicate gradation and detail. I would strongly advise the beginner to adopt the factorial method of development. There is nothing difficult about it, and, once adopted, it will always be employed for its saving in

time and labour, and for the great uniformity of the results to be obtained by it. Mr. Alfred Watkins was the discoverer and originator of this method of development, and full details will be found in his very excellent little book, "The Watkins Manual."

I know of no more delightful experience, in the study of marine life, than to take a boat out on a calm summer evening, for the purpose of collecting some of those denizens of the deep who rise towards the surface of the sea at the approach of night. As the boat moves very slowly over the glassy surface of the sea, it is a glorious sight to watch the varying opalescent tints that come and go, to see the great sun slowly sink to rest. Not a sound comes to mar the perfect peacefulness of the scene. The distant cliffs stand out boldly, all aglow in exquisite rosy light. Overhead a sea-gull circles and swoops in graceful curves, on outstretched wing, and in the deepening blue of the sky the first star begins to show. The silence is profound, broken only by the gentle lapping of the

water against the sides of the boat, and as the sun drops below the horizon, we seem to float on—

> "such a tide as moving seems asleep,
> Too full for sound and foam,
> When that which drew from out the boundless deep,
> Turns again home."

Gradually night spreads her purple mantle over sea and sky, and as the darkness deepens, the lights of the fishing village begin to twinkle like stars. But ere we turn the boat's head toward those beckoning lights, we may witness another wonder of the deep, for as we haul the tow-net gently into the boat, it comes from the sea like a thing of liquid fire, that burns with a strange, pulsating, greenish light. This weird appearance is due to the presence of countless phosphorescent Protozoa, particularly the tiny globular *Noctiluca miliaris*, and to other and higher forms of marine life that are endowed with this strange power of giving forth phosphorescent light.

A simple and useful tow-net can easily

be constructed from a ring of stout galvanised copper wire, about 12 in. to 14 in. in diameter, to which a conical net some 2 ft. long, made of fairly stout "book-muslin," is attached. The hoop of the net should be fastened by three lengths of whip-cord or snood-line to a stouter cord about 4 or 5 yards long. In use the net is thrown overboard from the stern of the boat, when the hoop of the net should set vertically in the sea, the end of the line being fastened to a ring in the stern. The boat is then either allowed to drift with the tide, or very slowly moved, so that the water shall not rush with too great force into the net. From time to time, about once in every fifteen to thirty minutes, the tow-net should be gently hauled in, and emptied into a bucket of sea-water, from which the specimens can be transferred to the collecting jars.

THE INCOMING TIDE.

CHAPTER II

THE PLANTS OF THE SEA

EVERY tidal pool is a treasure-house of many-coloured, graceful seaweeds, of varied size and form. Some clothe the rocks with a soft, green, moss-like mantle, others grow out in broad leaf-like expansions resembling hart's-tongue ferns, or as delicate, exquisitely graceful, filamentous fronds. Wander where you will, from high to low water-mark along the shore, seaweeds of varying form and colour abound; while those which dwell in the deep water are cast up at your feet by every receding wave after a storm. These plants of the sea, from their beauty of form and colour alone, must attract and arrest one's attention, and a little closer observation reveals the fact that they possess life-

histories of very great and absorbing interest.

A casual ramble along the beach, between tide-marks, will convince us that these plants have their respective zones upon the shore; we shall find certain forms peculiar to the region of high-water mark, others that live halfway between high and low-water mark, dwellers that are peculiar to the rock-pools, or that can only live at low-water mark and in the deeper waters beyond. In trying to gain some knowledge of these plants of the sea, it will be easiest, first, to collect specimens from the different zones, so as to become familiar with their general appearance.

On wooden breakwaters and stones, from high-water mark to half-tide, a dark olive-green weed will be found growing plentifully. It has an expanded process for attachment, and a stem dividing into two branches, each ending in two long cones soft to the touch, and termed the "receptacles," because they contain the spores, or reproductive organs. It is called the Channelled Fucus, and

belongs to the same group of seaweeds as that commonest of all, which has small round air-bladders on it, and is called by children "pop-weed."

Spreading over the rocks and stones near high-water mark, in a short, shaggy green pile, most slippery and treacherous to walk upon, grows one of the commonest green seaweeds, popularly called the Compressed Enteromorpha. Its cousin, which is supposed to resemble in form an intestine or tube, grows between tide marks, and varies in size according to its position, from 2 in. or 3 in. to 1 ft. or more in length, and from the thickness of a pin to some 4 in. in diameter. In the water, it looks a green, hollow, membrane-like tube, curiously crinkled in places, and its general appearance well accords with its Latin name of *Enteromorpha intestinalis*. It has a practically world-wide distribution, and is one of the seaweeds prepared by the Japanese for culinary purposes.

The common Bladder Fucus, or "pop-weed," as children call it, abounds between tide marks, and up the estuaries

of rivers as far as the water is strongly impregnated with sea-salt. It is collected as kelp for the manufacture of iodine, and utilised in some parts as manure for the land, and part of the winter fodder for cattle. Covering the rocks at half-tide with a luxuriant growth is the handsome Serrated Fucus, on which the little *Spirorbis* delights to dwell; large numbers of the tiny little spiral shells generally cover the broad, bladderless, saw-edged leaves. The *Confervæ* are amongst the commonest of the green seaweeds that are found in most of the zones of the shore. They grow as hair-like threads which cover the rocks in layers quite thickly.

The handsome olive-green or brown, broad, ribbon-shaped weeds, with wavy edges and tough slime-coated skins, called the Tangles or *Laminariæ*, are only found growing at and below low-water mark. Many of these *Laminariæ* seem to delight, and grow luxuriantly, in a boisterous sea, living on submerged reefs on which the waves beat furiously.

These Wracks and Tangles form a

dense and luxuriant growth in the shallow waters of our coasts wherever they can find a secure foothold. They afford shelter and support for countless interesting creatures; minute crabs and molluscs, which are only to be found amongst their roots; sea-anemones, zoophytes, ascidians, sea-slugs, that cling to or crawl about their broad, waving leaves; while amongst their stems and branches, which form a veritable marine forest, strange, uncanny-looking fish hide from their foes and hunt their prey.

Another dweller at and beyond low-water mark, down to nearly fifteen fathoms, is a very beautiful seaweed called *Nitophyllum punctatum*. It has delicate, graceful, membranous fronds of an exquisite rose-red colour, and is abundant all round our coasts.

One of the most beautiful of our seaweeds, that grows just beyond low-water mark, and is sometimes cast up along our shores in great abundance, is called *Delessera sanguinea*. In May and June it is at its perfection of growth, its beau-

tiful crimson, delicate, membranous fronds exhibit a midrib and veins, measuring from 1 in. to 9 in. or 10 in. in length; and there are as many as thirty fronds to a single plant. In the autumn and winter the turbulent waves lacerate and wear away the delicate membrane of the fronds, leaving little but the stout midribs, on which the reproductive organs now appear. These consist of delicate hyaline frondlets, the antheridia; spherical bodies like little red apples on minute stalks, the cystocarps; and towards spring, minute frondlets, which under the microscope are seen to contain numerous cruciate tetraspores. These are the asexual reproductive cells, and are called tetraspores, because they are almost always produced four together in one large cell, called the sporangium.

In the deep rock-pools near low-water mark we shall find the delicate filamentous seaweeds at their best. The *Dasya coccinea* is typical of these, and perhaps the handsomest of all our native filamentous seaweeds. It is of a glorious bright-red colour, with graceful feather-

CORALLINA OFFICINALIS.

DELESSERA SANGUINEA.

SEA-WEEDS.

like branches, and is another seaweed well worth the attention of the microscopist, for its reproductive organs are of considerable interest and beauty. The antheridia are formed around, and appear as a hyaline covering to, some of the lateral filaments. The cystocarps are ovate, vase-like capsules, furnished with a terminal pore, through which at maturity the numerous spores make their escape. The tetraspores are formed in long oblong pods (*stichidia*) produced by the transformation of some of the filaments. Another handsome filamentous seaweed, of a fine transparent crimson colour when growing, is the *Griffithsia setacea*. It is fairly abundant around our coasts, and is well worth seeking. Unfortunately, its beautiful colour soon fades, so that herbarium specimens give no idea of its lovely tints, and preserve only the graceful form.

Where the cliffs have much carbonate of lime in their composition, we shall find in the deep pools close to low-water mark a singularly unplantlike-looking seaweed. It is whitish in colour, hard

to the touch, and has a stony look; it grows in masses of slender stems made up of many pieces, placed one above the other, and each piece is more or less graduated, so as to appear narrower at one end than the other. From its stony appearance it has gained the name of Coralline, but of course it has nothing to do with the corals, which are forms of animal life; it is a true seaweed which absorbs and deposits on its tissues the carbonate of lime that is held in suspension in the sea-water.

Our British coasts are so singularly rich in seaweeds that they probably can yield the collector a greater number of genera and species than any other coast-line of the same area in the world. Seaweeds have two methods of reproduction, one sexual, the other asexual, and in many of our native species only one of these methods of reproduction has as yet been observed, although in many both are thought to exist. Therefore the seaweeds, which of all forms of marine life are the most plentiful on our coasts, and most easily collected,

offer to the would-be student a most interesting and encouraging field of work for original investigation and discovery.

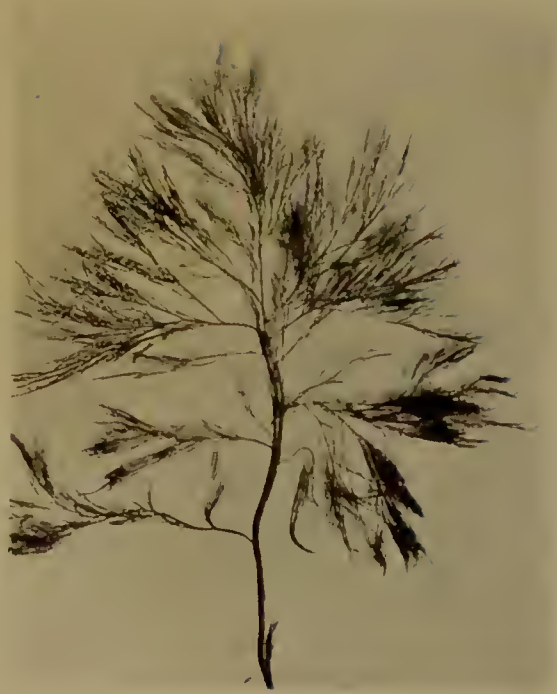
The permanent preparation of portions of seaweed, or of the reproductive organs for examination under the microscope, is not at all difficult, and is really very interesting work. Two or three dissecting needles, a pair of fine, small scissors, micro-forceps, a bottle of Deane's Medium, spirit lamp, glass slips and cover glasses, two soup-plates, and a saucer complete the outfit required for mounting the specimens. The soup-plates should be filled with filtered sea-water, or a solution of Tidman's sea-salt of the same strength, and the saucer filled with clean, fresh water. A piece of seaweed is placed in soup-plate No. 1, and stirred round several times to free it from dirt and slime ; it is then transferred to the second soup-plate, and there examined with an ordinary pocket magnifying glass, for the portion that is to be mounted. This is snipped off with the aid of the scissors, and placed in the saucer for a final wash. A glass

slip is cleaned, warmed over the spirit lamp, and a drop or two of the Deane's Medium placed on it. The piece of seaweed is then lifted with the forceps, drained, placed on the medium on the slide, and arranged in position with the aid of the *warmed* dissecting needles. A hot-water plate, or a warmed brass plate will be found most useful for keeping the slide quite warm while the seaweed is being arranged in position, which is important, as the medium sets when cold.

The specimen having been arranged, a cover glass is warmed, and gently lowered from one side on to the slide, so as to drive the superfluous medium in a wave in one direction, and expel any air-bubbles that may have formed. The slide should then be put away out of the dust for a day or so, to allow the medium to set, after which the superfluous medium may be cleaned off gently with a soft rag dipped in warm water. A couple of rings of gold-size are then run round the edge of the cover-glass, and when that is dry a coating of cement,

DAYSA COCCINEA.

A very beautiful red Sea-weed.



HYPNEA PURPURESCENES.

SEA-WEEDS

either white zinc, or ordinary "Club" bicycle enamel, slightly thickened by evaporation. A label should be attached, and the slide is then finished and ready for its place in the cabinet.

Interesting and beautiful as the seaweeds are, the most wonderful marine plants are the minute, unicellular Diatoms, the most ubiquitous of plants. These wonderful little plants inhabit fresh-water as well as the sea, but those species peculiar to the one are never found in a living state in the other locality. How numerous they are can be gathered from the fact that there are some 2,000 species of living forms. They have gained their name from a pigment, *Diatomin*, which gives a brown colour to the protoplasm of the cell, and also marks the chlorophyll; and they have a world-wide distribution. As a rule, they occur in large numbers together; in the colonial forms the cells are attached directly to the substratum, or by branching filaments. Some are attached to one another in zigzag chains (*Diatom vulgare*), or con-

tinuous ribbons (*Fragillaria virescens*). Many of them are motile, exhibiting a curious creeping movement, said to be due to an external sheath or to filaments of protoplasm.

A Diatom is a unicellular plant, belonging, like the more complex seaweeds we have been examining, to that great group of plants collectively classed as *Algæ*. Though very minute in size, and consisting, throughout its life, of a single cell, it is, nevertheless, very wonderful in its structure. The cell-wall of every Diatom is incrusted with silica. This wall consists of two halves or valves, called *frustules*, which fit into one another, something after the fashion of the lid of a pill-box. Under the microscope, these valves are seen to be of the greatest beauty and interest, for not only are they of the most diverse shapes, but they exhibit the most wonderful tracery of markings. From their extreme delicacy of marking, and beauty of form, these frustules of the Diatoms are amongst the most popular of microscopic objects, and so minute and peculiar are

CERAMIUM ECHINOTIUM, SHOWING TETRASPORES.

ARACHNOIDISCUS
A beautiful Diatom.

FUCUS VESICULOSUS (FEMALE CONCEPTACLE, SHOWING OOGONIA).

BONNEMAISONIA ASPARAGOIDES WITH DIATOMS ATTACHED.

the markings found on some species, that it requires the finest lenses and manipulative skill to demonstrate them.

Propagation amongst the Diatoms is by continuous longitudinal division ; the valves are slightly separated, and division takes place parallel to the faces of the valves. Thus each daughter-cell possesses one of the valves that belonged to the mother-cell, and they complete their integument by secreting another on the side away from it. By this process, the new valve is always smaller than the other one, and fits under its rim pill-box fashion ; and as a natural result, the Diatoms arising in this way gradually become smaller and smaller, until a certain limit is reached, when an enlargement is attained by the formation of what are termed *auxospores*. The contents of the cell gather themselves together, they become free from the valves, enlarge, and then form new valves. In some cases an actual conjugation takes place, two individuals uniting into an auxospore ; or, again, each may divide into two daughter-

cells, which fuse in pairs, forming two auxospores.

So abundant are the Diatoms in some estuaries, that their multiplication plays an important part in diminishing the depths of channels, and blocking up harbours. The observations of Sir J. D. Hooker upon the Diatoms of the southern seas prove their extraordinary abundance in some parts of the ocean. Within the Antarctic Circle, they become enclosed in the newly-formed ice, and by being washed up in millions by the sea on to the pack ice and bergs, everywhere stain the white ice and snow a pale ochreous brown. Sir J. D. Hooker remarks that the universal presence of this microscopic vegetation throughout the South Polar Ocean is a very important feature, as there is a marked deficiency in this region of higher forms of vegetation; and were it not for the presence of these minute plants, there would not be food for aquatic animals, nor would the waters of the ocean be purified from the carbonic acid which animal respiration and

decomposition are continually imparting to them.

Another instance of their abundance, demonstrated by deep-sea soundings, is the following. On the flanks of Victoria Land, in 70° south latitude, at a depth of between 200 and 400 feet, there is a deposit of mud, composed chiefly of the siliceous valves of Diatoms, which extends for not less than 400 miles in length and 120 miles in breadth.

The indestructible character of the silica forming the valves of Diatoms has served to perpetuate their presence in localities from which their living forms have long since disappeared. The so-called "infusorial earth" of Richmond in Virginia constitutes a stratum of 18 feet in thickness and of great area, and is very largely composed of the fossil frustules of marine Diatoms; while in the Botanical Department of the British Museum may be seen a block of such a Diatom deposit some 2 cubic feet in bulk, from a fresh-water lake in

Australia, which is estimated to contain more than twelve billions of fossil Diatoms.

To collect the marine Diatoms, the seaweeds must be carefully examined, for on them the Diatoms will show as yellowish-brown fringes. They also deposit themselves as a filmy stratum on sand and mud, and as a delicate velvety surface on the rocks. They will also be found in the fine mud or sand of soundings or dredgings. Rare and beautiful forms are often to be found in the stomachs of fish, whelks, crustaceans, ascidians, and other marine creatures.

A useful press for drying and mounting seaweeds can be made at home at a very small cost. Procure three or four thin wooden boards, or hard, stout cardboards, measuring 12 in. by 10 in., to form the leaves of the press. To form the clamps, two pieces of 1-in. planed board, 15 in. in length, will be wanted. One of these boards should be 2 in., the other 3 in. wide. Through the ends of these clamping-boards, bore holes to

take two 4-in. brass-headed sash-screws, which will hold the clamping-boards in position, and adjust the amount of pressure. It is also as well to have a leather strap to fasten across the boards in an opposite direction to the clamps, so as to make the pressure more even at the edges. Some sheets of botanical and blotting papers will now complete the outfit. The collected seaweeds must be carefully washed, and then either floated on to their paper supports, and the superfluous water carefully blotted off, or, in dealing with the large, stout forms, lifted out of the washing water, drained, and arranged in position. Each sheet, when dry and ready for placing in the collection, should be carefully numbered, and the name of the seaweed, the date of collecting, and the locality where it was found should be attached.

CHAPTER III

THE SPONGES, OR PORIFERA

Few visitors to the seaside realise that the rock-pools contain many species of sponges. Of course, the specimens to be found in such situations would hardly be suitable for washing purposes; and, indeed, the uninitiated visitor to the shore would probably pass them over without realising their real character. Nevertheless, many of our British sponges are very beautiful and interesting objects, well worth seeking and examining. They are to be found attached to stones and rocks in various situations along the shore, in the rock-pools, on rocks exposed at low tide, and may be dredged up from various depths. So firmly are the sponges attached to the objects on which they grow that it

is impossible to remove them without tearing or otherwise seriously injuring them.

Some of the branched sponges are very graceful in appearance, and are generally to be found growing perpendicularly from the under surface of the cliffs and shelving rocks. One of the most familiar of the spreading species of our native sponges is the so-called Crumb-of-Bread Sponge (*Halichondria panicea*), which loves a sheltered situation, and often forms a luxuriant growth on the sides of deep rock crevices. It varies considerably in growth and colouration, according to the situation in which it is found. Where but little light falls upon it, this sponge is almost white, while in other situations, where the light is stronger, it may be of a greenish or yellowish hue.

The sponges were a great puzzle to the early naturalists, who bandied them about from the animal to the vegetable world, while some writers placed them amongst an imaginary group of organisms called *Plant-animalia*, which were sup-

posed to partake of the nature of both. The mystery was at length solved, and the true character and physiological position of the sponges established, through the investigations of the late Professor R. Grant, who gave the following graphic description of his discovery: "In the month of November last I put a small branch of the *Spongia coalita*, with some sea-water, in a watch-glass, under the microscope, and, on reflecting the light of a candle up through the fluid, I soon perceived that there was some intestine motion in the opaque particles floating through the water. On moving the watch-glass, so as to bring one of the apertures on the side of the sponge fully into view, I beheld, for the first time, the splendid spectacle of this living fountain vomiting forth from a circular cavity an impetuous torrent of liquid matter, and hurling along, in rapid succession, opaque masses, which it strewed everywhere around. The beauty and novelty of such a scene in the animal kingdom long arrested my attention; but, after twenty-five

minutes of constant observation, I was obliged to withdraw my eye from fatigue, without having seen the torrent for one instant change its direction, or diminish, in the slightest degree, the rapidity of its course. I continued to watch the same orifice, at short intervals, for five hours, sometimes observing it for a quarter of an hour at a time, but still the stream rolled on with a constant and even velocity. About the end of this time, however, I observed the current to become perceptibly languid; the opaque flocculi of feculent matter, which were thrown out with so much impetuosity at the beginning, were now propelled to a shorter distance from the orifice, and fell to the bottom of the fluid within the sphere of vision, and in one hour more the current had entirely ceased."

This wonderful sight may be witnessed by anyone who possesses a student's microscope, and once seen is not easily forgotten. The mechanism which causes the intake and expulsion of the particles of matter suspended in the water

consists of innumerable minute whip-like filaments, called *cilia* or *flagella*, whose movements cause currents of water to pass from without inwards along the canals with which the sponge is honey-combed.

At certain seasons of the year, if a living sponge be examined, it will be seen to be studded with numerous opaque yellow spots, varying in size and shape, and increasing in number in the deeper parts of the sponge. These bright-tinted spots, when examined under the microscope, are seen to be composed of minute gelatinous gemmules or eggs. As these minute bodies reach maturity, they assume a more or less oval form, and passing into the canals of the parent's body, are expelled in the issuing streams of water. These gemmules, on making their escape from the parent sponge, are clothed with innumerable cilia, by means of which they propel themselves through the water in search of some rock or other suitable object, to which they can permanently attach themselves and grow into the adult

SPONGE SPICULES

A BRANCHING SPONGE.

form. There are two other methods of reproduction—one in which little protuberances form on the surface of the sponge which when mature break away from the parent, and are drifted to other localities by the ocean currents. In the second method, a budding process takes place, by which the mass of the sponge is increased both laterally and in thickness. This last method of propagation is taken advantage of in the bath-sponge industry, where the demand exceeds the natural supply. The sponges to be used for cultivation are carefully cut up, so as to cause as little injury as possible, into small cubes, and attached to strips of cane fastened into frames that are specially constructed to protect the sponge-cuttings from the access of mud. These frames are then sunk to a depth of about six or eight yards in the sea, and in due course the cuttings grow into fine globular-shaped sponges.

None of the sponges are parasitic, though the little Boring Sponge, *Cliona*, which burrows in the shells of oysters and other bivalves, might at first be

mistaken for one; but it is for protection and not food that the *Cliona* forms its galleries. The sponges frequently live in that close association with another animal or plant, which is called *Messmatemism*, or *Commensalism*, from its being an association benefiting one or both. Some of these sponges are to be found growing on the legs and backs of certain species of spider crabs—a case in which the crab escapes the notice of its foes, thanks to the concealing growth of the sponge, while the sponge benefits, by being transported from place to place, and so obtaining freer oxygenation. Sponges are also to be found growing in similar association with certain zoophytes, cirripedes, and algæ.

The sponges are divided into two sub-classes: the *Calcarea*, of which *Sycon* is an example, in which the spicules are calcareous and generally triradiate in form, and the *Non-calcarea*, in which the skeleton may consist either of spongin-fibres alone, of siliceous spicules alone, or of a combination of spongin-fibres with siliceous spicules; while in some,

skeletal parts are altogether absent, the place of the spicules being taken by radiolarian shells, or grains of sand. The spicules of the different species of sponges vary considerably, both in size and shape, but are sufficiently constant to afford one of the best means of classification, and when mounted for dark-ground illumination, form singularly beautiful and interesting microscopic objects.

CHAPTER IV

A SCIENTIFIC RIDDLE. THE HYDROZOA AND BRYOZOA

On a still, warm summer, or early autumn, afternoon, should we take a boat and row or sail out into the quiet waters of the bay to a point where a slight current sets in from the ocean, one of the most wonderful and beautiful phenomena of the sea may be witnessed. As we gaze over the side of the boat, we shall see, rising from out the dim mysterious depths, and floating away with slow rhythmic motion, countless pale, opalescent, graceful forms. They are jelly-fish, or *Medusæ*, and hour after hour they will pass in stately, silent procession, their wonderful, transparent, umbrella-like discs rhythmically expanding and contracting, forcing them through

the water with a lazy, almost effortless motion, trailing their graceful, riband-like arms behind them. As twilight gives place to the dark shadow of night many of the Medusæ begin to glow with a wondrous, strong phosphorescence, and to see these brilliant, living torches rising from the dark depths towards the surface of the sea, and drifting by through the calm waters, is one of the most beautiful, inspiring, and romantic scenes imaginable : a sight that one can never forget.

Spallanzani carried out a number of curious and interesting experiments in reference to this phosphorescence of the Medusæ, and ascertained that the power of emitting light appeared to be limited to certain parts, to the large arms or tentacles, the muscular zone of the umbrella-like disc, and the stomachal cavity. The phosphorescence appeared to be due to the secretion of a peculiarly glutinous or slimy fluid exuding from the surfaces of these organs. He found that this secretion, when mixed with other fluids, communicated to them

a certain amount of phosphorescence. Thus a single Medusa squeezed into 27 oz. of cow's milk was found to render it so luminous that it was possible to read a letter at a distance of three feet from the vessel containing the mixture.

There are many species of Medusæ, and they vary considerably in size and shape, some species growing to veritable giants ten or twelve feet in diameter, others rarely attaining the size of a hemp seed. All are provided with curious minute stinging cells, by means of which they capture their prey; and some are capable of producing a painful and nettle-like sting should they come into contact with a tender-skinned bather. On the under surface, and in the centre of the umbrella-like disc of a Medusa will be found an opening, surrounded by the delicate long arms. This is the mouth, which is connected by a short tube with a cavity in the body, the stomach of the creature.

For many years the Medusæ were a great puzzle, and the source of much

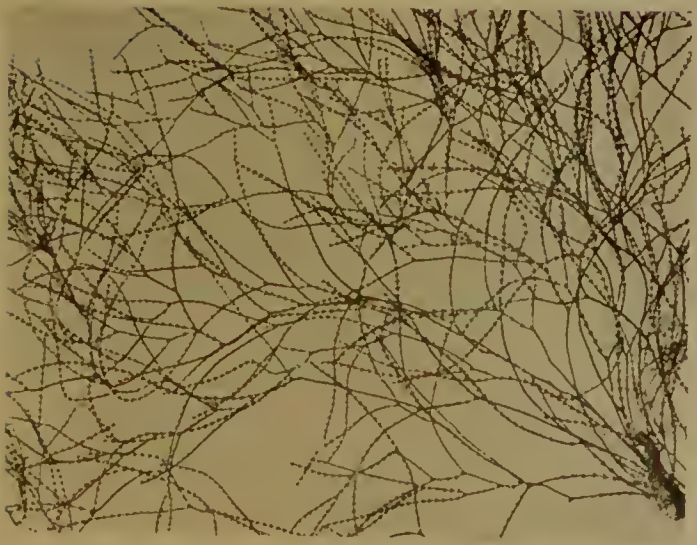
discussion to the early naturalists. For a long time their whole life-history was unknown and something of a mystery. There existed a sort of scientific riddle in connection with them: when is a Medusa not a Medusa? The answer was at last discovered, and proved that the life history of many of these jelly-fish is most remarkable.

There is a common jelly-fish frequently to be found cast up on the seashore, where it is readily recognisable by its gelatinous saucer-shaped umbrella, three or four inches in diameter, which has near the centre four red or purple horse-shoe-shaped bodies, lying embedded in the jelly. It is called the Aurelia, and its life-history solved the riddle. In these jelly-fish the sexes are distinct. Now, the little offspring of the Aurelia are totally unlike their parent when they start out on their journey in life, for they are little oval or oblong creatures covered with cilia. By means of these hair-like processes, or cilia, the tiny creature floats off on the tide and enjoys a brief free existence, during which

period of its life it is known as a *planula*. It soon abandons its roving life, becomes fixed by one end of its body to a rock, and loses its cilia. At the unattached end of its body, it forms a mouth, around which a series of tentacles soon make their appearance; while at the same time the attached end undergoes a change of shape, and becomes narrowed into a stalk-like organ of attachment.

The result of all these changes is the metamorphosis of the little planula into a Hydra-like polype. Safely attached to the rock, the little polype waves its tentacles slowly about, captures its prey, and gradually grows longer in the body. Then a series of constrictions or waists form in its tube-like body, which gradually deepen until the polype assumes the appearance of a pile of saucers, each with its edge produced into eight bifid lobes. Soon this process of constriction is completed, the saucer-like bodies separate from one another, and each one, turning upside down, begins to swim about as a small jelly-fish, which

PART OF A COLONY OF FLUSTRA.
(*Bryozoa.*)



COLONY OF HYDROZOA.

grows rapidly and eventually develops into an adult Aurelia.

Such is the extraordinary life-history of the Aurelia, and in it we not only find the answer to the riddle—(When is a jelly-fish not a jelly-fish? When it is a Hydra)—but we also find a remarkable example of that most interesting natural phenomenon, the alternation of generations, or *Metagenesis*. That is to say, we find a sexual generation, the Aurelia, producing a sexless offspring, the hydra or polype, which in turn develops asexually (by constriction) a sexual generation—the medusa Aurelia.

Nearly related to the Aurelia are the beautiful seaweed-like "Zoophytes," which, together with the fresh-water polypes, and many jelly-fish, mostly of small size, are included in the class *Hydrozoa*. The delicate, brownish, horny-textured polyparies of the zoophytes are familiar objects of the shore, and at first sight somewhat resemble feathery seaweeds. Fully to appreciate their great beauty, however, they must be seen alive; while their life-history is as

interesting and remarkable as that of the Aurelia.

If we examine the wooden piles of piers or breakwaters at low-tide mark, and also the broad fronds of some of the wracks growing in the deep pools, we may find a delicate, whitish or light-brown, almost fur-like growth, consisting of branched filaments about the thickness of sewing cotton. Some of these are closely adherent to the timber, and serve for attachment, while others are given off at right angles, and present at intervals short lateral branches, each terminating in a bud-like enlargement. We will carefully collect some of these living colonies of zoophytes, and placing them in one of our collecting jars, with a generous supply of sea-water, carry them home to examine under the microscope.

If we place one of these living colonies in a zoophyte trough filled with clean, fresh sea-water, and examine it under the microscope with a 2-in. or 1½-in. objective, a very beautiful sight will be revealed to us. Every slender branch

and stem is clothed with little cup-like cells, from which small heads, surrounded by gracefully waving arms or tentacles, are pushed forth. The whole colony presents a scene of great animation, and if we watch carefully we may see some of the minute living organisms that are swimming about become entangled in those graceful waving tentacles, and find their way into the hungry mouth of the polype.

Under a higher magnification, we can make out the structure of the polypes or hydranths in greater detail. We see that each polype consists of a somewhat cylindrical, hollow body, joined to the common stem by its proximal end, and produced at its distal end into a conical elevation, around the base of which the tentacles are arranged in a circle. In the centre of the conical elevation is the mouth, capable of great dilation and contraction, leading to a spacious digestive cavity, which communicates with the pith of the common stem. All the polypes are alike in structure, and they have no special

reproductive organs, the growth of the colony taking place by a singularly vegetative-like process of budding.

On certain parts of the colony, particularly towards the proximal region, will be found transparent cases, enclosing long cylindrical bodies, bearing numerous small lateral offshoots, varying greatly in form according to their stage of development. The transparent case is known as a *gonotheca*, and the small lateral offshoots are asexually produced medusa-buds. These latter are, in the young condition, mere hollow offshoots of the long cylindrical body, or blastostyle; but when fully developed, they appear like tiny saucers attached by the middle of the convex surface to the blastostyle, and with a fringe of sixteen very short tentacles.

Eventually these little fringed saucer-like buds make their escape through an opening in the transparent gonotheca, and swim away as little medusæ or jelly-fish. These asexually-produced medusæ of the hydroid colony, like the Aurelia Medusæ, are a sexual generation—that

THE TENTACLE-CROWNED POLYPES OF A HYDROID COLONY.

A HYDROID MEDUSA.

PORTION OF A HYDROID COLONY SHOWING THE OBLONG CELLS IN WHICH THE YOUNG MEDUSÆ ARE FORMED.

is to say, some are males and some are females. Their offspring is an oval ciliated planula, which after swimming about freely for a time, settles down on a piece of timber or a seaweed, fixes itself at one end by a disc attachment, and becomes converted into a *hydrula* or simple polype, with a circlet of tentacles round its mouth. This hydrula soon sends out lateral buds, and, by a frequent repetition of this process, becomes converted into a complex zoophyte colony. In following step by step the life-history of these beautiful feathery hydroid zoophyte colonies, we witness another wonderful example of the alternation of generations.

The broad leaves of the saw-leaved Fucus are frequently partially covered with a horny textured growth, composed of hundreds of minute tubes or cups placed side by side. If a portion be placed in clear sea-water and examined with a magnifying glass, hundreds of polypes, furnished with numerous ciliaclad tentacles, will be seen to appear at the portal of each cell, giving the

whole growth a curious mossy appearance. It is from this these little animals have gained the name of Bryozoa, or, to give them the name by which they are more familiar to English naturalists, and which refers to their numbers, the Polyzoa. They are in no way related to the hydrozoa, although from the general form which they assume they might readily be mistaken for the hydroid zoophytes. But their anatomy is more complex; they show no alternation of generations, the sexes are united, and the ciliated larvæ are free-swimming.

At one time the Polyzoa were thought to be plants, and the old author, Hooke, in his "Micrographia," gives the following quaint, though in some respects accurate, description of a very common form, called the Sea-mat or Flustra: "I have not, among all plants and vegetables I have yet observed, seen any one comparable to this seaweed. It is a plant which grows upon the rocks under water and increases and spreads itself into a great tuft, which is not only handsomely branched into several leaves,

but the whole surface is covered over with a most curious knot of carved work, which consists of a texture much resembling a honeycomb, for the whole surface on both sides is covered over with a multitude of very small holes, being no larger than so many holes made with a pin, and ranged in the neatest and most delicate order imaginable, they being placed in the manner of a quincunx, or very much like the rows of eyes of a fly, the rows or orders being very regular which way soever they are observed. These little holes, which to the eye look round, when magnified, appear very regularly-shaped holes, representing almost the shape of a round-toed shoe, the hinder part of each being, as it were, turned in, or covered by the toe of that next below it. These holes seemed walled about with very thin and transparent substance, looking of a pale straw colour, from the edge of which, against the middle of each hole, were sprouted out four small, transparent, straw-coloured thorns, which seemed to protect and cover those cavities."

This is really a wonderfully faithful description of the common Sea-mat Polyzoa, and one cannot help picturing the surprise and delight of old author Hooke, could he have seen a portion of a living colony under a modern microscope. He would first have seen the familiar "round-toed shoes," and then from out each shoe would come a head crowned with tiny ciliated arms or tentacles, which would wave about in all directions, presenting to his astonished gaze a scene of the greatest animation.

One of the most extraordinary sights to watch through the microscope is a living colony of the "Bird's-head" Polyzoa (*Bugula avicularia*). There are the familiar rows of orderly cells, with their tentacle-crowned inhabitants, but on the outer side of each cell rises a long neck, topped by what looks like a vulture's head, the beak of which ever and anon opens and shuts with an angry snap. The tentacles wave about in all directions, wafting food into the mouth of the polype, while the weird birds'-heads swing about, snapping angrily at

THE POLYPARY OF A COLONY OF BRYOZOA.
(*Bicillaria ciliata.*)

THE BIRD'S-HEAD BRYOZOA.

everything that comes in their way. At one time these bird's-head processes were thought to devour the creatures that they captured, and so help to maintain the life of the colony, but it is now known that such is not the case. Their real function is that of scavengers and policemen; to keep the colony clean by picking off and casting away all particles falling on it, and to frighten away unwelcome visitors. In many species of polyzoa, the bird's-head processes are replaced by hollow, flexible outgrowths called "lashers."

At certain seasons of the year many of the little cells of the colony will be found to contain minute eggs, from which escape small, ciliated, free-swimming larvæ, which after a period of freedom become the founders of new colonies; the colony growing from the single individual by a curious budding process. Many interesting and beautiful species of polyzoa are to be found in the deep rock-pools near low-tide mark, and may be dredged up, and sometimes found washed up on the shore

along with other treasures of the deep, after a storm.

While seeking for living specimens of the hydrozoa and bryozoa, many of those beautiful and interesting creatures, the Sea Anemones, will be found attached to the rocks in the deep pools. When seen thus, in their natural environment, with their numerous tentacles fully expanded, and varied colours, they indeed look like beautiful flowers of the sea, and well merit their scientific name, the *Anthozoa*, or flower-animals.

Nor is the beauty of colour and varied shape the most interesting part of the anemone, for its structure presents many remarkable features. The restless, waving tentacles are armed with highly specialised cells called *Nematocysts*, or stinging-cells. Each of these complex cells has coiled within it an extremely fine, hollow thread, armed with several minute barbs. This tiny, but formidable stinging apparatus, is set in motion by means of a delicate protoplasmic process, called the trigger-hair, which at the slightest touch causes the

barbed portion to shoot out and strike the object that brushed against the trigger-hair. These stinging-cells, or *Nematocysts*, are also present in the tentacles of the hydrozoa, and are used by both the anemones and hydroids for the capture of their food. The fine-barbed threads penetrate the skin of their prey, and secrete an irritant fluid which causes paralysis.

The sexes are distinct in the anemones, and as well as the true sexual method of reproduction, they have an asexual method by the vertical constriction from disc to base of an individual which results in its division into two. They appear to live to a considerable age, for Sir J. Dalzell recorded that he kept an anemone in one of his aquaria for twenty years.

Like so many of the dwellers in the sea, the anemones have the power of reproducing lost parts. The most familiar of the anemones is probably the Common Red or Strawberry Anemone (*Actinia mesembryanthemum*), which is to be found attached to the

rocks in most tidal pools. Although generally a deep red colour, some specimens will be found of an olive-green. The variation in the colours of individuals of the same species is a subject worthy of closer and more careful observation and investigation than it has as yet received, and will probably show that these creatures have in some degree the power of more or less adapting their colour to their environment. The Dahlia Anemone (*Tealia crassicornis*) is a magnificent creature, both in size and colour, and is fairly common in the deep rock-pools. On rocks at, and beyond, low tide mark, the beautiful plumose *Dianthus* may be found, its almost feather-like tentacles forming a dense tuft, sometimes four or five inches in diameter. With a little care and trouble anemones can be kept in a healthy condition in aquaria for years, and will be found to be well worth the attention bestowed upon them.

CHAPTER V

THE STORY OF THE STARFISH AND ITS KIN

LEFT stranded and helpless by the receding tide, the Common Starfish does not look a particularly interesting or inviting subject for investigation, and yet it is in every respect a most remarkable creature, and, as one of Dame Nature's ablest scavengers, plays a most important part in old Neptune's kingdom. It is known round our coasts by many names, such as Five-fingered Jack, Old Five-fingers, Devil's Hands, Cramps, and Cross-fish ; while from its weakness for oysters, and a propensity for absorbing bait on the end of their fishing lines, it is amongst the fishermen one of the most cordially detested denizens of the deep. Appearing in great numbers at

certain times on the coasts of the Eastern Counties, the starfishes are harvested and carted off by the farmers, who find them a valuable and comparatively inexpensive form of manure.

On examining a living Common Starfish in a rock-pool, it will be seen that the back of the body-disc and the five arms or rays are covered with a thick, rough skin, in which numerous plates of calcareous material are embedded, forming a sort of network pattern. Just between the origin of two rays, near the edge of the body, is a curious knob or plate, marked with many straight and radiating lines; this is called the madreporic body or water-tubercle, and acts as a filter, down which water passes into the animal.

Turning the starfish over on to its back, we can examine the under-surface. In the middle of the body is the mouth, surrounded by a number of spines. If the specimen is a fairly large one, it will be possible to introduce the little finger of one's hand, through the mouth of the starfish, down the gullet, a little

A GROUP OF STARFISHES.
Three are growing new arms.

UNDER SURFACE OF A STARFISH, SHOWING THE MOUTH AND SUCKERS, OR TENTACLES.

way into the stomach, and to reach on all sides for a certain distance into the rays. The finger in its exploration will probably come into contact with something hard like a wire, which is the tube or hollow cylinder connecting at the surface with the madreporic body, through which the water supply is drawn.

This exploration proves that the starfish possesses a capacious stomach; as a matter of fact, it resembles a bag, and nearly fills the body; it has an extension into each ray, and is open below for the gullet and mouth. A large digestive organ is very necessary to the starfish, for it is a voracious creature, and has to make up much muscle, nerve, and mucous tissue from its food.

Radiating from the mouth are five narrow grooves, each passing along the middle of the ventral surface of one of the arms to its extremity, and called the *ambulacral grooves*. In each of these ambulacral grooves there are two double rows of soft, highly sensitive, tubular bodies, ending in sucker-like extremities; these are the tube-feet, which act as the loco-

motive organs of the animal. These sucker-like feet have a tube in them, which leads from the outer surface down into a soft bag, the *ampulla*, which lies in the cavity of the arm, and forms part of the mechanism by which the tube-feet are protruded.

If we look carefully at the extremity of each of the ambulacral grooves, we shall be able to distinguish a small bright red spot, which is the eye of the starfish. Over this eye is a process similar to the tube-feet, but smaller and without the terminal sucker, called the tentacle. By experiment, these tentacles have been most conclusively proved to be olfactory organs, and the starfish is more dependent upon them for guidance to its food, than upon its sense of sight.

Thus far our investigations show that the starfish is by no means such a helpless creature as one might at first imagine. Indeed, with its large mouth, capacious digestive apparatus, tube-feet, eyes, and olfactory organs, it is remarkably well-equipped for the battle of life. What a good healthy starfish will eat is simply

extraordinary. It will cram fair-sized mussels into its stomach and devour the soft animals and part of their shells. Small sea-urchins, though its cousins and prickly withal, are bolted whole and digested. Should a fellow starfish abandon one of its arms—a curious but common habit of the tribe—it will greedily seize upon and devour it.

When in search of a delicate and nourishing lunch, the starfish will adjourn to the nearest oyster-bed, and commit serious depredation. How on earth this comparatively soft-bodied creature can manage to open an oyster and get it out of its shell without the aid of a knife, seems at first a puzzle. But the hungry starfish sets to work in a very business-like fashion. Having selected its victim, the starfish tightly embraces it, and places its mouth close to the sides of the oyster, and tries to tuck in as much of the shell as it can. The dragging and pulling motion of the arms, and a secretive fluid coming from the mouth of the starfish, is too much for the oyster, who soon has to give in

and open his shell. When the exhausted oyster does this, the starfish proceeds to protrude its stomach through its mouth towards its unfortunate victim. Gradually the great bag-like organ is pushed farther and farther out and over the body of the oyster, until it is completely covered. The stomach, now containing the oyster, is in a short time once more withdrawn into its proper abiding place, and the starfish digests at leisure his ill-gotten repast.

When it was first discovered what a serious foe the starfish was to the oyster fishery, all captured starfishes were ruthlessly torn across and thrown back into the sea. But they did not miserably perish, for the starfishes, like the rest of the creatures comprising the *Echinodermata*, have an extraordinary power of reproducing lost parts, so that a single arm has been known to grow up into a new starfish. As a natural result of the heroic would-be slaughter adopted by the fisher-folk, instead of their foes diminishing in numbers, they increased,

two or three new enemies resulting from the mutilation of every captive. Most uncanny, too, were these new foes in appearance, for the original arm would, of course, for some time be twice or three times the size of the new sprouting limbs and body, giving the creatures a most lop-sided and evil aspect. However, the oystermen know better nowadays; they collect all the starfishes, bring them on shore, and sell them as manure to the farmers.

The sexes are distinct in the starfishes and most of the *Echinodermata*, and the young are hatched as uniformly ciliated, free swimming embryos, who pass through a more or less complicated process of metamorphosis ere they assume the adult form.

There are many starfishes living near low-tide mark and in deep water that are well worth seeking. One of these is the long and slender-armed *Uraster glacialis*, which is rather fond of squeezing itself into odd crannies in the rocks, and, like its relative, Five-fingered Jack (*Uraster rubens*), has a weakness for

oysters. The Sun Star (*Solaster papposa*) is a very handsome starfish, generally of a brick-red and white or yellow colour, the colours appearing in alternate bands on the short arms or rays, which are very numerous. Probably the largest of our native starfishes is *Asterias aurantiaca;* full-grown specimens frequently measure 26 in. in diameter. A very curious little starfish, in which the rays appear only as five blunt projections of the body, is the Cushion Starfish (*Asterina gibbosa*): It measures about 1 in. to 1½ in. across, and frequents rocky situations.

The Sand and Brittle Starfishes are particularly beautiful and interesting creatures, which, although bearing many resemblances to the true starfishes (*Asteroidea*), have a number of special features of sufficient importance to justify their constituting a separate class, called *Ophiuroidea*. Their body is star-shaped, but the arms, instead of appearing merely as radiating prolongations of the central body-disc, are sharply marked off from it, and have the general appearance of

OPHIDIASTOR.

ASTERINA GIBBOSA.
Upper and under surface.

appendages. These arms are solid, but very flexible, long, slender, and tapering, and are used by rapid wriggling lateral movements when the Brittle Star wishes to travel. As their name denotes, these Brittle and Sand Starfishes are very fragile, casting off their arms, which frequently again break up into fragments at the slightest rough handling.

At low-water, along the Eastern coast of England, on the rocks and sand, and in the pools, is to be found the Red Brittle Starfish (*Ophiothrix rosula*). It is very beautiful in its colouring, which varies somewhat in different specimens, being rosy red, or red-brown, splashed with white, sometimes spotted with dark red tints, with perhaps a yellow tone on the disc between the rays. The five long, spiny arms may be white, grey, or deep blue, banded with bright pink, rose-colour, yellow, or with shades of brown. In the rock-pool it is a very wriggly little creature, and if touched suddenly will fling off an arm, while, unless removed from the water with the very greatest care and precaution, only the body will

be captured, the arms dropping off and wriggling about in the pool in a most uncanny snake-like fashion.

The Long-armed Brittle Star (*Ophiocnida brachiata*) is a very pretty little creature with arms some eighteen times longer than the body. It is to be found on the shores of Cornwall, Salcombe Bay, and Belfast Bay. It is practically impossible to kill it without its breaking up into pieces; the only way to obtain a perfect specimen for the collection is to hunt for one that has died on a heap of sand.

The Daisy Brittle Star (*Ophiopholis bellis*) has a fairly wide distribution round our coasts, it being found in Cornwall, Scarborough, along the coast of Scotland, and at times very abundantly in deep water just below low-tide mark, in Shetland and Orkney. It has a pretty red-coloured body disc generally about ¾ in. in diameter, with five very slender arms, clothed with short, stoutish spines stretching out at each joint.

The Sand Stars are not so often met

with on the shore or in the rock-pools as are the Brittle Stars ; they love a sandy bottom in fairly deep water, and some species are very abundant in the neighbourhood of oyster-beds and scallop-banks, where they may possibly devour the very young shell-fish, though their stomachs are generally found to contain only minute foraminiferal shells. In turn they are greedily sought after and devoured by cod, ling, and other fish.

The Feather Stars and their allies, forming the class *Crinoidea*, are particularly interesting and beautiful creatures. They bear a superficial resemblance to the true starfishes and Brittle Stars, but have many important points of difference. They are the modern representatives of a very ancient race that must have been very numerous indeed in the seas of past geological ages, judging by the quantity of their fossil remains to be found in some strata of the earth.

The Rosy Feather Star (*Antedon rosacea*) is one of the most beautiful of our native species ; its arms are long, flexible, and tapering, and shaped some-

what like a feather, with a main axis and a pair of lateral rows of short slender branches. The mouth is in the centre of that surface of the disc, which is directed upwards in the natural position of the Feather Star. On the opposite surface, the back of the star, are a number of little clawed hooks, the cirri, by which the animal anchors itself to stones and seaweeds. Thus the Feather Star, when at rest, assumes exactly the opposite position to an ordinary starfish.

When this beautiful creature desires exercise, or change of quarters, it detaches itself from the object to which it is anchored, and swims away with wonderfully graceful alternating movements of its arms. So unlike the adult in appearance is the young larva of the Feather Star in the early stages of its life that it was first described as a different creature. It was discovered in 1823, in the Bay of Cork, by Mr. J. V. Thompson, who called it *Pentacrinus Europæus*, and its discovery caused great interest, for it was the first animal of the encrinite

SPINES OF SPATANGUS.

ASTERINA REGULARIS.
Upper and Under Surfaces.

kind which had been seen in the seas of Europe.

Professor Rymer Jones gives the following very charming account of Thompson's observations : " The smallest specimens of Pentacrinus observed by Mr. Thompson did not exceed $\frac{1}{8}$ in. in height. In this stage the animal resembles a little club, fixed by an expanded basis, and giving exit at its apex to a few pellucid tentacula ; no other part of the solid fabric is as yet observable. In specimens that have made a little more progress, together with the elongation of the pedicle or stem, its joints begin to make their appearance ; the body acquires a larger size and brownish tint from a grosser food ; the tentacula of the mouth protrude in a greater degree, and move slowly in different directions. In others still more advanced, the joints of the stem become quite obvious from their opacity and white colour, and the base of the future arms, as well as the auxiliary side arms, are rendered palpable. The arms from this period lengthen apace from their bifurcation,

and have superadded to them a double range of transparent jointed tentacula; so that the animal begins to put on a more perfect appearance, and now for some time merely acquires a somewhat greater size and an extension of its arms, which, although they solidify from their origin upwards, remain pellucid and thick at their apices, where elongation, evolution and the secretion of calcareous matter are gradually going on. Here, then, we have the form, the structure, and the mode of growth of the Encrinite exemplified before us, and can see with our own eyes what, until the discovery of this little animal—doubtless common enough on our own coast—remained involved in impenetrable mystery, viz., the nature, habits, and attributes of the millions of extinct Crinoideans, whose remains constitute our limestone cliffs and encrinitic marbles."

These stalked, pentacrinoid larvæ of the Rosy Feather Star may be found attached to seaweeds and zoophytes on the Devon and Cornish coasts in the deep rock-pools. With care they may

LUTEUS LARVA OF ECHINODERM.

EARLY LARVAL STAGE OF
STARFISH.

ENTERCRINOID LARVA OF THE ROSY
FEATHER STAR EARLY STAGE.

PENTERCRINOID LARVA OF THE
ROSY FEATHER STAR.

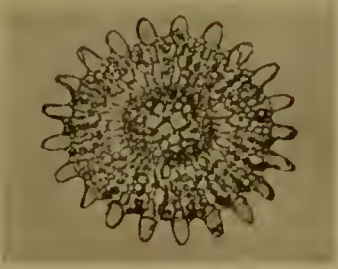
be kept under constant observation, so that one may see the gradual growth and development from the tiny little club-shaped organism until the beautiful, almost flower-like, feather-crowned head breaks away from its stalk and starts on its roving adult life as a perfect Feather Star.

A very prickly cousin of the starfishes is the sea-urchin, or *Echinoderm*, variously known as Sea-hedgehog, Sea-egg, and Sea-burr. Now and then one may be found cast up on the shore, but the home of the sea-urchin is well beyond low-tide mark. Like the starfish, it is given to frequenting the oyster beds, and is said by the oyster fishermen to do a certain amount of damage, but this seems to be a somewhat debatable question, if not an actual libel, for the examination of the stomachs of a large number of freshly-captured specimens only revealed quantities of pieces of seaweeds, zoophytes, bryozoa, and the like. So widely does the sea-urchin differ in general appearance from its cousin, the starfish, that we require to

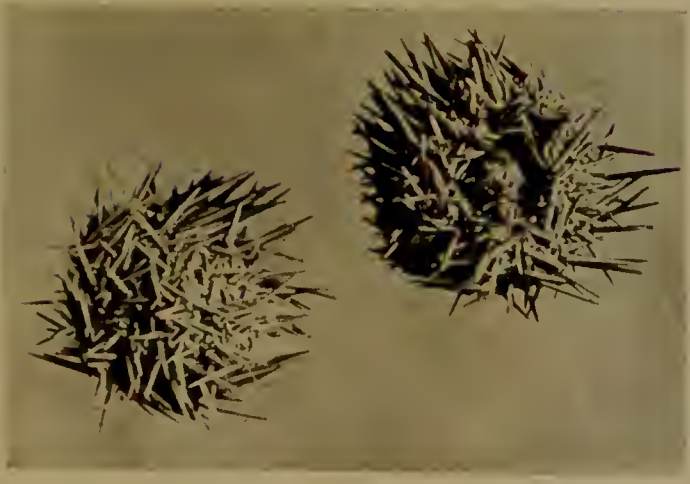
examine it pretty closely to realise the relationship.

The body of the sea-urchin is more or less globular in shape, and covered with spines jointed on to knobs or tubercles, which are borne by the closely fitting limestone plates of the test or shell. These tubercles do not cover the whole of the surface of the test, but are practically arranged in five broad zones, which extend from one end, or pole, of the body to the other. Alternating with these are five narrower zones, which bear smaller and fewer tubercles, and are pierced with small holes arranged in regular rows. Through these holes the sea-urchin extends its tentacles or tube feet, which are provided with terminal suckers, like those of the starfishes, and are used chiefly in locomotion. These narrow zones with the perforated plates are called the ambulacral zones, and resemble in function the ambulacral grooves on the arms of the starfish. Other features which help to make clear the relationship between the starfish and the sea-urchin are to be found at the top

UPPER SURFACE OF THE TEST OR SHELL OF A SEA-URCHIN, WITH THE SPINES REMOVED.



A TRANSVERSE SECTION OF ONE OF THE SPINES OF A SEA-URCHIN, *BOLITA-MICULATA.*



UPPER AND UNDER SURFACE OF A SEA-URCHIN

(the aboral pole) of the upper surface of the latter animal, and comprise the ocular plates and madreporite. A remarkable and characteristic feature of the internal anatomy of the sea-urchin is its complicated apparatus for mastication, known as Aristotle's lantern, and consisting of five jaw-like parts, each bearing a sharp tooth. The points of these five teeth can be seen through the opening of the mouth, which is situated in the common sea-urchin (*Echinus esculentus*) in the centre of the lower broad surface (oral pole).

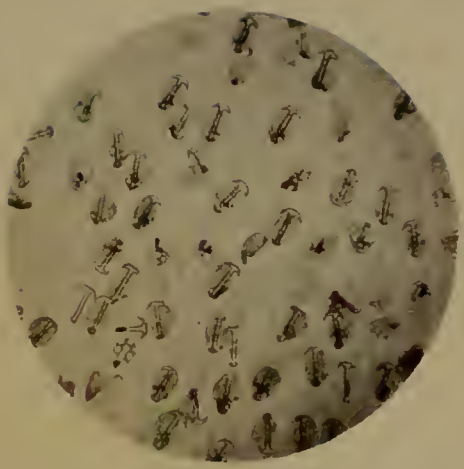
The Sea-urchins, or *Echinoderms*, vary considerably in shape, as well as in size. In some called Heart-urchins, the body is heart-shaped instead of globular ; in others, the Cake-urchins, it is flattened and disc-like. Some of the oval ones attain a very considerable size, and their spines are very nearly the size and shape of a small cigar.

Like the starfish, the sea-urchin starts out on its life's journey as a little ciliated free-swimming organism, passing through a somewhat complex metamorphosis ere reaching the adult stage of its existence.

All the sea-urchins are gregarious, and many of the oval egg-urchins inhabit coasts that are greatly exposed to the action of the waves, protecting themselves by hollowing out cavities in the solid rock, even in such hard formation as granite. This is particularly a habit of the purple egg-urchins of our coast. Commencing when young, they chisel out the rock with their teeth, by incessantly turning round and round, continually enlarging their prison to allow for the growth of their body and spines.

One of the most curious group of animals included in the Echinodermata, and forming the fourth class, are the Holothurians (class *Holothuroidea*), popularly known as Sea-slugs, Sea-cucumbers, Sea-puddings, Cotton-spinners, and in the Tropics as Trepangs, or *Béches de Mer*. Their bodies are more or less elongated and cylindrical, enclosed in a tough skin, containing a comparatively small amount of calcareous matter, arranged frequently in the form of very beautifully-shaped spicules, which in Synapta look like miniature, oval, rose-

OLOTHURIAN, OR SEA CUCUMBER.



SKIN OF A HOLOTHURIAN, SHOWING PLATES AND ANCHORS *IN SITU*

PLATES AND ANCHORS FROM THE SKIN OF A HOLOTHURIAN.

perforated plates and anchors, but only exceptionally forming a rigid shell of plates.

The more or less cylindrical body of the Holothurian generally bears a number of tube-feet, characteristic of the Echinodermata, and in one sea-cucumber (*Cucumaria Planci*), to be found off our coasts, these are arranged in five regular zones running from one end of the body to the other, like the ambulacral zones of a sea-urchin. The mouth is surrounded by a fringe of beautiful, branched tentacles connected with the water-vascular ring, which in most species hangs down freely into the body-cavity, and terminates in a sieve-like madreporite. Respiration is largely effected by the circle of branched tentacles round the mouth, and in some species two branched tubular organs, the "respiratory trees," are also present.

In the Tropics the collecting and curing of these curious creatures for food forms quite an important industry. Under the name of Trepang, or *Bêche de Mer*, they are considered quite a delicacy in China

and the Philippine Islands. Some idea of the importance of the industry may be gathered from the fact that the Eastern Archipelago supplies considerably over £120,000 worth of *Bêches de Mer* to China annually.

Most of the Holothurians of our coasts live among seaweeds, or in mud, or sand, in which they partially bury themselves, only leaving their crown of tentacles exposed. There is one species that is fairly plentiful in deep water off the coast of Cornwall, which is most cordially detested by the fishermen, who call it the "Nigger," or the "Cotton-spinner." It is very fond of getting into their lobster-pots, and then, finding itself a prisoner, throwing out what looks like a bunch of white threads that stick to everything; and as no self-respecting lobster or crab will enter a "pot" containing a cotton-spinner, it is not surprising that the creature bears a very bad character amongst the fisher-folk.

CHAPTER VI

WORMS

UNLESS one has read Charles Darwin's wonderful book on "The Formation of Vegetable Mould through the Action of Worms, with Observations on their Habits," the subject of this chapter hardly sounds inviting. In the past, unfortunately for the worms, their name was synonymous with serpent, and so they were more or less neglected, and shunned as "nasty, slimy, things." However, when one has gained an insight into their life-histories, one soon discovers what remarkable and really interesting creatures they are, particularly those which live in the sea, and their name is almost legion. If it were possible to gather together in one great aquarium specimens of all the marine

worms, they would indeed form a most weird and extraordinary-looking collection of creatures, some graceful and beautiful, others grotesquely ugly, yet all showing wonderful adaptation to their own special environment.

One of the most familiar sights at any season of the year by the seaside, is a group of fishermen hard at work on a strip of sand close to low-tide mark, digging for bait. The creature they are hunting is the Lug-worm, which makes its home in the sand and mud at and beyond low-tide mark. It is a long, cylindrical worm, generally a dark blackish-green colour, somewhat inflated anteriorly. Its body is composed of a considerable number of segments, thirteen of which are furnished with most beautiful arborescent branchial gill tufts, of a fine red or purple colour ; while six segments, destitute of branchiæ, are provided with remarkable bristles or setæ, clothed with delicate, minute barbules at their points. Spiral rolls of sandy excrement, coiled like ropes above an opening in the sand, betray the burrow

of the Lug-worm. The worm lives head-downward in its burrow, which it excavates by swallowing the sand as it scoops it out with its anterior portion, and then lines the hole with a glutinous secretion from its skin.

Another fairly common sand-dwelling worm to be found near low-tide mark is the White-rag Worm, or Lurg. It varies from about six inches to ten inches in length, and about three-tenths of an inch in width, and is a beautiful mother-of-pearl colour. It is a very remarkable-looking worm, for down each side of its body it has well-developed setigerous feet, which increase in size till they reach about the middle of the body, and decrease in size as they extend towards the head and tail. The Lurg can burrow through the sand and mud with extraordinary rapidity, and is equally active in the water, using its feet as oars, and swimming with a curious wriggling, serpentine motion.

One of the most extraordinary marine worms is the *Nemertes Borlasii*, which frequently attains a length of 20 to 25

or 30 feet. It is a slender creature, of a dusky reddish-brown colour, over which a rich purplish sheen appears to play as the light falls upon the almost endless coils of the worm's body. The Rev. Hugh Davis, who paid much attention to marine worms, kept one of the giant *Nemertes* under observation for some time, and gives the following interesting account of it :

"I laid a specimen of this wonderful creature in its own element in the largest dish I had, with a design to observe its habits and manners. It partook in some respects of the nature of the leech, seeming, like it, in some degree amphibious, as it frequently in part left the water, and, to the length of a foot or two, extended itself along the edge of the dish, and the table on which the dish was placed. At other times, particularly during the day, it was compactly collected together in a heap, and perfectly still, unless the dish or table was touched, of which it seemed very sensible. This it indicated by a vibratory motion of its whole mass and by

retracting the head and fore-part, which were generally somewhat extended. In the night I always found it coiled in a more lax and diffuse manner, covering nearly the whole dish; but on the approach of a candle, it seemed affected and inclined to contract itself, so that, although I could not see that it had eyes, I was quite sure that it was very sensible of light. It frequently by morning assumed somewhat of a spiral or screw-like form, and on one morning in particular I was highly gratified in finding it almost perfectly and closely spiral from end to end. I was forcibly struck with this appearance, as it seemed to suggest the solution of a difficulty which perplexed me much, concerning the manner how such a wonderfully soft, delicate, and seemingly unmanageable length of body could possibly move itself from one place to another. But from the moment when I observed this, I was convinced that this must be the state which the creature assumes when disposed to change its station; not only as thus it is contracted into the most

compact size which it is susceptible of, but likewise that when so modified, every spire or volution, by a distinct impulse applied in an appropriate manner, will assist in the act of progression by shifting forward the whole of its amazing length at the same instant, without danger of breaking.

"It is impossible to make a guess at the length of it when alive, on account of its constantly extending and contracting itself when touched, and that with such ease as almost to exceed belief. I once observed a part of the fore-end extend to a length of between 2 and 3 feet along the margin of the dish and the table, which part, on the animal being disturbed, was in a short time contracted so as not to exceed so many inches; and as, when it was thus extended, it was full three times as thick as I have seen it upon other occasions, I may well say that it is capable of extending itself, without any inconvenience, to twenty-five or thirty times the length that it presents at another period."

It being impossible while the animal

was alive to make any reasonable conjecture as to the length of it, Mr. Davis killed it, and then carefully measured it, when he found that it was "full two-and-twenty feet long, exclusive of the proboscis."

The Sanguine Eunice is one of the giant worms of our shores, sometimes reaching two feet in length, and the thickness of a man's finger, the body of such a specimen being composed of some three hundred segments. The gills are comb-shaped, finely coloured, and placed on the back of each foot. It has a most formidable masticating apparatus, for in addition to a proboscis it has three pairs of horny jaws, one pair being serrated. The colour of these Eunice worms varies according to the situation in which they are found, those living in the clefts of the rocks being far handsomer and more brilliant in hue than specimens found amongst seaweeds or in the mud under flat stones at low tide.

One of the Eunicidæ, called the Sao, constructs a quill-shaped flexible tube, in which it lives. That careful observer

of marine life, Dr. Johnston, gives the following accurate and interesting description of this remarkable worm :— "One unceasing object of its life is the capture of prey. For this end it must protrude the anterior portion of the body beyond its tube, and raise itself above the surface of the mud, and remain in this position on watch. To enable the worm to do this with ease is, I conjecture, the office of the forceps-like bristles of the feet ; with their ends, it may hook itself to the rim of the tube, and thus obtain a support without the waste of muscular power. A long watch is thus rendered less irksome, while at the same time the capacity to seize upon a passing prey is increased. The prey caught, analogy leads us to conclude the worm will instantly retreat and sink within its tube, where it can feed without disturbance or fear ; but as the entry and passages are narrow and unyielding, it seems to follow that the prey should be held by the mouth alone, when in the act of being dragged within the tube, and hence, surely, the reason

UPPER SURFACE OF SEA-MOUSE.

UNDER SURFACE OF SEA-MOUSE.

EUNICE

SEA-WORMS.

that the mouth has been furnished with the hard tubercles to the lips ; for when pulled together and put in contact, they must give a firmer grip and hold than could otherwise be taken. The use of the tube is to protect the body from the pressure of the soft mud in which it stands immersed. When the tube is overset, or cast out by the waves or accident, the worm leaves it, and becomes in its turn exposed to enemies. To protect itself from these, while a new tube is being secreted, Nature has amply furnished the Sao with a series of bristling lances on each side. These arms are of exquisite make, very fine and very sharp ; and those of the upper bundle have their points bent and inclined towards those of the lower bundle, which are likewise bent to meet them. Arms like these will inflict wounds on the tiny assailants of the Sao, sufficiently painful to repulse them, and a lethal wound is not necessary."

Of the wandering worms, the Sea-mouse (*Aphrodita aculeata*) is perhaps the most beautiful and remarkable. As its

popular name implies, it is a very unwormlike animal, and can crawl rapidly or slowly, or swim equally well, as circumstances and inclination demand. The body is oval in shape, coming to rather a sharp point at each end. The upper surface of the body is somewhat rounded, the under surface is flat, and attached to the head are two antennæ-like feelers. A short, thick, brownish-coloured fur covers the back, and effectually hides numerous scales or elytra. Towards the sides of the body the short fur is interspersed with long, bright-green and yellow iridescent hair; and intermixed with this are cross-rows of long, stiff, thorny brown bristles or setæ. These setæ, which are used as weapons of defence, exhibit a complexity of structure far beyond anything to be met with in the hairs of higher animals; indeed, in one species, the Porcupine Sea-mouse, they are veritable harpoons, the point of each being provided with a double series of barbs. The play of iridescent colour on this complex fringe of hairs and bristles that

surrounds the body of the sea-mouse is most beautiful. Indeed, it is as if all the hues of the rainbow were collected there, making this remarkable animal a living jewel, and truly worthy of the name of Aphrodita, the Queen of Beauty.

When collecting seaweeds, particularly the Saw-leaved or Serrated Fucus, some specimens will be found on which are numbers of tiny white tubes, about the size of a pin's head, and coiled up flat, something like a miniature single coil of rope. These are the homes of little tube-making worms, called Spirorbis. If we place a piece of seaweed to which a number of these tubes are attached in a shallow vessel containing fresh sea-water, and watch quietly with a good hand-magnifying glass, we may see a little trap-door open on one of the tubes and a tiny tuft of feather-like gills come cautiously out. A shadow, or any sudden movement, will cause the little creature instantly to withdraw within its tube, and close the trap-door, which in shape is somewhat like the rounded

end of a table-knife, and is made out of one of the tentacles of the worm, near to its mouth. When the little Spirorbis thrusts out its feathery circlet of gills or branchiæ, they set up currents in the water and bring the microscopic creatures on which it lives within reach.

A very handsome tube-building worm, from 12 to 14 inches in length, and about as thick as a goose-quill, is the Fan Sabella (*Sabella penicillus*). It is common on our coasts, abounding in immense numbers on the Essex coast, where the fishermen call them "Hassocks." The tube formed by the worm out of particles of sand or mud cemented by a glutinous secretion, is long, flexible, and cylindrical. The worm itself is composed of many segments of a brownish-orange colour. The gills or branchiæ form a pair of exquisitely coloured, graceful, fan-shaped tufts; each tuft consists of from thirty to ninety filaments, densely fringed, and united together at the base by a cartilaginous membrane. When these remarkably complex, fan-shaped gills are fully ex-

A TUBE-BUILDING WORM.

A NERIS WORM.

SEA-WORMS.

panded above the tube, they present a most beautiful appearance, looking like some dainty feathery flower crowning a slender dark-brown stem.

The manner in which the Sabella constructs its tube is very interesting, and may be observed by placing a living specimen in a small glass jar or aquarium filled with perfectly clean sea-water. When the worm has recovered from the shock of being removed from its natural environment to the jar or aquarium, and has once more fully expanded its beautiful plume, or branchiæ, a drop of liquid mud should be allowed to fall into the clear water. The worm will then be seen to rouse itself, and the cilia which cover its plume will be set in active motion, collecting the particles of mud into a loose mass at the funnel-shaped base of the plumules. The Sabella now raises the first segment of its body above the orifice of the tube, and two fleshy lobes or trowels are brought into action on the mud particles, as they are brought down to the base of the branchiæ. The beating and pressing action of these

miniature trowels results in the working up of the mud particles and consequent prolongation of the tube. When the supply of mud ceases, the Sabella once more lowers the first segment of its body to the normal position, and takes a well-earned rest.

A very interesting tube-building worm is the Shell-binder (*Terebella conchilega*), which constructs its tube almost entirely of broken pieces of shell and fragments of pebbles. It is a worm that keeps fairly well in a cool aquarium, so that it is not very difficult to watch it at work. It confines its building operations to twilight and night time, but by diminishing the amount of daylight falling directly upon the tank, it can be induced to work during the day. If dislodged from its tube without injury, and placed in a vessel filled with sea-water and containing crushed shells and sand, the Terebella will soon be seen to set to work and construct itself a new and ornate tube from the materials with which it has been supplied.

In a deep rock-pool, an old shell, or

stone, will often be seen more or less covered with a number of tubes, all much intertwined,and mutually adherent. The worm that constructs these tubes is a very handsome and interesting one, called the Serpula (*Serpula vermicularis*). The Serpula is about an inch long, and carries on its thorax prominent tubercles in place of feet, which are protrusile, and within which bundles of stout bristles are thrust in and out. But the most remarkable part of the worm's anatomy is a row of microscopic hooks, which extend across the back and are wielded by long thread-like tendons, which are fixed on mechanical principles to the attached end of each hook.

Mr. Gosse, who paid great attention to the microscopical structure of the Serpula, describes the remarkable hooks as follows: "These organs are formed on the model of a hedger's bill-hook, only that the edge is cut into long teeth. Carefully counting them, I have found that each Serpula carries about 1,900 such hooks on its corselet, and that each of these being cut into seven teeth, there

are between 13,000 and 14,000 teeth employed in catching the lining membrane of the tube, and in drawing the animal back."

The gills or branchiæ of the Serpula consist of graceful comb-like filaments, very richly coloured, forming the most attractive feature in this remarkable worm. They are well worth mounting and examining under the microscope with a low-power objective, when each filament will be seen to consist of a pellucid, cartilaginous stem, from one side of which springs a double series of secondary filaments, like the teeth of a comb. The exterior of these filaments is set with strong cilia, which in life drive the water current upwards along one side of the filament in a vigorous stream, and downwards along the other.

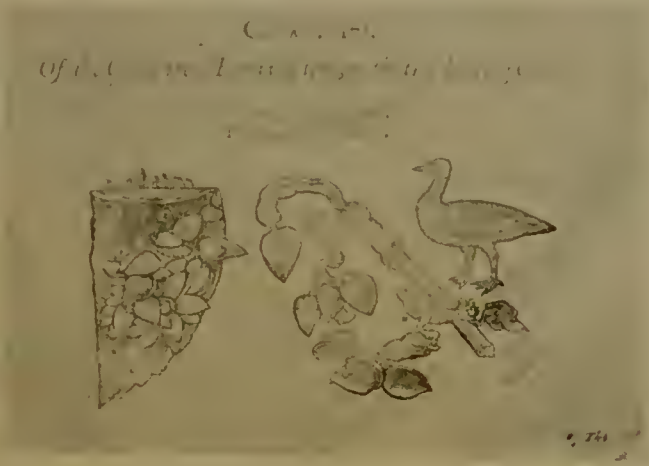
Such is a brief description of some of the worms that dwell in old Father Neptune's garden, and will perhaps serve to give some idea of how varied and wonderful they are in structure, colour, and mode of life. To do them anything like justice would require the

space of a dozen volumes twice the size of this, and still probably much would be left undescribed, for their life-histories, the transformations through which many pass from their emerging from the egg to reaching the adult stage, are of great interest. To the young naturalist they offer a very fascinating and fruitful field for original investigation, for many exist that have yet to be fully described.

CHAPTER VII.

BARNACLES, CRABS, AND LOBSTERS

THOSE animals known to the naturalist as the *Cirripedes*, comprising the *Lepades* or true Barnacles, and the *Balani* or Acorn-shells, are familiar enough objects to all seaside visitors. And yet but few people probably know how wonderful and remarkable is the life-history of these animals; indeed, of all the denizens of the deep, the life-story of the barnacle is one of the most romantic. The barnacle was very dear to the imaginative heart of the early student of Nature, and many and most extraordinary were the stories he set down concerning it. One of the most remarkable myths connected with it, and one that even lingers amongst the peasant fisher-folk to-day in Europe, is that the barnacle is



THE BARNACLE TREE AND GOOSE
(*From Gerard's "Herbal."* 1597.)

STALKED, OR SHIP BARNACLES.

but a stage in the life of a goose-like bird, and that at certain seasons of the year the bird is formed within the barnacle-shell, and, increasing in size, at last makes its escape into the water. This curious belief is particularly prevalent in Roman Catholic countries, where the peasants eat the birds associated with the barnacle, during Lent, under the impression that it belongs to the finny tribe.

Old Du Bartas sets forth the barnacle-goose legend in the following quaint lines :

"So slow Boötes underneath him sees,
In the Icy Islands, Goslins hatch'd of trees ;
Whose fruitful leaves falling into the water
Are turn'd, 'tis known, to living fowls soon after.

So rotten planks of broken ships do change
To Barnacles. O transformation strange !
'Twas first a green tree, then a broken hull,
Lately a mushroom, now a flying gull."

The old sixteenth-century author, Gerrard, is more explicit on the subject than poetical Du Bartas, and in his

celebrated "Herbal" gives the following detailed description of the barnacle and its transformations :—

"But what our eyes have seen and our hands have touched we shall declair. There is a small island in Lancashire, called the '*Pile of Foulders*,' wherein are found the broken pieces of old and bruised ships, some whereof have been cast thither by shipwreck, and also the trunks and bodies with the branches of old and rotten trees cast up there likewise, whereon is found a certaine spume or froth that in time breedeth into certaine shels, in shape like those of the Muskle, but sharper pointed, and of a whitish colour ; one end whereof is fastened unto the inside of the shell, even as the fish of Oisters and Muskles are : the other end is made fast unto the belly of a rude mass or lumpe, which in time commeth to the shape and form of a bird : when it is perfectly formed, the shell gapeth open, and the first thing that appeareth is the foresaid lace or string : next come the legs of the bird hanging out, and, as it groweth greater,

it openeth the shell by degrees, till at length it is all come forth and hangeth only by the bill : in short space after it commeth to full maturitie, and falleth into the sea, where it gathereth feathers, and groweth to a fowl bigger than a mallard, and lesser than a goose, having black legs and bill, or beake, and feathers black and white spotted in such a manner as our mag-pie, called in some places a *Pie-Annet*, which the people of Lancashire call by no other name than a tree-goose, which place aforesaid, and all those parts adjoining, do so much abound therewith, that one of the best is bought for three-pence. For the truth hereof, if any doubt, may it please them to repair unto me, and I shall satisfie them by the testimonie of good witnesses.

" Moreover, it should seeme that there is another sort hereof ; the historie of which is true, and of mine owne knowledge : for travelling upon the shore of our English coast, between Dover and Rumney, I found the trunke of an old rotten tree, which (with some help that I procured by fishermen's wives that

were there attending their husbands' return from the sea) we drew out of the water upon dry land: upon this rotten tree I found growing many thousands of long crimson bladders, in shape like unto puddings newly filled, before they be sodden, which were very cleare and shining; at the neither end whereof did grow a shell-fish, fashioned somewhat like a small Muskle, but much whiter, resembling a shell-fish that groweth upon the rocks about Garnsey and Garsey, called a Lympit: many of these shells I brought with me to London, which, after I had opened, I found in them living things without forme or shape; in others which were nearer come to ripenes, I found living things that were very naked, in shape like a Bird: in others, the Birds covered with soft downe, the shell half open, and the Bird ready to fall out, which no doubt were the Fowles called Barnakles. I dare not absolutely avouch every circumstance of the first part of this historie, concerning the tree that beareth those birds aforesaid, but will leave it

to a further consideration; howbeit that which I have seen with mine eyes, and handled with mine hands, I dare confidently avouch, and boldly put downe for veritie. Now if any will object, that this tree which I saw might be one of those before-mentioned, which either by the waves of the sea or some violent wind had been overturned, as many other trees are; or that any trees falling into those seas about the Orchades, will of themselves beare the like fowles, by reason of those seas and waters, these being so probable coniectures, and likely to be true, I may not without prejudice gainsay or indeavour to confute."

Thanks to the careful original investigations of Charles Darwin, Huxley, Bate, and other biologists, we now are familiar with the true life-history of the barnacles, which is every bit as wonderful as that mythic history set forth by old Gerrard and his contemporaries. Every visitor to the seaside is more or less familiar with the Acorn-shells, or *Balanidæ*, that cover the rocks, timbers

of the pier, etc., and perhaps while rambling along the shore has seen a stranded piece of timber to which was attached, by their long, membranous pedicles, a group of Stalked Barnacles or *Lepades*. These Acorn-shells and Stalked Barnacles represent the adult condition of the two great divisions of the *Balanidæ* and *Lepadidæ*, and have arrived at that, the final, stage of their existence, after a most remarkable series of metamorphoses.

Early spring sees the birth of the young barnacles, and certainly no one could imagine, *à priori*, that they were the offspring of such completely dissimilar parents. Doubtless, it was due to this extraordinary dissimilarity between the immature and adult individuals, that prevented the early naturalists realising that the barnacles are really unmistakably crustaceans. On escaping from the egg, the young barnacle larva is a free-swimming creature, having three pairs of legs, a very simple eye, and a probosciformed mouth, with which it is constantly feeding, for it

YOUNG BARNACLES IN THE EARLY (*NAUPLIUS*) FREE-SWIMMING STAGE.

YOUNG BARNACLE AT A LATER (*CYPRIS*) STAGE.

LEGS OF AOULT BARNACLE.

increases in size fairly rapidly. The little creature remains in this condition for some time, swimming actively about, absorbing all the food it can, and generally enjoying itself; and this stage of its existence may be compared to the larval stage in the life of an insect. The second stage, corresponding to the pupa of an insect, is even more remarkable.

The young barnacle has now attained a size of about 1–10th of an inch in length, is translucent, brownish in colour, and of a somewhat elliptic form. At rest, it looks like a tiny mussel. All its legs and antennæ are withdrawn within the shell, which consists of two valves united by a hinge along the upper part of the back, in such a manner as to enable the valves to open from end to end along the front, so as to give freedom to the legs and antennæ. The little creature has now six pairs of beautifully constructed natatory legs, and a pair of large and very complex antennæ, provided with a cup-like sucker and hooks, which serve solely to

attach the young barnacle to rocks, stones, or timber, etc. When the animal is swimming, the six pairs of legs, acting in concert, give a forcible stroke to the water, so that the little creature advances by a succession of jerks or bounds, strongly reminding one of the motion of some of the fresh-water *Entomostraca*, such as Cyclops, or Daphnia, the so-called water-flea.

A most extraordinary feature in the structure of the barnacle at this stage of its life, is that although it is constantly shielded by the valves of the shell, it possesses a pair of magnificent compound eyes, which are pedunculated, as in the crabs and lobsters. Stranger still, perhaps, is the fact that during this stage—and here we have a similarity to the pupa state of an insect, during which no nourishment is taken—the young barnacle has a closed and imperfect mouth, and cannot feed : for its function at this stage is solely to search for, by means of its well-developed organs of sense, and to reach, by its active powers of swimming, a suitable place on which to

STALKED BARNACLES ATTACHED TO FLOATING TIMBER.

become attached, and where it may undergo its final metamorphosis.

When this final change is completed the barnacle is fixed for life: its legs are converted into prehensile organs, and it once more obtains a well-constructed mouth.

It is now literally standing on its head, and in that extraordinary position will pass the remainder of its days. As it is for the future to live in the darkness within its shell, the two wonderful compound eyes that would be useless, have disappeared, reconverted into a minute, single, and very simple eye-spot. Ever and anon the wonderful feathery-looking, prehensile legs are thrust out through the opening in the top of the shell, and by their curious movements kick the food down into the mouth of the creature as it rests head downwards within the shell.

There is something grotesquely human about the appearance and movements of the crabs, and each individual seems to have its own peculiar characteristics and idiosyncrasies. Collect some half-dozen shore-crabs, for instance, put them

down in a heap on the sand, and carefully watch their proceedings. One or two will start off in various directions, frantically waving their claws, as if thoroughly distracted and alarmed ; two may engage in mortal combat, as if labouring under the delusion that each was in some way the cause of the other's capture and discomfiture ; others will stand up, brandish their claws, and foam and bubble at the mouth with impotent rage and longing to rend their human captor ; while the more modest, desiring neither combat nor observation, seek to escape further attention by quickly burying themselves in the sand. Altogether they are most amusing and interesting creatures.

A very curious sight may be witnessed, if a dead fish be placed on a strip of wet sand that is close to the seaweed-covered rocks where the shore-crabs hide while the tide is out. In a little while, if no movement has been made to disturb them, the crabs will be seen approaching from all directions, making sidelong darts, and running very quickly for a short space, and then standing quite still

for a moment. Finally, when they have got fairly close to the fish, they make a sudden rush, seize it, and strive to drag it nearer or into the sea. Then they settle down to the feast, which they eat in a laughably sedate manner. Holding a piece of the fish in one claw, they pick it rapidly to pieces with the other, and stuff the fragments into their hungry mouths. They work fairly quickly, and clean every morsel of flesh from the bones.

The life of the crab is a romantic and adventurous one; indeed, he may almost be said to lead the "strenuous life." Mother Crab makes a hole in the sand, and with the aid of her hind legs deposits her eggs in this snug retreat; her maternal duties may then be said to be practically finished. On escaping from the egg, the young crab is covered loosely by a transparent skin, from which in a few hours it extricates itself, when it appears as a comical, little, free-swimming creature, totally unlike its parents in appearance. A loosely-fitting shell covers the sides of its oblong

body ; it has a long tail and legs, which are used for swimming rapidly through the water ; on its back is an extraordinary outgrowth, looking like an exaggerated dunce's cap ; and it has an absurdly long, tapering nose-piece, and two great eyes.

In this condition the little creature for some time swims actively about, feeding, growing, and at regular intervals changing its skin. If closely watched, it will be seen that with each moult a fresh limb or organ is added, but at the expense of some infantile feature which disappears with the cast-off skin. In this way, after many moults, the dunce's cap disappears, while the nose-piece shortens to more reasonable proportions ; the hind legs grow bigger, and the great eyes and the hearing organs become more perfect. Gradually the body broadens out, the tail shortens and turns up under the body, forming that triangular appendage which children call the "purse" ; the great claws become perfect, and the tiny, but now perfect, crab begins the adult stage of its exist-

ZOEA OF A CRAB

A CRAB DUEL *À LA MORT.*

ence. For some time it leads a somewhat precarious life, for its larger and stronger relations are ready to pounce upon and devour it, if they get a chance ; while in scuttling away from the too pressing attentions of big relations, it may inadvertently fall into the clutches of a sea anemone and be engulfed and digested. Should it escape the latter, however, it obtains some satisfaction and revenge for any frights or hair-breadth escapes that it may have had, when it has grown larger and stronger, for it will then fearlessly thrust its claw down into the mouth of the anemone and withdraw any tempting morsels from the creature's stomach, and devour them at its ease.

As the adult crab increases in size, it from time to time casts off its old shell, which breaks across between the hind pair of legs, permitting the soft-bodied animal to back out. For a while the crab is a soft, flabby thing, until its new armour has grown and hardened. It is a period of discomfort and persecution for the crab, its natural enemies taking

full advantage of its temporary defenceless state. Should it be a male, the lady crabs are not above pinching the legs off their swain and making a meal of him ; but later, when they very literally, for the time being at any rate, become the softer sex, they are by no means insensible to the persuasive advances of a fully armour-plated, persevering, and persistent admirer. The crabs, in common with the rest of the Crustacea, cast off injured limbs, which in time grow again, increasing in size with each moult.

The Spider Crabs, dwellers in comparatively deep water, are particularly curious and interesting creatures. Notwithstanding their long, slender legs, their movements are generally very deliberate and slow. Many of these curious crabs are quite coated over with a growth of corallines, and others again cultivate a growth of red and green seaweeds on their backs, and, thus disguised, cautiously stalk their prey. The Slender-beaked Spider Crab is frequently to be met with in deep water

THE SHORE-CRAB.

off Torquay. Its small, exquisite pink and puce-coloured body, and exceedingly long, slender limbs, make it the most spider-like of all the Spider Crabs. The Spinous Spider Crab is common to the western and southern coasts of England, and the southern coast of Ireland. It is by far the largest species of the family, as may be judged from a specimen captured off Plymouth, the carapace of which measured eight inches in length and nearly six inches in breadth, whilst the length of the fore limbs was fifteen inches. Like all the triangular crabs, it is looked upon as a "Spider" by the fishermen, who generally appear to be very doubtful as to its affinity to the Great and Shore Crabs.

Professor Bell used to tell a story of how he once saw, when passing down a back street in Poole, a couple of large Spider crabs cooked and exposed for sale on a stall. "Pray, do they eat these crabs here?" he asked the vendor, who with a look of pitying surprise at his ignorance, replied, "They ain't crabs, sir; *them's spiders.*"

A very pretty crab, that is not uncommon on the south-west coast of England, on the coast of Ireland, and in the Moray Firth, and Firth of Clyde, is known by the fisher-folk as the Velvet Fiddler Crab. It has gained its popular name from being covered by a dense pile of fur, and having the last pair of legs flat and spatulate, remotely resembling in shape a violin. It is a handsome, brownish-coloured creature, with longitudinal blue ridges on the legs. When alarmed or apprehensive of assault, it strikes transversely with its powerful claws, in much the same manner as a mower uses his scythe.

The Hermit Crabs are of particular interest as forming the connecting link between the crabs and lobsters. Whether the Hermit Crab always selects for its habitation a whelk-shell that is already empty, or whether it actually kills and devours the original inhabitant before taking possession, appears still to be somewhat a doubtful question. The fact that it is most frequently to be found in fresh shells, points rather to the sup-

position that it is often in the habit of obtaining its habitation by violence, and literally by eating the rightful tenant out of house and home.

If we remove a Hermit Crab from the whelk-shell that forms its portable home, we see that while the head and a good portion of the body are covered with shell, the hinder, or tail portion, is bare, soft, and devoid of any protecting armour. The two claws differ considerably in size, one being much larger than the other, and used to close and guard the orifice of the whelk shell, when the animal retires into concealment. The two succeeding pairs of legs are used for walking, and are consequently stoutly built and of considerable size, for the Hermit is a particularly energetic crab. Behind these locomotive legs are two feeble pairs, scarcely strong enough to enable the Hermit to shift his position in his shell; while attached to the abdomen are the false feet which are even more rudimentary in development. The most remarkable modification is the fin of the

tail, which is transformed into a holding-apparatus, by means of which the crab retains a firm grasp upon the interior of the apex of the whelk-shell forming his home, and enables him to carry it about with him without any difficulty.

It is a very curious sight to watch a Hermit Crab drag its house along amongst a number of vacant whelk-shells, pausing from time to time and gazing with speculative eyes, as if considering the advisability of a change of residence. When he does make up his mind, the change is rapidly effected, the Hermit pushing his tail into his new home with great alacrity. Now and then a Hermit will take up his residence in a shell that is somewhat large for him, evidently with an eye to personal growth in the near future. But he is not always left in undisputed possession of his roomy mansion, a larger Hermit frequently pulls him out and appropriates the coveted shell to its own use.

There is a strange, and probably not altogether disinterested, friendship

between the Hermit Crabs and a very beautiful little sea anemone, which always selects for its place of attachment a whelk-shell that is inhabited by a Hermit Crab, and so obtains the benefit of free portage.

The lobsters, like the crabs, undergo a more or less elaborate metamorphosis, in the early stages of which they are active free-swimming little creatures. Large families are the rule in lobster-land, and one brood may number from twenty to thirty thousand. The young lobsters, on quitting the eggs, somewhat resemble the adult form. At first they are very weak, but they soon begin to gain in size and strength, and for some three weeks lead a restless life in the open sea. It is during this period of their lives that hundreds of the young lobsters meet a violent and untimely death, for they are eagerly preyed upon by most fishes.

When the baby lobster has grown about as big as a shrimp, that is to say, about one inch long, it ceases the restless life it has hitherto led, and, sinking

down to the floor of the sea, begins to lead the same somewhat sedentary life as its parents, crawling and hiding amongst the rocks. Growth is fairly rapid during the first year of the lobster's life, and consequently the shell is cast several times. During the succeeding years the shell is cast less frequently, and by the time the lobster has attained his maximum size, which takes about five to seven years, the shell will only be cast about once a year. A full grown lobster can always be recognised, as generally a number of barnacles and serpulæ will have attached themselves to its shell.

The Common Lobster haunts the rocky coasts of Cornwall, Scotland, Ireland, and the Orkneys. He is a handsome creature, and with his great and powerful claws, one that commands respect and careful handling. One of the most graceful species is the Norway Lobster, which is found on the coast of England as well as Norway, and even as far south as the Mediterranean. It has large and prominent eyes, an elegant, long,

THE NORWAY LOBSTER.

cylindrical body, its claws are long and slender, and are spiny and ridged down their centre. In colour it is much paler than the Common Lobster, and it has bands of a darker colour on the body rings.

Very remarkable and interesting little creatures, marine allies of the fresh-water crayfish, are the so-called Burrowing Prawns, which all somewhat resemble the lobster in shape. As their popular name denotes, they are fond of excavating tunnels in the sand and loose, fine shingle; indeed, in one species, called *Axius stirhynchus*, the claws are so modified for digging as to almost remind one of the hands of the mole. From their habit of burrowing, these interesting crustaceans are little known to the casual visitor to the sea-shore, and indeed are rarely to be seen unless one can find the open end of a burrow and dig the creature out.

Perhaps the largest and handsomest of our crustacea is the Crawfish or Spiny Lobster (*Palinurus quadricornis*), which attains a length of 20 inches. It

is clad in rough, spiny armour, but has not the formidable claws of the common lobster, while its antennæ are very beautiful organs, frequently twice the length of the animal's body. The baby crawfish is a very singular-looking little creature, not resembling the adult stage in the least, and prior to its life-history being studied thoroughly, was supposed to be quite distinct from the crawfish, and was called a Glass Crab. By means of the horny plates on the sides of the rostrum and a polished surface to the large basal joint of the antennæ, which lie close to the rostrum and are rubbed against it, the crawfish produces a curious grating or grunting sound, that can be heard for some distance.

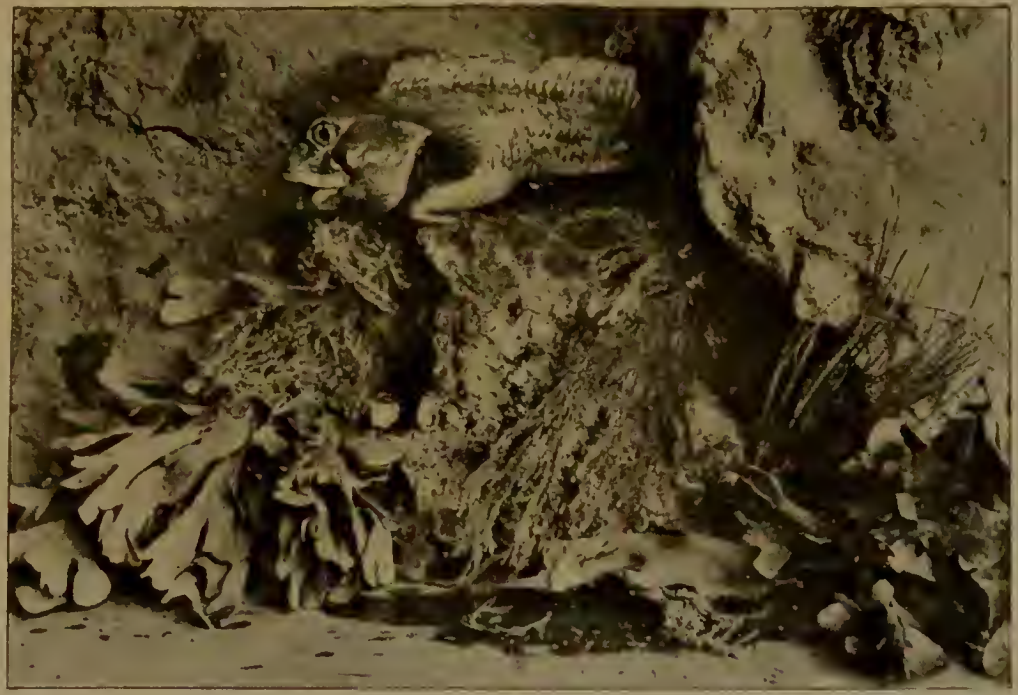
CHAPTER VIII

SOME QUEER FISH

When wandering along a rock-strewn shore in search of specimens, particularly about halfway between high and low-tide mark, if we go slowly and cautiously, keeping a sharp look-out on all sides, we may be rewarded with a very curious sight, that of a small bullet-headed fish resting with its head and shoulders out of a hole in the rocks, most obviously enjoying a sun-bath. This is the Smooth Blenny, or Shanny, a quaint and most interesting little fish, that delights to indulge in the unfishlike habit of spending an hour or two out of water. It always selects a sort of little cave with a flat projecting ledge, on which it can rest quietly and enjoy the soft sea-breezes and sunshine while

waiting for the return of the tide. As its gills are kept moist by a copious natural secretion, the little blenny suffers no inconvenience. To catch sight of it, one has to approach very quietly, for the fish is always alert and on the watch for such foes as the gulls, cormorants, and shag, to whom it would be a very dainty morsel. Therefore, it always rests with its head and shoulders outward on the rock, retreating backwards, by the help of its pectoral and ventral fins, into its cave.

The blenny rarely exceeds five or six inches in length, and is a stout, compactly built little fish. Its head is large and fleshy, with a high forehead and full cheeks, and the eyes are fairly large and high in the head. The lips are membranous, and the teeth are in an even row, with a single canine tooth in each lower jaw. The body is smooth, tapering towards the tail, and the fins have fleshy rays; the ventral fins are firm, finger-like projections partly divided into two. It is a brave and



THE BLENNY ENJOYING A SUN BATH.

pugnacious fish, and should you insert your finger into the hole in the rock forming its retreat, the enraged blenny will seize it and hold on like a little bull-dog. It is not a difficult fish to keep in an aquarium, provided it is given a sloping rock or stone rising a little above the surface of the water, on which to sun itself at pleasure ; and as regards food, nothing comes amiss that is of an animal nature.

When photographing fish, I have been greatly interested in observing how many of them have, to a greater or less degree, the chameleon-like power of varying their colours so as to tone with their surroundings. To the photographer this is often very exasperating ; for after taking a great deal of trouble to select rocks and weeds, and so arrange them in the photographic aquarium that they shall form a background against which the fish will stand out well, it is particularly vexatious to see the fish, on being placed in the aquarium, and before it assumes the desired pose, gradually changing colour, and, as it were, sinking

into the background. The sea-bream, which is a fine, handsome fish, indulges in this trying habit, and it was some time before I could get a good photograph of one.

Photographing living fish, although a very difficult and temper-trying task, is really most interesting work, and it has its humorous side. I shall never forget the preparation for obtaining the two photographs of the skate which appear opposite this page. As I have already stated in Chapter I., it is necessary to wash the fish before placing it in the photographic aquarium. This particular skate was a fine large and active specimen, and resented being washed like a professional tramp. How he floundered and flapped about, covering myself and the good-natured fisherman who helped me with sand and slime, to the huge delight of sundry small boys and long-shore loafers who had gathered round to see the fun! At last we got him moderately clean, and in sheer desperation shot him into the tank. As if delighted with the mess he had got

UPPER SURFACE OF SKATE.

UNDER SURFACE OF SKATE

us into, he rose with his under-surface pressed against the glass front of the aquarium, with open mouth and a most comical expression as if he were laughing at the photographer. Fortunately, I was able to take a photograph of him in the act, ere he settled down into his more normal attitude on the floor of the aquarium.

A most interesting and peculiar-looking fish occasionally caught off our shores is the Remora, or Sucking-fish (*Echeneis Remora*). It is at once recognisable by the flattened, oval, adhesive disc upon the top of its head, by means of which it is able to attach itself firmly to the sides of large fish, or to the bottoms or sides of ships, and so travel through the sea for miles without any exertion or fatigue. It is brownish in colour, and about 4½ inches in length. From its peculiar habit of attaching itself to the sides or bottom of a ship, and probably also from its peculiar shape, the Remora attracted the attention of the early naturalists, and was looked upon with much superstitious dread by

sailors and fishermen, by whom it was accredited with the power of arresting the progress of a ship in full sail. The old herbalists gravely stated that from it could be compounded a nostrum which would extinguish all feelings of love, would impede justice, and arrest the mandates of the tribunals *judiciorum mora;* but would preserve pregnant women from accident, and, if salted, "its very approach is sufficient to draw gold out of the deepest wells into which it may have accidentally fallen."

The following quaint old translation from Pliny shows how general and sincere was the belief in the almost supernatural powers attributed to this little fish: "The current of the sea is great, the tide much, the winds vehement and forcible; and, more than that, ores and sailes withall, to help forward the rest, are mightie and powerfull; and yet there is one little sillie fish, named *Echeneis*, that checketh, scorneth, and arresteth them all. Let the winds blow as much as they will,

rage the storms and tempests what they can, yet this little fish commandeth their furie, restraineth their puissance, and maugre all their force, as great as it is, compelleth ships to stand still, a thing which no cables, be they never so big, and able as they will, can perform. She bridleth the violence and tameth the greatest rage of this universall world, and that without any paine that she putteth herself unto, without any holding or putting backe, or any other means, save only by cleaving and sticking fast to a vessel; in such a sort that this one small and poore fishe is sufficient to resist and withstand so great a power both of sea and navie; yea, and to stop the passage of a ship, doe what they will to the contrarie. Of late daies, and within our remembrance, the like happened to the Roiall ship of the Emperor Caius Caligula, at what time he rowed backe and made saile from Astina to Antium; when and where this little fish detained his ship. And yet it was not long ere the cause of this wonderfull staie of his ship was

known ; for so soon as ever the vessel (and a galliace it was, furnished with five banks of ores on a side) was perceived alone in the fleet to stand still, presentlie a number of tall fellows leapt out of their ships into the sea to search what the reason might be that it stirred not, and found one of these fishes sticking to the very helme ; which being reported to Caligula, he fumed and fared like a very emperour, taking great indignation that so small a thing as it should hold him back perforce, and check the strength of all his mariners, notwithstanding there were no fewer than four hundred lustie men in his galley, that laboured at the ore all that ever they could to the contrarie. But this prince (as it is for certaine knowne) was most astonished at this, namely that the fishe, sticking only to the ship, should hold him fast, and the same being brought into the ship, should not work the like effect."

A very remarkable nest-building fish is the Sea Adder, or Fifteen-spined Stickleback (*Gasterosteus spinachia*). It

is a handsome fish, long and slender, with large tail-fins. The shape of the long head reminds one somewhat of that of a pike, and there is a row of fifteen small spines on the back, from which the fish gains one of its popular names. That able Cornish naturalist, Mr. J. Couch, F.L.S., was the first to observe and record the nest-building habits of this fish, and he describes its procedure as follows: "The fish either find growing, or, certainly in some instances, collect together, some of the softer threads of green or red seaweeds, and join them with so much of the coralline growing on the rock, as will serve the purpose of affording firmness to the structure. They constitute a mass five or six inches long, of a pear-like shape, and about as stout as a man's fist. A thread is employed with much skill and patience in winding these materials together, and there is no doubt that its substance is derived from the creature's own body. It much resembles silk, and is elastic, and appears to consist of smooth threads glued together."

In this nest the female deposits her spawn, and then departs, leaving the devoted male to watch over the precious eggs until the period of incubation is over. The handsome little male is fully alive to his responsibilities, and keeps faithful watch and ward, driving away, and fighting fiercely, any creatures that dare to approach the nest. When first hatched, the embryo is unlike its parent in appearance, the head being round and blunt, and the pectoral fins relatively large, while the dorsal and anal fins extend along the body to unite with the caudal fins; the ventral fins are at first absent. Altogether, the newly-hatched youngster is a queer-looking little creature.

Very queer-looking creatures, too, are the Pipe-fishes (*Syngnathidæ*), that frequent our coasts. The largest is the Great Pipe-fish (*Syngnathus acus*), which attains a length of nearly eighteen inches. It frequents bays and harbours, usually swimming in a nearly vertical position, by the rapid undulation of its pretty dorsal fins, which gives it a very

SEA-BREAM.

graceful, gliding movement through the water. The head is long and very curious, as the slender upper and lower jaws are united, and open only just in front. The most remarkable feature about the pipe-fish is that the male is provided with a pouch, formed by an infolding of the skin of the abdominal surface of the body. Into this pouch the female places her eggs, which are carried about by the male until they hatch and make their escape. It has been stated that the young return to the pouch in which they were hatched, if alarmed; but this is carrying the analogy to the kangaroo and its young too far, and is not true.

A cousin of the pipe-fishes is the beautiful and interesting little Sea-horse (*Hippocampus brevirostris*), which in shape reminds one so much of some quaintly-carved knight from a set of chess pieces. It can be kept fairly well in an aquarium, and if two are kept in the same tank, they will be found to communicate with each other by short, snapping noises, produced

by a somewhat complex muscular contraction and sudden expansion of the lower jaw.

Very few people, I think, have any idea of how numerous and varied are the species of fishes that frequent our coasts and find their way into the deep rock pools. Many of them are very beautiful in form and colour, some are extraordinarily grotesque in appearance, others are armed with formidable spines with which they can inflict a very painful, if not poisonous, wound.

All round the coast of Devon and Cornwall is an ideal hunting and collecting ground for the naturalist interested in marine life, and I cannot imagine a more delightful way of gaining some knowledge of old Neptune's children than by spending a long summer holiday in some quiet Cornish fishing village. Every rock-pool will be found a treasure-house of beautiful seaweeds, zoophytes and anemones; while the kindly, hardy fisher-folk, once they find you are truly interested in the

denizens of the deep, will willingly help you in your investigations, and do their best to keep you supplied with all sorts and conditions of marine creatures.

CHAPTER IX

SOME SHELL-FISH

THE general appearance of the Oyster is familiar to all, and needs no detailed description, but its life-history is probably not quite so generally known, although it is a singularly interesting one. The eggs of the oyster, when fertilised, give rise to little ciliated embryos (*Trochospheres*), which are contained in a sort of pouch within the parent. They are very minute, about $\frac{1}{160}$th to $\frac{1}{200}$th of an inch in size, and may number close on two million individuals within a single oyster. As these tiny embryos increase in size, they soon begin to develop a little transparent, double-convex shell, through which the dark lines of the alimentary canal may be seen. Two ciliated flaps

protrude from the edges of the shell, and when the embryos are discharged from the parent oyster into the sea, they swim rapidly by means of these cilia. They have now reached the black-spat stage of their existence, a period of their lives fraught with innumerable dangers, and during which thousands of them must perish, being devoured by young and adult fishes, crustaceans, pelagic worms, and other marine creatures. This black-spat stage lasts for about fifteen to twenty days, during which the baby oysters lead a restless free-swimming existence. At the end of this period the survivors seek out a suitable anchorage, such as small stones or pieces of shell, to which they attach themselves, at first by the little flaps, and later more firmly by a secretion of lime.

Growth is fairly rapid, and by the end of their first year the young oysters will probably have attained nearly to the size of a florin. As the growth of the oyster takes place chiefly during the summer months, when a layer of

new shell is formed around the margin, it is possible, by counting these successive layers, which are generally fairly distinctly marked, to ascertain the age of the oyster. When three to four years old, the oyster is ready for the market; but, left in its natural environment, it probably attains to the respectable age of fifteen to twenty, or twenty-five years.

From the moment it is expelled from the protecting shell of its parent, till old age at last demands its death, the oyster has numerous foes to contend with. During the free-swimming stage of its life, it is chased by all sorts and conditions of marine creatures, and when it has attained maturity, it falls a victim to mankind, or may, as we have seen, form a luncheon for some greedy star-fish; or, escaping these two enemies, it may fall a victim to the dog-whelk, which calmly drills a hole through the shell of the oyster, and inserting its protrusible mouth, devours the unfortunate mollusc.

The Common Scallop, or Pectan,

STARFISHES DRAWING OYSTERS FROM THEIR SHELLS.

DOG-WHELK BORING THROUGH OYSTER SHELL.

throughout its life has a certain power of locomotion, effected by an alternate swift opening and closing of its shell, producing a rapid expulsion of water, which drives the scallop backwards. When the scallop is at rest, and its shell is slightly opened, what looks like a double row of minute, bright green beads may be seen on the edges of the mantle. These are shown, on microscopic examination, to be well-developed eyes.

The Cockles also have the power of locomotion highly developed, and can leap a distance of five or six yards, by the smart projection of the foot against the sand. It is an extraordinary sight, at low water as the tide begins to turn, to see numbers of cockles emerging from the shingly sand where they had hidden themselves as the tide receded, and jump seawards towards the incoming waves.

The tenacity of the Limpet is proverbial, and considering that the circular foot of the creature has no hooks or claspers, but only acts as a sucker, it

is extraordinary what force is required to detach the limpet from the rock. The tongue, or radula, of the limpet is a very wonderful, horny structure, armed with about a hundred and sixty rows of teeth, by means of which the limpet rasps the seaweeds, corallines, and other objects upon which it feeds. The limpet must have been an important article of food to prehistoric man, when a dweller by the sea, for its shells are always found to be very abundant in the old refuse heaps called "kitchen middens," whenever they are opened.

Of the so-called Sea Slugs, or *Nudibranchiate Mollusca*, the Sea Lemon, or Doris, is an interesting little creature. It is one of the few animals which feeds upon sponges, and the microscopist will find it well worth dissecting, not only for the examination of its anatomy, but for the treasures he may find in its stomach, which will frequently be found crammed with the flinty needle-, star-, and dagger-shaped spicules, the undigestible portions of its singular diet.

During the summer months curious

gelatinous rosettes, containing the eggs of the doris, may be found fixed against the rocks. These egg-sacs, in immense numbers, are embedded in a ribbon-shaped, gelatinous substance about twenty inches long, beautifully frilled and coiled, rosette fashion. A portion of one of these ribbons presents a very beautiful sight under the microscope, when the young are just hatched. Each egg-sac contains three or four embryos, which have exquisite, transparent, nautilus-shaped shells, which show that the doris comes from a shell-bearing ancestry. These beautiful little embryos are very active, and by the action of their cilia are in constant motion, swimming round and round the imprisoning egg-sac, presenting one of the most interesting and animated scenes that the microscope can reveal.

In examining the various molluscs described in this chapter, we have seen that some have well-developed eyes and a wonderful rasping organ—the tongue, or radula, which is used for breaking up food. The doris, moreover, has two

conical or nail-shaped tentacles, upon its head, where the head joins the back of the animal. Keeping these points of anatomy in mind, it will be easy to trace the relationship between these well-known molluscs and the less familiar octopus and cuttlefish, which, although at first sight appearing to be such totally different creatures, are really near relations.

CHAPTER X

DEVIL-FISH AND KRAKEN

Of all the denizens of the deep, the Devil-fish, or Octopus, and the Kraken, or Cuttle-fish, are the most grotesque and uncanny-looking creatures. With their great eyes, and snake-like, sucker-clad, writhing arms, they are indeed awesome creatures, and it is small wonder that they struck terror to the heart of ancient explorers and voyagers, who brought back from their travels thrilling and blood-curdling stories of desperate encounters with these fearsome monsters, who were accredited with the power of dragging large ships down to the bottom of the sea. Aristotle, some 300 years before Christ, placed on record a very careful and accurate description of the habits and appearance of these

creatures, which remained the most truthful and authoritative account of them until the middle of the nineteenth century, when they formed the subject of careful investigation by Owen, Darwin, and Huxley.

The bizarre form of the octopus has always a great fascination about it; there is something so mystical, awe-inspiring, and attention-arresting about it, like those wondrous carved dragons of the Far East. It is one of the most trying models imaginable for photography, for not only does it rapidly change to the same colour as its surroundings, but it has a practically inexhaustible supply of an inky fluid, which it discharges freely when alarmed or irritated. As its feelings are very easily upset, it will, more frequently than not, discharge some of this inky fluid the moment it is placed in the photographic aquarium, with the result that many weary hours are spent in alternately cleaning out the aquarium, arranging the background of rocks and weeds—which also have to be cleansed

FRONT VIEW OF AN OCTOPUS, SHOWING THE SUCKER-CLAD ARMS.

THE OCTOPUS AT REST.

each time—placing the octopus in it, and then having promptly to fish him out on account of another discharge from his ink-bag. In this way days, and sometimes weeks, slip by before one is able to obtain a satisfactory picture showing the creature in a characteristic attitude.

The octopus has a weird appearance when at rest, with its wrinkled, bag-like body, joined by a short waist to the great ugly head with its circle of eight long, snake-like arms, which are joined at their base by a common web. The two large, prominent eyes that never close, gaze fixedly at you with a cold and wicked look. Each of those long, restless arms is clothed with a hundred and twenty pairs of powerful suckers, which vary in size from perhaps a couple of inches or more in diameter at the base of the arm to less than $\frac{1}{8}$th of an inch at the tip.

These suckers are most wonderfully constructed; each has a raised margin, and from the edge of this rim folds of skin, which outline the powerful

muscles beneath, converge towards the centre. The centre of each sucker is occupied by a hollow cavity, with a fleshy piston at the bottom for producing a perfect vacuum. These suckers are truly wonderful in their mechanism and strength, for once they have fastened upon an object, it is easier to tear the arm away from the head of the octopus than make them release their hold.

In the centre of the circle of these writhing, sucker-clad arms, is a round, thick-lipped mouth, armed with powerful jaws, shaped like the beak of a parrot, and formed, not of bone, but of a tough, horny substance called chitine. Within the mouth is a most extraordinary tongue, armed with recurved spines, or teeth, forming a formidable rasping organ. When in a hurry, the octopus shoots through the water, stern foremost, with great rapidity, by the discharge of water from its funnel. Indeed, it is a peculiarity of both the octopus and the cuttlefish that they cannot turn their backs and flee from

their foes, but must always retreat facing them. When undisturbed, however, the octopus crawls about by means of its arms, or swims by the contraction of the membrane connecting the arms. When getting the worst of an encounter, the octopus suddenly discharges the inky fluid from its ink-bag into the face of its foe, and beats a hasty backward retreat under cover of the turbid water. To escape attention, it has the power of changing colour, so as to resemble the general tone of its surroundings.

The octopus generally spends the hours of daylight comfortably concealed in a rock cranny, or he may sit at the entrance to his grotto and fish for unwary crustaceans and other denizens of the deep that may pass within reach of his long arms. Normally, however, he does not start out to hunt his prey until the approach of dusk, when he issues forth from his cave like a veritable dragon of the deep, and steals silently and swiftly upon his unsuspecting victim. In a moment it is pounced upon and wrapped around by those long,

writhing arms, in an ever tightening embrace, from which there is no escape. The frantic and wildly struggling victim is hugged tightly, and its body pressed against the cold mouth of the octopus. The powerful beak-like jaws are buried in the quivering flesh, and the silent tragedy is soon ended. With the approach of dawn the octopus steals, like some dark, evil shadow, back to his grotto, to rest, and sleep the sleep of repletion.

One would hardly expect such forbidding and formidable creatures as the octopus, and its cousin the cuttlefish would be troubled with many foes desirous of seeking combat, and yet such is the case, for there are certain species of whales, monster congers, dogfish, and sharks, all of whom eagerly hunt out and greedily devour them. Sometimes the octopus escapes from the encounter minus an arm or two, but this is not a very serious business, and only causes temporary inconvenience, as, like so many of the inhabitants of the sea, it has the power of replacing lost limbs.

OCTOPUS (*ELEDON*) ATTACKING A CRAB.

Mamma Octopus is a model mother, and it is a very interesting sight to witness how devotedly she guards and tends her grape-like bunches of eggs during the fifty days or so, covering the period of incubation. She deposits her eggs in elongated bunches on a secluded rock at the bottom of the sea, and hardly quits their vicinity, except for a moment, when compelled by hunger, until the young emerge. Large families are the rule in Octopus-land, as the infant mortality is simply appalling. Each bunch contains nearly a thousand eggs, and Mamma Octopus may deposit on the rock she has selected as a nursery, forty or fifty of these egg-clusters. Ever and anon she may be seen to send a stream of water from her exhalent locomotor tube, to cleanse them; then she will pass her arms lovingly beneath a bunch, and dilating the membrane on each side of the base of the arms, form a sort of pouch, or cradle, in which she will hold and gently caress them. Her maternal cares make her somewhat uncertain of temper and

fussy, so that Papa Octopus is likely to meet with a warm reception should he venture to put in an appearance. Possibly she has doubts of his real intentions, and thinks that rather than solicitation for her welfare, he has cannibalistic designs upon her precious charge. At any rate, she greets his advent with a heightened colour and a gleam of anger in her eye; should he approach nearer than she considers desirable, she will open fire upon him with her ink-bag, and unless he beats a swift and hasty retreat, she may rush upon her spouse and devour him, and so make certain of no further interruption of her maternal duties.

When the young escape from the eggs, they leave the dim-lit depths so dear to the adult octopus, and seek the brightly illuminated and warmer surface waters of the sea, where they disport themselves, and where hundreds of them are greedily devoured by various species of fish.

There are several ways of fishing for the octopus. The method generally

employed in the Tunisian Fisheries, where they are regularly caught, dried, and consumed as food by the Orthodox Greek Catholics during Lent, is to lower earthen jars to the bottom of the sea, where they are allowed to remain for some hours. Off our English coasts, a weighted line, with a shore crab securely attached, and just above it a bunch of scarlet flannel, will often prove a good bait ; or a good-sized white earthenware jam jar, if let down and left for a few hours, also has great attractions for the octopus.

The Cuttlefish, the Kraken of the old travellers and naturalists, differs from its cousin the octopus both in appearance and mode of life. While the octopus leads a somewhat hermit-like existence at the bottom of the sea, the cuttlefish loves a roving life in the surface waters, often appearing in shoals near the coast. They vary greatly in size, some species never exceeding a couple of inches in length, others attaining the gigantic dimension of 60 feet or more. The body may be long, tapering, and cylindrical, or more or less oval.

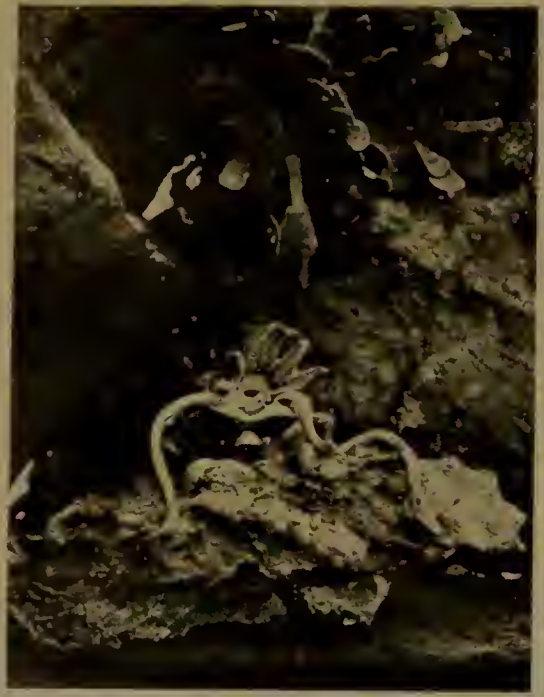
The eight arms round the mouth of the cuttlefish are much shorter than those of the octopus, but from within the circle rise two extra, very long arms, sometimes thrice the length of the animal, which terminate in a club-shaped expansion, covered with suckers. The cuttlefish employs these for grasping its prey when beyond the reach of the eight shorter arms, and as anchors to moor itself to floating timber and seaweed. The two long arms are destitute of suckers except at their terminal expansions, which are covered with them ; and the suckers are even more formidable than those of the octopus, as they are bordered by a horny ring having a finely serrated edge, and are mounted on short foot-stalks. In some species the serrated edge is developed into a series of sharp-pointed, incurved teeth, which must sink into the flesh of any unfortunate fish that may be captured and render its escape absolutely impossible. The cuttlefish has similar jaws to the octopus, though they are not quite so large ; it has an ink-bag, very beautiful

CUTTLEFISH CAPTURING ITS PREY.

internal plume-like gills or branchiæ, and similar powers of changing colour.

Of course, it is inevitable, with such extraordinary creatures as the octopus and cuttlefish, that many very tall and romantic stories should be told of their power and size. Nevertheless, there are many well-authenticated records of truly gigantic cuttles having been seen, and indeed, portions of these giants repose in various museums. In the "Annals and Magazine of Natural History," 4th series, vol. xiii., the Rev. M. Harvey, a careful observer of natural history, gives the following description of parts of a giant cuttlefish captured near St. John's, Newfoundland: "A few days ago three of our fishermen residing in Logie Bay, three miles from St. John's, were overhauling a herring-net, when they found entangled in its folds a huge Calamary (cuttle). With great difficulty they succeeded in despatching it and bringing it on shore, being compelled to cut off its head before they could drag it into their boat. Having purchased it of the fishermen, I have carefully

examined and measured it, and have had the head and surrounding arms photographed, as well as the body, both being at present preserved in brine. The body is eight feet in length and five feet in circumference. The arms, ten in number, radiate from the top of the head. The mouth of the creature consists of a strong, horny beak, exactly like that of a parrot in shape, and about the size of a man's fist. The eyes are placed on each side of the head, from which the arms extend, and are large, dark, and prominent, the membranous sockets being 4½ inches in diameter. The two longest arms measure each 24 feet in length, are only 3 inches in circumference, and are very tough and strong, and at the extremity are covered with powerful suckers, the largest being 1¼ inch in diameter, the smallest not larger than a split pea. There are about eighty suckers on each arm, which tapers to a pretty fine point. Each of the eight short arms is six feet in length, and at the point of junction with the head is 9 inches in circumference. They



THE CUTTLEFISH AT HOME.

THE SMALLEST OF OUR NATIVE CUTTLEFISH.
(*Sepiola Atlantica.*)

taper to a point, and on the under side are entirely covered with a double row of powerful suckers 1¼ inch in diameter, each having a sharp denticulated edge, and a membrane in the centre, which the creature can retract at pleasure, and thus create a vacuum. No cuttle of such dimensions as the one I am describing has ever before been captured. If its arms were extended they would be 48 feet between their extremities, while two of the shorter arms would measure 13 feet from tip to tip. This specimen, although large, is but an infant compared to some which have been seen around these shores. The Rev. Mr. Gabriel assures me that in 1870 two cuttles were cast ashore at Lamaline, their bodies measuring 40 and 47 feet. Another gentleman here, whose testimony is thoroughly trustworthy, tells me that he measured the body of one which came ashore two years ago, and found it was 80 feet in length." There is also a record of one of these giant cuttles appearing on the north-west coast of Boffin Island,

Connemara. The head and arms were cut off and sent to the Dublin Museum, where they are probably still to be seen.

The most familiar cuttle to be found off our coasts is the Common Cuttlefish (*Sepia officinalis*), whose "bone" or internal shell is frequently to be seen cast up on the shore, and has commercial value, being sold as a dainty for cage birds and, ground up, enters into the composition of various polishing powders. The cuttle itself is caught and used very largely by the fishermen for bait. At one time the fishermen did a good trade with the manufacturers of artists' colours, in collecting and selling to them the ink-bags of the Common Cuttlefish, from the contents of which true sepia is manufactured. Of late, unfortunately, this industry has almost ceased, owing to the German manufacture of an artificial sepia from a coal-tar product. This artificial "ink," however, like most of the aniline dyes, is not lasting, and drawings made with it will fade in a few years, whereas the natural sepia lasts for all time.

CUTTLEFISH OPENED TO SHOW THE PLUME-LIKE GILLS, SEPIA BAG, ETC.

CUTTLE-BONE, OR INTERNAL SHELL, UPPER AND UNDER SURFACE.

There is a very handsome little cuttle to be caught off the Cornish coast, which has a beautiful grey upper surface, and a white under surface spotted all over with pink ; it is called the Elegant Cuttlefish (*Sepia elegans*). One of the dwarf cuttles, the Atlantic Squid (*Sepiola atlantica*), sometimes finds its way unintentionally into the shrimpers' net. It is a queer little creature, rarely exceeding a couple of inches in length, and buries itself up to its large goggle eyes in the sand, where it keeps a sharp look-out for passing shrimps and prawns.

While the fossil remains of many species of cuttlefish and octopods, which are to be found in the different strata of rocks formed in past geological ages, tell of the ancient ancestry of these most remarkable and interesting creatures, we can find off the coast of Great Britain to-day some fifteen living species.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