

*Grace Coit*  
Boston Society of Natural History.

*Meloney*

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GUIDES FOR SCIENCE-TEACHING.

No. IV.

A FIRST LESSON IN NATURAL  
HISTORY.

By MRS. AGASSIZ.

NEW EDITION.

BOSTON, U.S.A.:  
D. C. HEATH & COMPANY.

1899.



**A FIRST LESSON IN NATURAL HISTORY.**

THIS little book, long out of print, is now offered by us to teachers as one of our "SCIENCE GUIDES," because it fits very appropriately into the series. With admirable clearness and brevity, it gives in narrative form for young children a general history of Hydroids, Corals, and Echinoderms; thus rendering unnecessary a part of the work we had proposed to ourselves in connection with our late lectures on this subject. It will be found, we think, of great service where this kind of teaching is needed, and has saved us much trouble and expense in the preparation of the supplementary guide which is to follow.

For the use of the wood-cuts we are indebted to Mr. Alexander Agassiz. It is one of many favors received at the hands of the family of the late Professor Agassiz, as well as from others; all of which it will be a pleasant duty to acknowledge at some future time.

**ALPHEUS HYATT.**

Boston Society of Natural History.

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**1879.**

Press of  
Berwick & Smith,  
Boston.

THESE Natural History Stories for very young children were written twenty years ago, under the direction of Professor Louis Agassiz, and owe to his guidance any merit they may possess.

E. C. A

CAMBRIDGE, March, 1876

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# FIRST LESSON IN NATURAL HISTORY.

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## CHAPTER I.

### SEA-ANEMONES AND CORALS.

MY DEAR LISA AND CONNIE,

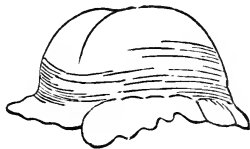
I was thinking, the other day, of the pleasant times we passed together at the sea-shore last summer, and remembering how often in the evening, when your playtime was over, and we were sitting in the quiet twilight waiting for your bedtime, you used to beg for stories ; and it occurred to me that, in the long and snowy winter, I might prepare some stories for next summer ; and then, when you come after tea, and say, " Now, Aunt Lizzie, tell us a story," I shall have one all ready, and need not answer, as I often used to do, that my brain was empty, and, hunt as I would, I could not find a story in any corner of it. But there is one thing you may not like about the stories I think of writing for you : they are to be true stories, and not about little boys and girls, but about animals. Do you recollect the nets we made last summer, and how

you used to catch in them the tiny little fishes that lived in the pool left by the sea-waves in the hollow of that large rock near our house? Now, there are many other animals living in the little pools left by the tide on the beaches and between the rocks and stones, which are both beautiful and curious ; and which, if you knew a little more about them, would interest you quite as much as the little fishes you liked to see swimming about in your Aquarium last summer.

Have you ever heard of a Sea-Anemone? Do not fancy, from its name, that it looks any thing like the pretty white or pink Anemones that delight you so much in the woods in spring ; and yet the Sea-Anemones are so called, because, though they are as much animals as Berty's little dog Pinky, or your pussy-cat, they yet have a look like a flower. But this is only when it pleases them to spread out their little bodies, and flaunt all their pretty fringes ; and, as you will see when I tell you a little more about it, they can shut themselves up, and look as ugly and dull as they please. In this they differ very much from a flower, which cannot fold up its leaves and put them away when it likes. It is true that some flowers close at night, and open in the day ; but it is not because they want to do so, but because the state of the atmosphere causes them to shut and open.

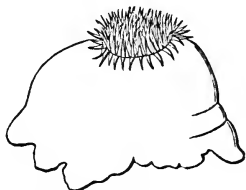
Some day next summer, at Nahant, we will go at low tide in search of a Sea-Anemone ; and, if we are fortunate, we shall find somewhere among the rocks near Sunken Ledge one of these ocean flowers. It will be rather slippery on the wet sea-weed, but we shall not mind one or two tumbles, if we find what we are seek-

ing. I dare say we shall meet with one, hiding himself away in some little dark corner of the rocks (for they rather like the shade), with his fringes all drawn in, looking like a brown soft lump, and thinking that because he has made himself so ugly and unattractive, nobody will disturb him. Here we have a drawing of him.\* But we will not be deceived by his uninviting looks. We will take him up very softly,



No. 1.

parting him gently with our fingers from the rock, for he is very tender and adheres closely to his resting-place; and when we have him safely at the house, we will put him in a glass bowl with some sea-weed and a few stones, that he may, if possible, believe himself to be still at home in his puddle. And now we must watch him long and patiently, if we would see how he changes himself into his flower-like form. As he lies now, he is like nothing but a ball of rather dark, soft substance, flat on the side by which he was attached to the rock. But watch him, — slowly, very slowly, for he has not the power of any quick motion, — he begins to expand; the little soft ball rises gradually, till it stands up, as it does in the picture you see



No. 2.

here; from its summit it puts out long and graceful

\* This, and the three following wood-cuts, represent the common Sea-Anemone (*Actinia marginata*, of our coast.

feelers, growing so close that they look to you like fringes, forming a sort of wreath around the top. Very slowly and softly these beautiful fringes creep out from

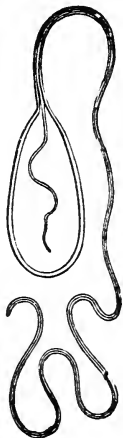


No. 3.

the inside of the little animal, where they have lain, drawn in and packed away so snugly that you never suspected they were there ; and then when they are fully spread, they move gently up and down, with a slow, waving motion.

My wood-cut gives you no idea of their beauty ; you must imagine them light-colored, and soft and delicate as the down on a feather. Pretty and soft though they are, you will hardly believe that they have attached to them an instrument which is as dangerous and deadly to all the little animals which the Sea-Anemone likes for its food, as the claws of your pussy are to a mouse. Do you know what a lasso is ? It is a long rope which, in some countries, is used for catching cattle. It has a noose at one end, and is carried coiled up in the hand, till the animal comes quite near, and then it is thrown suddenly out ; the men who use it understand how to cast it with such dexterity and force, that the noose slips over the animal's head or feet, and then they have him fast enough. Now, the Sea-Anemone has upon these fringes or tentacles, as I will call them, because that is their true name, numbers of what are called lasso-cells : they are so small that you cannot see them with your naked eye, but each little cell contains a long

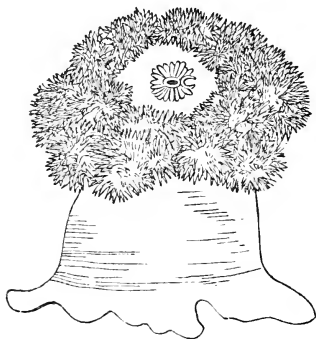
bolow thread coiled up in a spiral within it. They have the power of flinging this thread suddenly out, when there is any little shrimp or shell swimming about in the water which they fancy for a meal, and in an instant he finds himself entangled in their tiny cords, like a fly in a spider's web. Little shrimps swimming near them, full of activity, are suddenly struck dead at the mere contact with these poisonous whips, and may be seen hanging lifeless on the feelers. Here is the figure of a magnified lasso-cell, with the coil partly turned out. It is a sort of bag, as you see, within which the thread is wound up in a spiral, and from which it can be thrown out in an instant at the will of the animal. These cells are very numerous, and so small that only a very powerful microscope will reveal them to the sight.



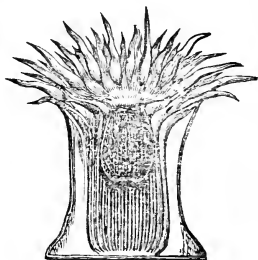
No. 4.

When the prey is caught in this way, the tentacles close upon it and pass it into the mouth ; but, in order that you may understand this, I must tell you something about the mouth, and about the inside of our little Sea-Anemone. If we look down upon him from above (No. 5), we shall see in the centre of the fringes a hole ; that hole is the mouth which opens into a kind of sac hanging below it, inside the animal. This sac is its stomach, into which all the food passes, and where it is digested. Making a cut across our little friend, so as to get a glimpse of his internal arrangement, we see that this

sac forms a cavity in the middle of the body, the rest of the space being divided by a number of partitions,

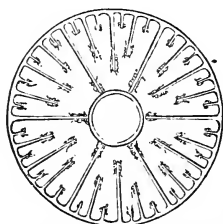


No. 5.



No. 6.

running from top to bottom, and radiating from this central sac to the outside; so that looked at from above they run from the middle to the edge like the spokes of a wheel (No. 7),



No. 7.

but seen in a vertical cut, as in No. 6, they run from the summit to the base. Now, in order that you may understand how he digests his dinner when he has caught and killed it, you must know that the sac or stomach in the middle of the body opens by an aperture in the bottom into the main body. The sea-water, which enters freely through the mouth with the food, softens it, helps reduce it to a kind of pulp,

and it passes from the stomach into the body, circulating through all the partitions and passing from them into the tentacles ; for every one of the tentacles connects with one of the spaces divided off by the partitions. Thus you see the whole body is nourished by whatever enters at the mouth. On the inner side of the partitions, little eggs are formed, which hang there till they are ready to be hatched, and then they pass out through the mouth into the water, where they grow into Sea-Anemones like the one of which we have been talking.

I hope that the Sea-Anemone has interested you so much, that you will like to hear about some other animals of the same kind, which live also in the sea, and of which I have a strange and wonderful story to tell you. Some of them are scarcely larger than a pin's head, yet they have built up large islands, and even considerable portions both of Europe and America. These are the coral animals. They are very rare on our northern coasts, and you cannot therefore see them alive. Though most of them are much smaller than our Sea-Anemone, yet, as they are constructed on a similar plan, what I have told you about his tentacles, his partitions, his internal sac, his lasso-cells, may help you to understand what I have to tell you of the coral animals. With few exceptions, they do not live singly, like the Sea-Anemone, whom we found all alone in his puddle, but they grow together in clusters. Such clusters, however, start from a single little animal ; it is born free, a pear-shaped, transparent body, white and jelly-like, swimming about in the water. (Nos. 8, 9.)\*

\* The young, just hatched, of *Porites*, — a Coral, found on

It moves with great rapidity, because it is covered all over with a little vibrating fringe,\* and that fringe quivers incessantly, thus keeping the little



No. 8.      No. 9.

Coral in quick and constant motion. But when it finds a suitable place at such a depth in the sea as it likes, and where the water is clear and bright, — for it does not fancy muddy or sandy water, — it attaches itself either to the rocks or the sea-bottom by one end, which flattens and adheres to the ground, while the other spreads ; and the whole has then a cup-shaped form a little depressed at the top. That depression marks where the mouth is presently to be, and before long it becomes a hole in the centre, and all around it feelers or tentacles begin to appear. At this stage it looks very much like our Sea-Anemone, though it has not so many feelers ; but then the Sea-Anemone, when young, has not more. Only in its full-grown condition, does it have the numerous tentacles represented in the picture. The sides of the coral animal begin to thicken ; the sac, which is the stomach, forms in the centre, and also the partitions dividing the rest of the body. If we could make a cut across the little Coral, we should see that he is formed inside like the Sea-Anemone ; we should see the cavity in the centre formed by the stomach, and the partitions spreading from it like the spokes of a wheel. But I must explain to you a very important difference between them and the Anemone, which will help you to

the Reef of Florida. No. 8 seen from the side ; No. 9 from above.

\* *Vibratile Cilia* of Physiologists.



understand the long story I have to tell you about these wonderful little animals, who play such an important part in the history of the world.

We have seen that our little Sea-Anemone is soft throughout, — he is just like a mass of jelly, — and though the parts of his body are quite distinct, yet his partitions, his tentacles, the walls of his body, and the sac serving him as a stomach are all quite soft ; and he can change his form, contract all his parts, and roll himself up like a little ugly lump, because the whole of his substance is pulpy and gelatinous. But with the Coral it is quite different. It is true that when he is first born, he is, as I have described him, a little, oval, jelly-like animal, swimming about in the water ; but after he has selected his resting-place, has grown larger, and his mouth, his stomach, the partitions of his body and his tentacles are formed, then begins a process which ends in giving him a very different character from that of the Anemone. There are hard particles of lime in his substance, and these accumulate, first at the base of the body, where it is attached to the ground, so that it becomes quite firm and solid, then in all the partitions, so that they become like little solid walls, and in the sides of the body, so that they too grow quite hard ; and now the whole has a solid frame, the only parts of the little creature which remain soft being the summit, the mouth, the fringes around it, and the stomach within.

I have said that the coral animals grow in clusters, but thus far I have only described the single animal that begins the coral stock. Now I will show you how he multiplies himself, till, instead of one animal, there are

countless multitudes living together in one community.

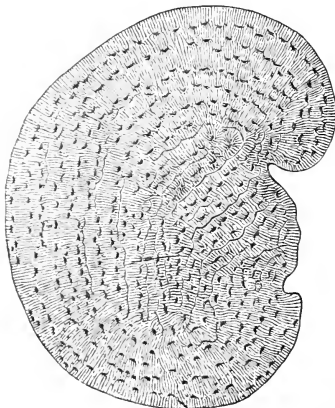


No. 10.

The adjoining figure shows you a part of such a community.\* When the first coral animal has undergone the changes I have described, and assumed its permanent character, it begins to spread and grow taller; and from its surface, either from the base or from the sides, grow up other animals of the same kind, remaining always attached to the first, and increasing till they are

crowded together in hundreds and thousands and millions, on one foundation. This way of growing is called

budding, because it resembles a little the branching of a plant; but each bud is nothing but a new animal, remaining connected with the preceding as the branches of a tree with the stem.

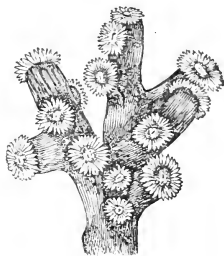


No. 11.

The various kinds of Corals differ greatly in size and mode of growth. In some coral communities, the separate animals are no larger than a pin's

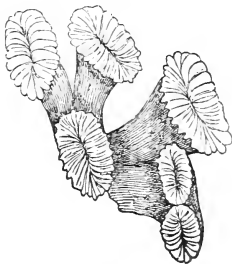
\* A branch of full-grown *Porites* in natural size.

head, and bud from the base: (the figure represented in wood-cut 11 is one of this kind).\* In others, the animals are larger and bud from the side, as in our little picture here (No. 12).† In others, each animal widens gradually toward the summit as it grows, assuming thus a sort of trumpet shape; then divides, so that where there was but one mouth there are now two, as you see in the picture (No. 13);‡ and these again may spread and divide in the same manner, thus increasing by division till they form a



No. 12.

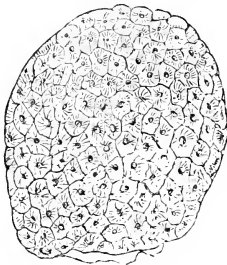
very large cluster. In another kind, the individuals do not divide and widen as they grow higher, and cannot therefore, by spreading, fill up the spaces between, which enlarge with their increasing height; but in those spaces the new buds form, filling all the intervals, and making a coral mass covered all over with thousands of closely packed pits, each one of which marks the spot occupied by a little animal (No. 14).§ Others grow in lighter branches, so like plants that I am sure, if you looked into water where numbers of these singular ani-



No. 13.

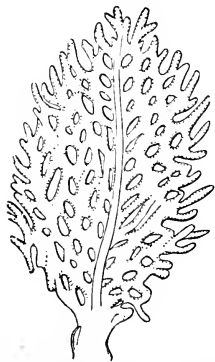
\* *Agaricia* or *Mycidium*.† No. 12: *Caryophyllia*.‡ No. 13: *Mussa*.§ No. 14. *Astrea*: heads of this kind measure frequently several feet across.

mals were growing in the sea, waving their branches to and fro, like an ocean shrubbery, you would suppose they were gigantic but exquisite seaweeds, rather than living beings. On these branches are crowded thousands of these little creatures, living a common life, and building up coral groves under the water. Here you have a little picture of one commonly called the Sea-Fan (No. 15),\* which when living is particularly beautiful,



No. 14

on account of its ornamented tentacles. They not only form a fringe around the summit of the animal, but they are themselves fringed, or lobed, along their edges. The woodcut represents only a small branch, but they

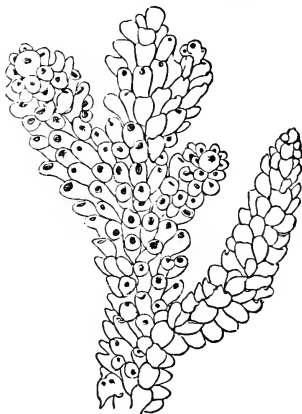


No. 15.

grow to the height of several feet. Among the branching Corals, there is one kind, the so-called Finger Coral (No. 16),† which differs from the others in having a somewhat larger animal on the top of each branch, with smaller ones all around the stem and branches. The larger ones represent, as it were, the patriarchal heads of the family, occupying the seat of honor at the summit of every branch, while the little ones grow around and below them.

\* No. 15: *Gorgonia*.† No. 16: *Madrepora*.

I dare say you have seen specimens of Corals, because they are so beautiful that all who travel to the tropical oceans where they grow,—to the coast of Florida, to the Pacific, and the East Indies,—bring home specimens of them. But when we see them at home, as they are brought from foreign lands, we must remember that all the soft and moving parts are gone; they decay when the animal dies, and nothing remains but

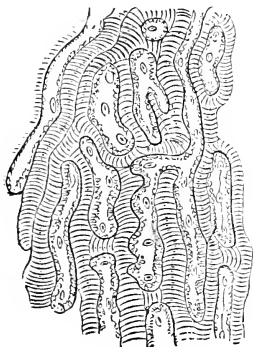


No. 16.

the hard frame which I have described to you. Notwithstanding this, however, we can see in such a mass of dead Coral the spot where every little animal has lived. Some of them form round masses called coral heads. Such coral heads differ in appearance according to the method of growing of the coral animal by which they were formed. In a dead coral mass, for instance, made by those animals which have the trumpet shape, and which increase by dividing and spreading till the separate mouths or openings coalesce and run into one another, the marks that are left are uneven, forming undulating lines on the surface (No. 17).\* In the kind which does not widen as it grows, but in which the spaces are filled by the budding of new ani-

\* *Meandrina*.

mals, the holes are quite regular, and have a star-shaped figure (see wood-cut



No. 17.

No. 14), produced by the partitions arranged like the spokes of a wheel, as I have described them to you in the single little Coral and in the Sea-Anemone. All Corals of the kinds I speak of are formed in this way, whether they grow in branches or in round masses, whether they bud from the base or from the side, or increase by division; the structure of every sepa-

rate little animal is the one that I have tried to explain to you.

Persons who have not had an opportunity of watching the Corals when alive, and have only seen the dry coral heads with their regular pits throughout, often talk of coral insects as building the Corals, comparing them to the bee that builds its honeycomb. But this is not correct. There are no coral insects, for insects are entirely different from the coral animals. The hard Coral is composed of the solid frame of the animals themselves, their skeletons as it were, and is not a structure built by them, as the bee builds its honeycomb. The honeycomb is truly a kind of house which the bee constructs for itself; there it lives, lays its eggs, and stores its honey, flying in and out at will. But the cells in a coral head are a part of the coral animals themselves;

and though they can expand their soft parts, or withdraw them at will into their solid frame, they cannot be separated from it, for it is as necessary to their life, and as much a part of it, as our bones are a part of our bodies.

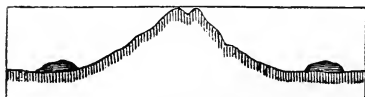
There is one thing I have not told you about these animals, and that you will think very odd in their way of living. They are all connected with each other, the body of each one opening at its base into that of the next ; so that what enters in at the mouth of one, after circulating in his body, passes into the next : thus you see when one eats his dinner, it nourishes **not only himself, but all his neighbors too.**

## CHAPTER II.

## CORAL REEFS.

I HAVE told you that these strange little beings have built up large islands and parts of continents, and I hope with what I have said of their way of growing, of their solid frame, and of their living in such crowded communities, forming large, hard masses, you will be able to understand how these busy little animals—who, in order to fulfil their appointed work have only to grow—have helped to make the world.

We will suppose that under the level of the ocean there is an island or a rocky hill growing up from the bottom of the sea, which, if it became large and high enough to be seen above the water, would be what we call an island. Perhaps you think of the bottom of the ocean as one great level floor (I remember I did, when I



No. 18.

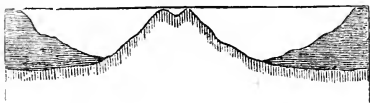
was a little girl); but in the ocean, as well as on the land, there are hills and valleys, and even mountain

chains. Suppose, then, that there were an elevation under the sea, which, if it rose higher than the water, would be an island, but which stops at a depth of ten



fathoms below the surface. On page 22 we have its picture (No. 18). Now fancy that some of those little coral animals I have described as swimming about freely in the water when they are first born, should attach themselves upon the side of this island, and should begin to bud and spread in large coral heads all around it. We must remember that it is not only by budding that they increase, but also by eggs ; these eggs, when hatched, are the little pear-shaped, free Corals which float about for a while, and then fasten themselves upon the community, so that they not only multiply by dividing and branching, but also by the addition of all the little animals that are born from their eggs. As this coral bank grows, the lower ones gradually die, their solid frames still remaining to form a firm foundation for all that grow above them. All the cracks and crevices are filled with sand, bits of shell, &c., so that it makes a wall as strong as any masonry. When they have, by their growth, formed a ridge all around the island, they begin to grow upward from the foundation which they have laid, — thus raising a circular wall about it. When they have reached a certain height in the water, those Corals which like to live in deep water will no longer grow there, and they die out ; but, on the surface that they have prepared, new kinds, such as like the shallow water, begin to establish themselves, and they continue the wall the others had begun. As it goes on increasing in height, these also find the water too shallow for them ; and now, to complete the work, come in the branching ones, which I have described to you as resembling sea-weeds and plants, and so the wall is crowned by a waving shrubbery. This brings it at last to the sur-

face of the water. Our island is now surrounded by a circular wall, rising to the level of the sea (No. 19).



No. 19.

Above that no Corals can live; and therefore as soon as the wall rises above high-water mark, the

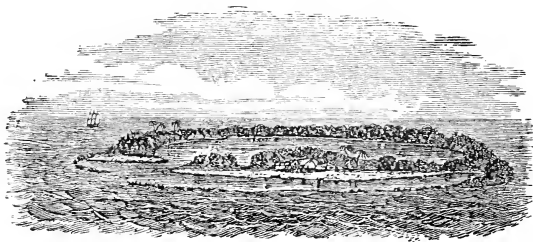
work of the little builders is done, — they can bring it up no higher, and they die for want of the constant action of the sea-water. But now other influences come in to complete the structure. The waves beating against the coral wall wear away its surface, break off large pieces from it and wear them into sand by constant rolling and grinding; in storms these broken masses of coral rock, and quantities of coral sand, are thrown up on the top of the wall. Gradually all the scattered materials floating in the sea around settle upon it, and the summit becomes covered with a soil composed of broken coral masses, sand, mud, parts of shells, drifted sea-weed, &c. And now perhaps birds drop there the seeds of some plant, or such seeds are floated from some neighboring shore: trees spring up there, flowers and grass grow upon it, men come and settle there, they build their houses and plant their gardens on this circular island, which lies like a green ring on the sea, and incloses within it a calm ocean lake. And so you see these tiny creatures, many of them no larger than a pin's head, build up from the ocean depths lands that may grow green and luxuriant with the beautiful vegetation of the tropics, and in which men may find a pleasant home.

I should tell you that all coral structures, while the Corals are building them, and before they are transformed into land, are called Reefs. I have spoken of the circular one which I have been describing as a wall, because I thought you would understand my meaning better; and they are truly walls. But the common name for them is Reef, and the coral animals are called Reef-builders.

Other kinds of islands are built by Corals; sometimes they build around an island which rises above the level of the sea; and then, of course, the centre is filled with solid land, instead of being a lake inclosed by the coral growth, as in the one I have been describing. The circular ones we have been talking about, are Lagoon Islands. There are many of them in the Pacific Ocean. When people first made voyages in the Pacific Ocean, they could not at all understand the meaning of these islands, formed like rings, with calm water in their centre. Usually, when the islands are large, they do not close completely, but sometimes one or more gaps are left in the ring, through which vessels can pass in, and anchor in the quiet harbors formed within the shelter of these coral banks with the trees that grow upon them. You may imagine how surprised voyagers must have been, when they first sailed through such an opening in a circular coral island, and found themselves in a quiet lake in mid-ocean. Sometimes these coral structures are made into Lagoon Islands by the sinking of the land around which they have begun to grow. Suppose, for instance, that Corals establish themselves around an island (see upper figure of diagram on page 28), and the island gradually subsides below the level of the sea,—

as islands are often known to do in the Pacific Ocean : the Corals continue to grow upward as the island continues to sink, and by the time the Corals reach the level of the sea, the island is out of sight, nothing being visible but the ring of coral bank, with water in the middle.\*

I have told you that not only are islands built up by Corals, but parts of continents also ; and I will show you how the whole peninsula of Florida has been patiently added to the continent of North America on which you live, by these busy little reef-builders, during



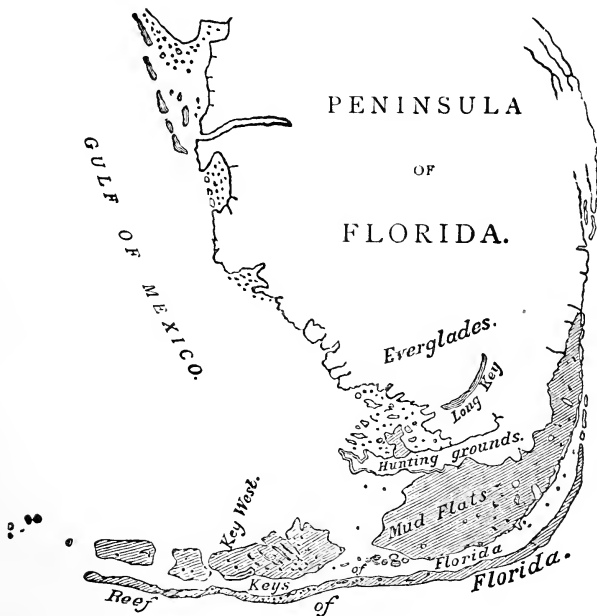
No. 20.

so many thousand years that you would find it difficult to count the centuries.

Do you remember how Florida is shaped and situated, — like a long tongue of land running out into the Gulf of Mexico? On the next page is a picture of it (No. 21). Outside, at a little distance, you see, there are a number of small islands called Keys, lying in a curved line around it ; and about five miles beyond these islands, if you could look below the water, you would see a crescent-shaped wall growing up from the sea-bottom. But as yet it rises to the surface of the water

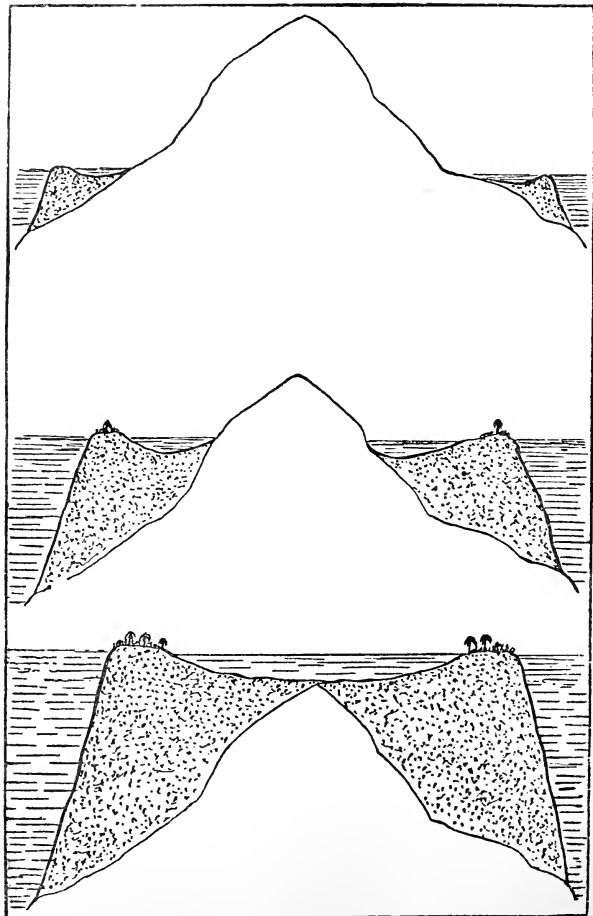
\* No 20. Also lowest figure in No 22.

only in two or three spots, and then only as points of rock, where light-houses and beacons are placed to warn away vessels ; for if a ship drives in upon that



No. 21

treacherous wall beneath the water, she may be broken to pieces. Can you fancy who has been building that wall? I think you will say at once that here also our little masons of the sea have been at work : and so it



No. 22.— ISLAND IN PROCESS OF SINKING, WITH CORAL GROWING AROUND IT.

is. The Coral-builders have been erecting that wall ; but though they have been at work upon it for many thousand years, they have not yet succeeded in bringing it to the sea-level, except at two or three points, as I have mentioned. They are not however discouraged, — they are far more patient than little boys and girls ; more patient even than men, — and they will go on, adding little by little to their wall, till they have joined it to the mainland of Florida.

But they cannot do this all alone, — other agencies must help them ; and in order to understand how this is, we must look a moment at those islands lying within the outer wall, and at the space that divides them from the mainland. Those islands are part of a coral wall exactly like the one outside of them below the water, and the islands are those parts of it which have reached the surface, and on which a soil has been formed by the collection of sand, mud, broken shells, coral, seaweed, &c. There, as on the circular islands of the Pacific, trees and flowers grow, and people live ; and if you were to see some of the gardens of Key West, — that is the name of one of these islands, — with their tropical flowers of the most brilliant hues, their coconut trees, their banana trees, and their delicious fruits, you would hardly believe that on this spot, not very long ago, the waves washed over the little Coral-builders. There are, as you see by the wood-cut, several of these islands, all formed in the same way, by those parts of the inner coral wall that have risen above the surface and have become covered with soil. Between these islands and the mainland, — the present coast of Florida, — all the space is filled by mud-flats ; that is.

by a large collection of mud, formed by the washing of the sea against the shore and against the coral reef, wearing it into sand and mud, which has been heaped up in the channel between the line of islands and the shore, till it fills it completely.

I think that, with these facts, we can see how, in the course of many years, the solid land of Florida will extend to where that outer coral wall now runs beneath the surface of the water. The mud-flats will increase by the constant addition of all the mud, sand, broken shells, and materials of all sorts floating about in the channel between the coast and the islands, till they are raised to a level with them, and thus connect them by solid ground. The wall, of which the islands are only those parts that have grown more rapidly here and there, will complete its growth, and rise above the level of the sea for its whole length. The outer reef, now rising only in two or three rocky points above the sea-level, will gradually form islands here and there, as the inner one now does; and between those islands and the inner reef, which will then be the coast of Florida, mud-flat; will collect and fill the space. The outer reef will then gradually complete its growth, no longer remaining a series of islands, but becoming a long strip of land; the mud-flats will unite it to the inner one, and then there will be solid ground all the way from the present coast of Florida to where the outer coral reef now runs beneath the sea.

This will take place in centuries to come; but it actually has taken place, to the north of the present reefs, during thousands of years past, and the whole peninsula of Florida has been formed by the same



process that is going on at its southern extremity now. All that part of Florida which has been examined is found to be formed in this way: first a reef and then a mud-flat, and then a reef and then a mud-flat, one within the other, just as they lie now at the southern end. Seven such reefs and mud-flats have been discovered already, and I suppose there are many more in the northern part. Of course, without digging down below the surface and studying the formation of the ground, we could not detect this; because for centuries all traces of those old reefs and mud-flats have been covered with soil and grass, and trees and flowers. We should no more suspect, from its present appearance, that Florida had once been the ocean home of the reef-builders, than the people who live centuries after us will suspect that what will then be its southern extremity was, in our time, almost entirely under water.

You may ask why the little Corals do not settle nearer the shore, and connect their reef immediately with it, instead of beginning at a distance of three or four miles from the shore, thus leaving a channel to be filled up afterwards by mud-flats. The reason is this. The Corals which form the foundation of the reef delight in deep water, and could not live in the shallow waters of a sloping shore; and they like also perfectly clear water, untroubled by the mud and sand washed off from the land by the waves. They naturally seek the conditions most favorable for their growth, and establish themselves at a little distance from the coast, where they find the deeper, purer waters which they need.

There are other kinds of Corals beside those that I have described here: some that are vegetable, — a kind

of stony sea-weed, as it were, growing hard from the quantity of lime particles it contains ; and others which, like those we have been speaking of, are little animals, differing somewhat from them, however, in the arrangement of their parts. But it is not necessary, in order that you should understand the building of a coral reef, to explain to you the different nature of all the Corals that compose it.

Florida is not the only country that has been built up in this way. One of the most beautiful parts of Switzerland, called the Jura, lying on the border between Switzerland and France, is formed of coral reefs such as are now forming in Florida. If you look at your map of Europe, you will see what great changes must have taken place since then. Now, you see, Switzerland is completely shut out from the sea ; it lies between France, Germany, Austria, and Italy, and is land-locked on every side. But, as we know that Corals can live only in the salt water, it is evident that, in the days when they were building up the Jura, the ocean must have washed the shores of Switzerland on its western side, and the southern part of France cannot have existed at all.

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The structure which I have described to you in the Sea-Anemone and the Coral, belongs to many other little beings having their home in the sea ; and all animals so constructed are called *Polyps*. That is their scientific name, and it includes thousands of animals which, however they may differ in external form, have their parts arranged internally in the same way.

## CHAPTER III.

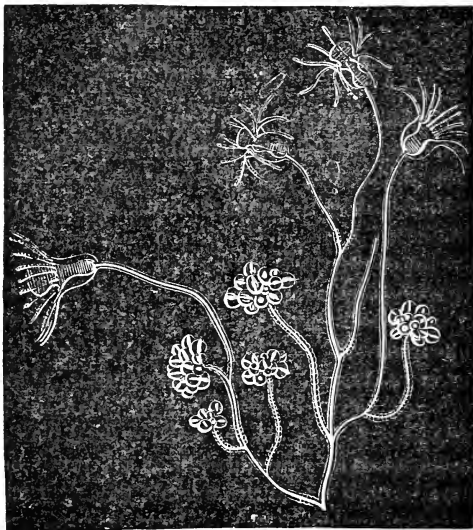
## HYDROIDS AND JELLY-FISHES.

OUR walk, beginning at Nahant, has extended rather far, — has it not? Let us come back now from Florida and the Corals, and see what else we can find that is interesting among the animals living close about our own home.

In many of the pools left by the retreating tide along our beaches and rocks, — such as that in which we found our Sea-Anemone, — we may find little animals resembling flowers even more than that does, because they grow in clusters like miniature shrubs. On page 34 we have a picture of one (No. 23).\* You will hardly believe that it is built on the same general plan as the Anemone, when its appearance is so different; but you will soon learn, if you watch animals, that their external form may differ very much, and yet that they may be constructed according to the same plan. If we examine each of these little animals, hanging like flowers at the summit of each slender stalk, we shall find that they have many of the features belonging to the Anemone and to the Coral. They have the wreath of tentacles, looking like a fringe around the mouth, and the mouth opens into a cavity in the middle,

\* No. 23. *Eudendrium*.

which is the stomach ; but they have not the partitions that in the Sea-Anemone and the Corals divide the rest of the body into separate parts ; nor is the stomach a sac hanging within the body, as in the Sea-Anemone, but it is a cavity hollowed out of the sub-



No. 23.

stance of the body. If we look at the slender stalk with a microscope, we shall find that, instead of a stalk, it is a hollow tube, connecting with the central stem, which is also hollow. In this community of animals, as in the coral community, each one is connected with the next by these stems, so that all the water and food

that enters in at the mouth of one, feeds all the rest. Beside the little flower-like animals on the upper branches in No. 23, some of the lower branches terminate in bunches of small oval bodies resembling eggs; and such, indeed, they are.

There is one very odd thing about these little animals: the young that are born from them are quite different from themselves. You know that usually the young of animals are like the parents. From the eggs in our hens' nests, chickens are hatched; from the pretty blue eggs in the robin's nest, come forth the little robins: and I think you must remember the funny little turtles that came out of the turtles' eggs, which we kept in a box of earth two summers since, to see what would become of them. We should naturally suppose, then, that from these little animals which I have been describing, there would be born animals like themselves; just as chickens are born from hens' eggs, robins from robins' eggs, and tortoises from tortoises' eggs. But we shall see that this is not so.

We will suppose that we have carried home one of these little clusters of animals, differing somewhat from the preceding, and put it in our Aquarium. Here you have its picture (No. 24).\* A day or two after, we may find swimming about in the water a little, fairy-like, transparent thing, so slight and delicate, indeed, that it seems almost as if some drops of the water had taken form and shape; and as if this strange little being that is



No. 24.

\* No. 24: *Coryne*.

darting about in it were but a part of the element in which it floats (No. 25).\*



No. 25.

from the lower side hang four long threads ; in the centre of the lower side hangs a proboscis, at the end of which is the mouth, and four tubes run from the summit of the upper side to the lower edge, where a circular tube unites them all around. It seems to delight in its life : it shoots through the water in every direction, and appears to move by breathing, for every motion is made by a sudden contraction and expansion, which is in truth produced by the taking in and throwing out of water under the cup. Up and down, and on every side it darts about ; and no bird can enjoy its flight through the air more than this animal — which scarcely seems to have a material body, so frail and unsubstantial is it — appears to enjoy its freedom of motion through the water. It is perfectly transparent : a drop of water, a bubble of air, a spider's web, a

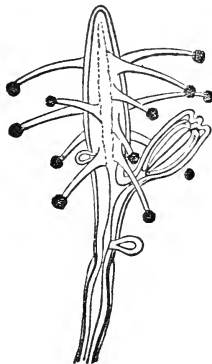
fly's wing, any thing that has form and shape at all, can hardly be more slight in texture than this little creature. And this is the being produced from the cluster of ani-

\* No. 25: *Sarsia*.

mals, so different from itself, which we brought in and placed in our Aquarium. If our eyes had been sharp enough, or had we been in the habit of using the microscope, we might have seen that very near the tentacles around the mouth of each one of the little animals were hanging bunches of little spheres (No. 26).\* These are buds, quite different from the buds of the stem; and from them are born the singular little creatures, such as the one I have just described.

Let us watch him now for awhile, and see what becomes of our fairy friend. From the centre of the lower side hangs down, as I have said, a kind of proboscis (see wood-cut 25). I use that word, because it is

the one used by naturalists to describe the thing; but I hope it will not remind you of an elephant's proboscis, though I suppose you have never heard the word used in any other connection. If you ever examine the almost imperceptible and transparent organ attached to this little creature, and called by naturalists a proboscis, you will wonder that the same name should be used to describe two things, one of which is so delicate, and belongs to such a slight and transparent ani-



No. 26.

\* No. 26. A head of *Coryne* magnified, of which a great many are clustered together in wood-cut 24, where they are shown in natural size.

mal, while the other is so heavy, and belongs to one of the largest and clumsiest animals living. Along this proboscis little spheres are scattered, which are eggs. From these eggs are born little pear-shaped bodies, very like those which I have described to you as the single coral animal (see wood-cut 8 ) before it has grown into a coral stock. It swims freely about for awhile, then becomes attached to some shell or sea-



No. 27.

weed or stone, puts out first a few tentacles\* (No. 27), then gradually more, then buds from the base and from the side, and grows at last into a cluster of animals, a little shrub, like the one with which we began. So you see, with this animal, it is not the child that resembles the parent, but the

grandchild that resembles the grandparent; and we must go through two generations before we come again to the form with which it started.

These little animals growing in clusters are all called Hydroids, though there are a great variety of them, distinguished from each other by special names, with which I will not burden your memory now. Those which are born from them are called Jelly-Fishes, though of these also there are a number, differing in form and size, having also their special names. You must not fancy from this that these animals are in any way connected with fishes. They are no more like a fish than a bird is like a fish; but this common name has been given to them, because any thing that lives in the water is apt to be associated with fish by people who know nothing about them, except the fact that they inhabit the sea.

\* Young *Hydroid* of *Coryne*.



There is one of these Hydroids living as a single animal, not in a community or cluster like the one I have described, which is excessively small, perhaps half an inch high, and yet produces some of the largest Jelly-Fishes. It does not bear them by buds or eggs, as I shall show you, but by dividing itself into a succession of animals, each one of which is a Jelly-Fish.



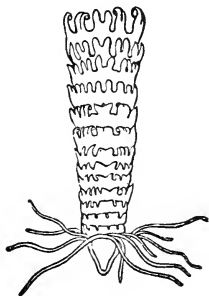
No. 28.

Here is a picture of this Hydroid somewhat magnified, and before this process begins (No. 28); and here is another picture of the same after it has begun to divide, and very much enlarged, in order to show you how this change takes place (No. 29).



No. 29.

After the little Hydroid has lived for a time as you see him in the first picture, — that is, as a single animal attached to the rocks or sea-weed, — the upper part begins to contract, then another contraction takes place a little lower down, and so on till the whole animal is divided by contractions through all its length, and it looks something like a pile of saucers (No. 30).<sup>\*</sup> Then each one of these contractions deepens more and more, till each part that has been so marked off separates from the rest, and swims away a free animal, shaped like the picture on the next page (No. 31).<sup>†</sup>

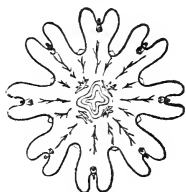


No. 30

<sup>\*</sup> No. 30: *Strobila*.

<sup>†</sup> No. 31. This jelly-fish has been described as *Ephyra*.

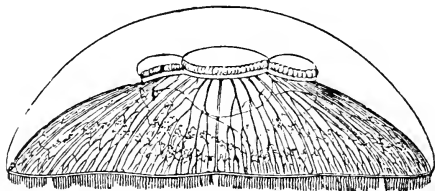
After this separation has taken place, the tentacles begin to grow ; and when the animal is complete, it



No 31.

is bordered all around the margin by the fringe which they form. You see that in order to have the bulging side above, as it is in the picture (32), each one, as it floated off, must have turned upside down ; for if they retained the position which they have while still attached together, their shape would be like

that of a saucer standing on its bottom, as it is usually placed. But each one, as it leaves the pile, turns a somerset ; and though it has still the shape of a saucer, it is of a saucer overturned and resting on its edge, the edge being scalloped ; for the fringe of tentacles around the margin is not then fully formed.



No. 32.

There are a variety of these singular, self-dividing Hydroids and of the Jelly-Fishes produced by them, all of which grow to a considerable size. The most common is the so-called white sun-fish (No. 32),\* seen in our bays and along our wharves. It is remark-

\* No. 32 : *Aurelia*

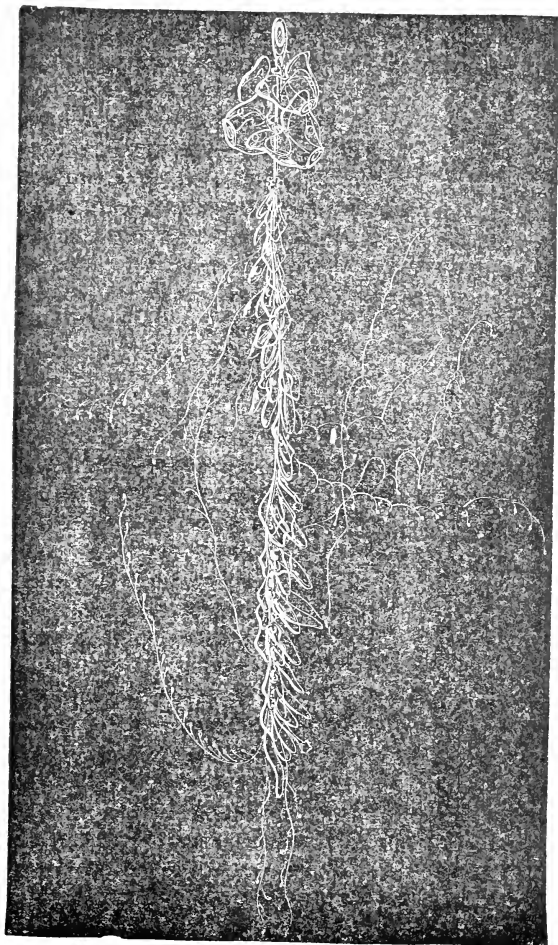
able on account of four crescent-like figures of a rosy or purplish color, so placed as to form a cross in the centre. These are produced by the large accumulation of eggs forming these crescent-shaped bunches. Another Jelly-Fish produced in the same way by the division of a Hydroid is much larger, varying in circumference from that of a dinner-plate to that of a large tub (I have often seen one filling completely the largest-sized wash-tub), and with immensely long tentacles hanging from it. When one of the largest of these animals is swimming in the sea, its tentacles may stretch out for twenty or thirty feet behind it. The color of this Jelly-Fish is a deep claret, and it is by no means so transparent and delicate as the others I have described. Yet, though it has a great deal more solidity, it is soft nevertheless, of the consistency of jelly; after the autumn storms, it is seen in large numbers strewn upon the beach, like immense cakes of brown jelly. So large a part of the weight of Jelly-Fishes is derived from the water they absorb, that a Jelly-Fish weighing, when taken from the sea, thirty-five pounds, if left to dry in the sun will shrink to a film weighing only half an ounce. All those jelly-like masses which sometimes lie stranded in such numbers along the beach in summer, and which are often called Sun-Fishes, are Jelly-Fishes of different kinds.

In many of these Hydroid communities, the work is curiously divided between the different individuals. Some are the sportsmen and the feeders of the community. It is their business to catch the prey, and they are furnished with the lasso cells which I described to you in the Anemone. They fling out their long

whips, and entangle in them the little shrimps, shell-fish, or any other food that may fall in their way. They have also to eat and digest for the whole family; and then the food, reduced to a pulp by the process of digestion, passes through the whole community by means of the stems, which, as I have told you, are hollow tubes, and communicate with each other. Next, there are the swimmers; for this community is not attached, but floats freely in the water: their office is to move the whole establishment; and one may see such a Hydroid community moving along like one individual, though all the motion is performed by these swimming members alone. Finally, there are those whose business it is to produce the buds that bear the little Jelly-Fishes; and so well is this wonderful community regulated, that each one performs his own work faithfully, and never interferes with the affairs of his neighbor.

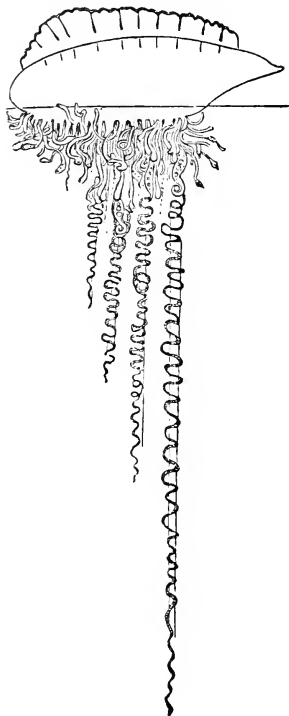
A pretty example of these compound households, leading a common life and moving as one being, is the *Nanomia*, which may be found upon our immediate coast, in the Lynn Bay, or off the shore of Nahant. On the next page is its picture (No. 33).\* The oval ring at the top is formed by a little oblong sac which contains oil, and serves the little community as a balloon or float, steadying it in the water. This float is as transparent as a bubble of glass, and deep red when seen in certain lights. Just below the float you see a cluster of bell-shaped organs. These are the oars; by alternately opening and closing, they have the power of taking in and throwing out water, and thus they drive the community along. Below these

\* Sea-Side Studies (A. Agassiz).



No. 33.

swimming bells, as they are called, various little individuals, each one working in its own way for the



No. 34.

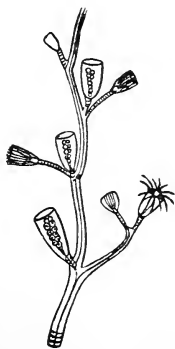
general good, are scattered along this living string. Some are the feeders; they have only to catch and eat the prey, and, having digested it, to pass it along to all the rest; others are the egg-bearers, from which new individuals are born; and others still there are, whose function is not yet explained. All are furnished with fine, flexible, thread-like tentacles, and these tentacles are ever in motion, — sometimes caught up in coils or loops, sometimes flung out like fairy ropes, and upon their whole length little bright red pendants are hung, giving a rosy color to the whole community.

Another of these communities is the beautiful animal, or combination of animals, commonly known in the Gulf of Mexico as the Portuguese Man-of-War\*

\* No. 34. *Physalia*.

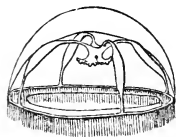
(No. 34). The various individuals composing the community hang down like long bright-colored streamers, attached to a bladder filled with air, of the size of a large pear, and not unlike it in shape, — with a crest rising above it, sometimes pink or purple, and sometimes blue, which catches the wind like a sail, and carries it along like a little boat upon the surface of the sea. From the lower side of the bladder hang all kinds of threads and bags, being as many distinct animals of smaller kinds, but having immensely long tentacles, capable of an extraordinary extension, sometimes measuring many yards when stretched to their full length. Nothing can exceed the beauty of these brilliant little communities as they are seen on the water, with purple crest erect, proudly floating on the surface of the sea, like a miniature ship under full sail. It is for this reason, I suppose, that the sailors have called it the Portuguese Man-of-War.

This most beautiful kind of Hydroid belongs to tropical seas, and is rarely found on northern coasts. But we have many varieties of very pretty Hydroids on our rocks and beaches, which you can easily collect for your Aquariums; all producing their own kind of Jelly-Fish, and this, in its turn, bringing forth again the same kind of Hydroid from which it came. Besides those I have described, there is one in which some of the buds have somewhat the shape of little



No. 35.

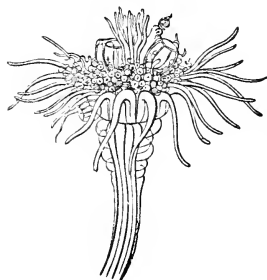
bells.\* On page 45 is a branch of one (No. 35), and you see that the buds are not all alike, but that one is longer than the others, and has no tentacles; and within you see a number of little spheres. These are the buds, about to drop out as little Jelly-Fishes,† somewhat different from the one I first described, but equally delicate and beautiful. It has not the long



No. 36.

threads hanging from it, but tentacles surround its whole lower edge like a fringe (No. 36). From the eggs of this Jelly-Fish will be reproduced again the little flower-like Hydroid, with the bell-shaped buds, from which it was born.

Then we have another Hydroid forming also a little shrub-like community, which bears its Jelly-Fish buds



No. 37.

among the tentacles at the crown or summit of each individual (No. 37). The Jelly-Fish born from it has a strange name; it is called the hunchback,‡ on account of its singular, one-sided shape. It is larger on one side than the other, and on that side it has one long tentacle with buds growing upon it.

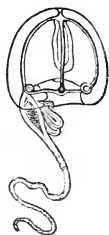
This again produces the Hydroid from which it was born. On the next page you have a little picture of it (No. 38).

\* No. 35: *Campanularia*.† No. 36: *Tiaropsis*.‡ No. 38: *Hypocodon*.



There are still other Jelly-Fishes and very beautiful ones, having no connection with any Hydroid, and simply reproducing themselves by eggs. They may be found on our coasts, throughout the spring and summer; and I hope you will have many a good ramble on the rocks and beaches of Nahant to find both Hydroids and Jelly-Fishes.

There is one thing I must not forget to tell you about the Jelly-Fishes before we leave them. They are the lamps of the sea. Have you ever heard of the phosphorescence of the ocean? It is a strange light on the surface of the water following in the wake of vessels as they cut their way through the waves, or seen at night along the line of foam that breaks upon the shore. There are a variety of phosphorescent animals in the sea, and a part of this singular illumination of the ocean is due to all of them; but the Jelly-Fishes are among the brightest and most beautiful. The large ones float slowly like translucent globes among the lesser lights, while others sparkle like stars, or spread a more diffused and paler light over the water. This luminous property of the Jelly-Fishes belongs to their more active and sensitive parts; and the light is more perceptible when a vessel breaks the surface of the sea, or where the waves break upon the shore, because the disturbance of the waters in which they float excites them into unusual brilliancy. It is easy to watch the action of this singular quality in the Jelly-Fishes, by keeping them in glass jars in a dark place. If you trouble the water by passing your hand through it, they will begin to



No. 33.

shine ; and sometimes, if you have one of the larger ones, you may see the light run along the more highly organized parts of the whole body. He seems to tell you thus, in fiery characters, the story of his own structure.

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I have told you that all animals like the Sea-Anemone, — that is, with the stomach hanging in the centre, and the rest of the body divided by partitions, — are called *Polyps*. As we have come to the end of our talk about Jelly-Fishes, I will give you their scientific name also. All animals constructed like Jelly-Fishes, — that is, with a transparent, jelly-like body, traversed by tubes like little channels running through it, and with the stomach hollowed out of the substance of the body, — are called *Medusæ* or *Acalephs*. Now I will tell you something about Star-Fishes and Sea-Urchins, or, as I think you have heard them called, Sea-Eggs.

## CHAPTER IV.

## STAR-FISHES AND SEA-URCHINS.

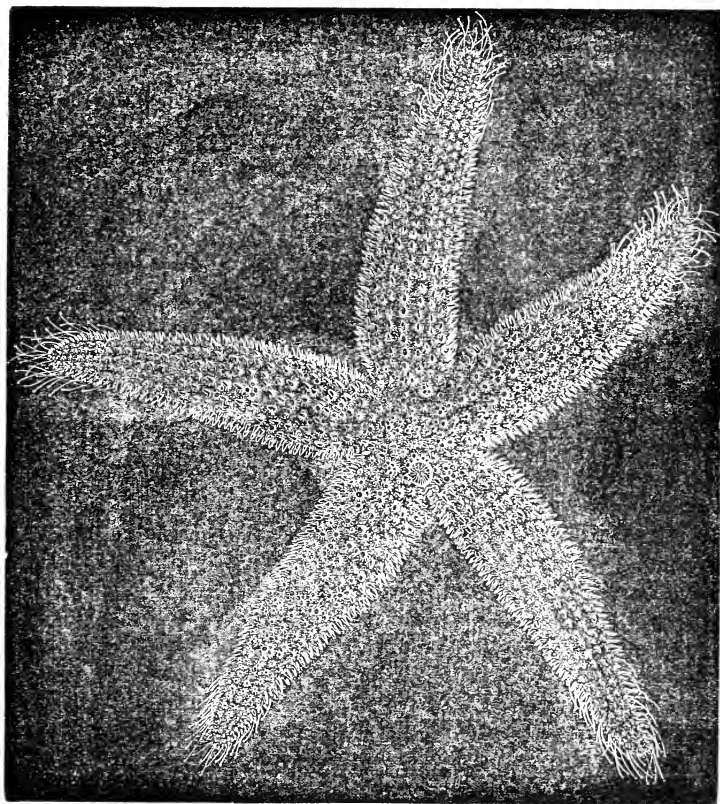
WE will begin with an old friend of yours, — the five-armed Star-Fish that you have often collected on the beaches. There is no trouble in finding these Star-Fishes; there is scarcely a puddle or sea-weedy rock along any part of the Nahant shore where they are not to be seen in numbers; and if you ever have an opportunity of rowing in a boat around Egg Rock at low tide, you may count them by hundreds, especially at the side of the rock farthest from Nahant, where there is a very populous Star-Fish settlement. But, though you are so familiar with their general appearance, I doubt whether you know much of their habits of life, or of the way in which they are made. You know that they move about, but you do not know what organs they have to serve them as legs; you know, if you have ever watched them when alive, that their lower side is covered with all sorts of appendages, seeming to be in active motion, but you do not know what office these appendages have to perform; you take it for granted that they eat, but you do not know where their mouth is, and I think you could not tell me whether they have any eyes or not. Let us see what is the meaning of these different parts; and

when you have them in your Aquarium next summer, you will have more interest in watching them and in learning something of their habits of life.

The figure shows us only the upper side or back. It is studded all over with little knobs, differing in color in different Star-Fishes (No. 39).\* These knobs are in fact short spines, and around them are arranged little fork-like projections with two prongs. These forks can open and shut their prongs at will, and may sometimes be seen to catch between them small prey, — little shrimps and the like. They probably have some other purpose, but their exact use is not understood. Between the spines are very short hollow tubes, so small that you will not easily distinguish them ; but it is owing to them that the upper side of the Star-Fish has its full and rounded outline. These tubes absorb water, and when a Star-Fish has been left upon the rocks or beach by the retreating tide, its outline becomes comparatively flat ; but as soon as the tide comes up and covers it again, it assumes its rounded shape once more, expanding its whole body with the water which fills these minute tubes. If you watch a Star-Fish when just taken from the sea, you may see the water oozing out all over the surface of the back. Near the centre and between two of the arms there is always a round bright-colored spot : in our figure it looks dark. That is a little sieve, through which the water is filtered as it passes into the five principal tubes that run from the stomach to the extremity of each of the arms.

Now let us turn our Star-Fish over and examine him on the lower side. In the centre you will see a small

\* *Pedicellariæ.*



No. 39.\*



aperture. That aperture is the mouth, and it opens, like the mouth in Sea-Anemones or Jelly-Fishes, into a cavity which is the stomach. From that cavity, tubes run up each of the arms to its extremity, so that the food, passing from the stomach into these tubes, can circulate through the whole body. They have a very singular way of obtaining their food. They have no long tentacles like the Sea-Anemone to catch their prey, but they turn the stomach out over the food, enveloping it in this way ; and having so secured it, they turn it back again. On the lower side of the Star-Fish, arranged along the centre of each ray or arm, there are a number of small appendages that look like short feelers ; they are almost constantly in motion ; and if you look at them closely, you will see that the end of each one spreads very slightly into a club-shaped extremity, and has a small depression, forming a little pit. These are their organs of locomotion ; they are suckers, and are so constructed as to cling closely to any surface they touch. When the Star-Fish wants to move, he stretches one of his arms in the direction in which he means to go, and attaching his suckers to a rock or sea-weed, or any object near him, he drags himself along. You know, when you are climbing a tree, and you come to a part of it where there is no branch upon which you can fix your foot to take the next step, you may stretch your arms to some higher bough, and draw the rest of your body up in that way. This is not unlike the Star-Fish's way of moving ; he turns one of his rays in the right direction, stretches his suckers as far as he can, adheres by them closely to the surface along which he is moving, and drags the rest of his body on by the

force of their adhesion. To be sure, it is a slow and clumsy way of moving ; but then the Star-Fish is rather a dull fellow, and he is as well satisfied if he has walked an inch or two in an hour as you would be if you had walked a mile in half that time. These suckers are placed along the centre of the lower side of each ray, as I have told you, and on each side of the row of suckers along the edge of every ray there are appendages of a different kind. These are stiff spines, the object of which is not well understood, but perhaps they serve as a protection to the animal. Here is a picture of a single ray, showing the arrangement of suckers and spines (No. 40).



No 40.

At the end of each ray there is a little red speck which is an eye ; so that, as they have five rays, they have also five eyes, which I dare say will give you a great respect for their powers of vision. But let me tell you that five of their eyes are by no means so good as one of yours ; and indeed, though these red specks are essentially organs of sight, it is very doubtful how much they see with them. Perhaps they are only receptive of light without discerning any objects ; for though we call them eyes, they have no complicated structure, such as our eyes have, by which every object is distinctly drawn like a picture within them. Yet I once heard a story of a Star-Fish which inclined me to believe that, if they do not see, they have at least some very keen perception of what goes on about them.

Star-Fishes carry their eggs near the mouth, and keep them safely by stretching their suckers around



them, and thus holding them fast. A friend of mine was one day watching a Star-Fish in a large glass dish, which had its eggs folded within the suckers in this way ; and wishing to examine the eggs more closely, he parted the suckers, took the eggs away, and kept them for some time. When he had finished his examination, he dropped them back into the dish. At once, to his surprise, the Star-Fish seemed to be aware that its eggs had been returned to it ; and moving towards them at its utmost speed (which is, at best, but creeping very slowly), it placed itself over them, folded its suckers once more around them, and so took them up again. Wishing to be quite sure that this had not been accidental, he removed the eggs again, put the Star-Fish into another and larger dish ; and having placed it at one end, and putting also some obstacle in the centre of the dish to divide it from the other side, he then dropped the eggs in at the end opposite the parent, as far from it as possible. The Star-Fish immediately began its journey (now quite a long one for a Star-Fish) toward its offspring ; and having reached them, covered them, and took them up again as before. A third time the experiment was repeated, but always with the same result : the creature perceived its eggs the moment they were placed in the same vessel with itself, and went at once to shelter and protect them. You see by this it is not lost time to watch even these lowest creatures that God has made. They, too, care for and cherish their young ; they have certain ends to fulfil in life, and they, as well as the higher animals, enjoy the existence that has been granted to them.

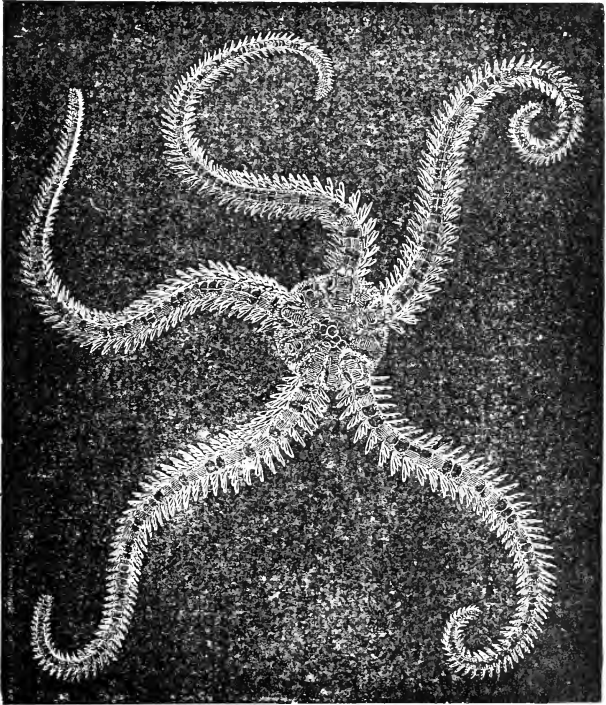
There are a great variety of Star-Fishes ; some in

which the arms are very spreading, being divided into branches and tendrils, as it were, that extend in every direction, but yet bear the same relation to the centre as the rays in the one with which you are familiar ; others in which the arms are united for a part of their length, so that the compact centre is larger ; others in which there are ten arms instead of five, and so on. I will not tire you with the details of all these varieties, because, however their appearance may differ, the structure of one explains, in a general way, the structure of all.

I should, however, mention one group of these star-like animals, — the *Ophiurans*, as naturalists call them, — because they differ in many features from the other Star-Fishes. On the next page is a picture of one (No. 41).\* You see that his build is very unlike that of the Star-Fishes you have seen. The centre is more distinct, and the arms start from it abruptly instead of spreading gradually outward. The locomotive appendages of the *Ophiurans* differ slightly in structure from the suckers of the ordinary Star-Fish, and so also does their fashion of moving. Extending one of the arms in the direction in which they mean to go, they then bring forward two others to meet them ; and having thus advanced three arms, they drag the rest of the body on. They are not as easily found as the common Star-Fish, because they are very shy, hiding in crevices of the rocks, and shrinking from any approach however gentle. They are of various colors, — yellow, purple, or red, — and are very brilliant on the back-ground of dark sea-weed, where they are commonly found.

\* Sea-Side Studies (A. Agassiz)

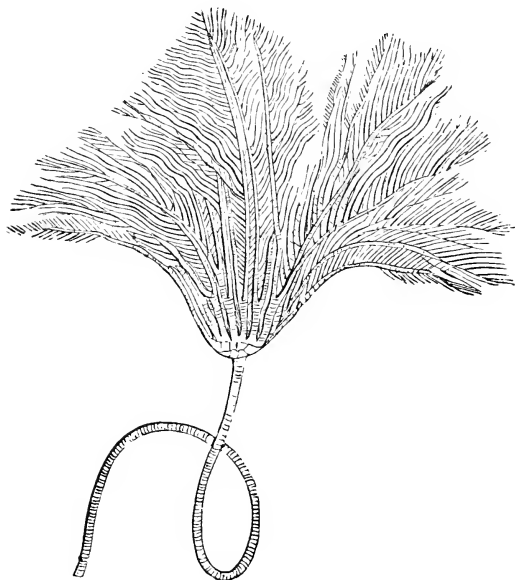
Lastly, I wish to tell you something of the first Star-Fishes that ever were created : and for these we must



No. 41.

look, not in the water, but on land. Sometimes in breaking up or blasting rocks, there have been found upon them impressions that looked as if some large but

graceful flowers, not unlike a widely opened tulip or lily, had been roughly drawn there (No. 42). At first, the persons who found these strange old flowers as they seemed, buried in the rocks, could not understand how



No. 42.

they came to be there, or what they were ; but from their appearance they were called "stone lilies." When, however, they were more closely examined, and carefully studied by naturalists who were familiar with animal structures, it was found that what looked like a

flower-cup was a kind of Star-Fish, growing upon a tall stalk, which must have been attached to the ground when the creature was alive. And so they were no longer considered as flowers of old times that had been hidden away in the rocks ; and they lost their pretty name of "stone lilies," and are now called *Crinoids*, the first animals of this kind that ever lived.

You will wonder, perhaps, how we know that they were the first. We know it because they are found in very ancient rocks, where are preserved the impressions of a variety of animals that lived many thousand years ago. Among them are Corals, Star-Fishes, shells, worms, queer crabs, and strange fishes, — old-fashioned creatures very unlike those living on the earth now ; creatures that vanished away many, many centuries ago, leaving their traces in the rocks to tell us something of the story of those old times, before man and the animals living with him upon the earth were born. And perhaps you may ask another question, — how it happens that any animals could be preserved in hard rocks? At the time these animals were buried there, the rocks were not hard. Many of our rocks were mud or sand at first, and have become hard only in the course of time, from the continual pressure of the layers of mud and other materials constantly added above them year by year, till the whole mass is consolidated into rock. Now, during this process, which may last for centuries, many animals die in the soft mud or sand ; and, when it afterwards becomes hard, the solid parts of their bodies are preserved there, and are thus built, as it were, into the rocks. There are still among the living Star-Fishes a few forms\* resembling those

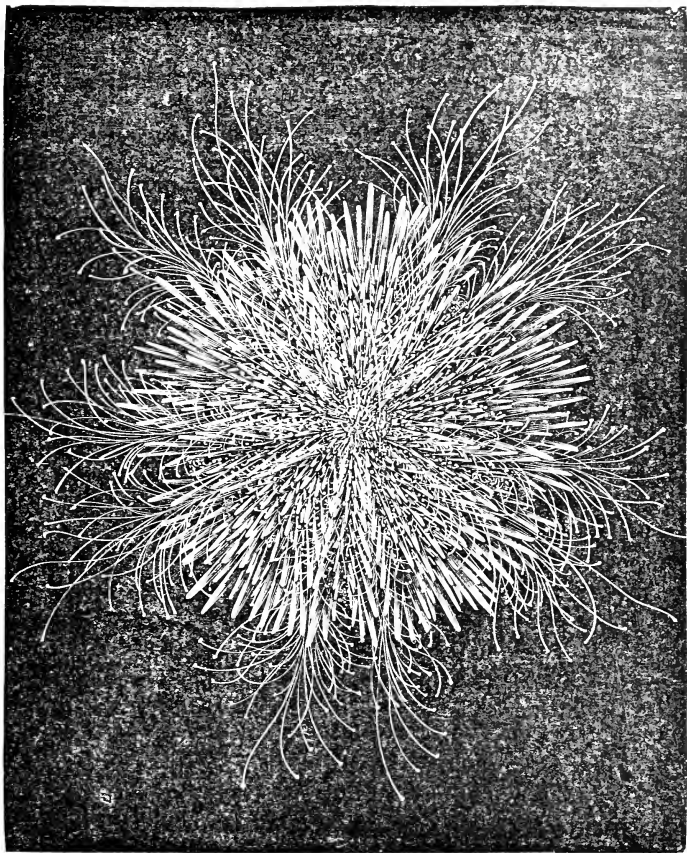
\* *Pentacrinus* and *Comatula*.

ancient Star-Fishes on stems ; but, as they are rare and are not found in our waters, I will not attempt to describe them to you.

Let us look now at the Sea-Urchin, or Sea-Egg (No. 43.) Though very different in appearance from a Star-Fish, it is almost exactly like it in the number and arrangement of its parts. The arms which are stretched out in a five-rayed Star-Fish, if drawn together and joined at the points, would make a Sea-Urchin ; the rows of suckers and spines, arranged along the five rays in the Star-Fish, are arranged in alternate rows up and down the surface of the Sea-Urchin ; the five eye-specks at the extremity of the rays in the Star-Fish are drawn close together on the summit of the Sea-Urchin, and the mouth is placed at the centre of the lower side in the Sea-Urchin, as in the Star-Fish ; but it has five little teeth not to be found in the Star-Fish. The tubes carried along the arms of the Star-Fish follow the line of the rays in the Sea-Urchin, and the little sieve through which the water enters them is on the upper side of the body, between two of the rays. The little forks, which have three prongs, instead of two as in the Star-Fish, are scattered over the surface between the spines. In the Sea-Urchin, they are often used to cleanse the surface of the body, and you may see the rejected bits of food, for instance, caught in these little forks, and passed along from one to the other down the sides of the body, till they are dropped off into the water.\*

You may form some idea of the way in which the difference in the outline of a Star-Fish and a Sea-Urchin is produced, by making five equal divisions on the

\* For further details, see "Sea-Side Studies" (A. Agassiz).



No. 43.





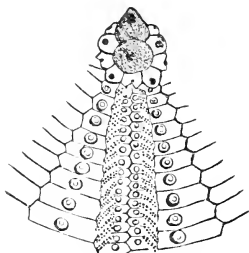
skin of an orange, leaving them united at the base ; then peel it off, and stretch it out, you have a star with five rays ; draw the rays together and unite them at the top, and you have again the round form of the orange.

The Sea-Urchin has one very peculiar habit. He bores for himself a hole in the rocks, which just fits him, and makes a very snug and comfortable retreat. I have seen a dead Sea-Urchin, about as large round as a five-cent piece, packed away as closely as possible in its hole, that fitted him as neatly as if it had been cut with the nicest instrument. Their mode of making these holes is not known ; and as they are found in all kinds of rocks whether hard or soft, where Sea-Urchins exist, — in granite or basalt as well as in limestone or sandstone, — it is difficult to understand how animals not furnished with any sharp and powerful instruments can produce such an effect. There is, however, no doubt that these holes are made by the animals themselves, not only because the Sea-Urchins are found in them, but because they fit their inhabitants so perfectly that no animal not exactly of the same shape and size could have produced them ; and they are of all sizes, from that of the young Sea-Urchin to the full-grown one.

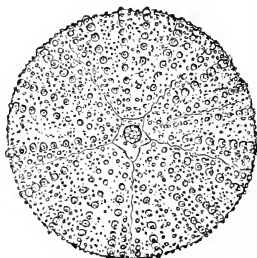
It has been supposed by some naturalists that they were made by the constant friction of a fringe that is in unceasing motion, called the *vibrating cilia* ; this fringe, though invisible to the naked eye, covers the spines of the Sea-Urchin, and, by the constant turning of the animal over and over in the same spot, may wear a hole in the rock. It seems difficult to believe that a substance so soft and delicate as the vibrating

fringes on these animals should produce any effect on a substance hard as granite ; yet we know that the constant dropping of water wears away a stone, and it may be that the continual friction even of the soft parts of the Sea-Urchin would be equally effectual.

The common Sea-Urchin of Nahant is one of those that make these singular holes, and you may have an opportunity of seeing them in the rocks there. I hope you will try to find some Sea-Urchins for your Aquarium next summer, and watch them in their living condition. I



No 44.



No. 45.

dare say you have often seen them dead and dry on the beaches, but you cannot then judge at all of their appearance when living. They look very pretty when dried in that way, because, though they have lost all their spines and suckers, the spots where these appendages were attached form a sort of pattern in regular rows or zones over the surface of the animal, and you can trace in this pattern the lines along which the spines and suckers were arranged when the animal was living. No. 45 shows you such a dried Sea-Urchin shell ; No. 44

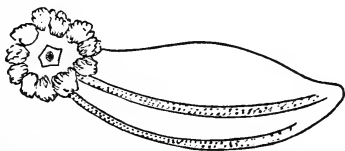
shows you a portion of such a shell where the different parts are still more clearly seen. The broader rays with the largest spots are those along which the spines were attached; the narrower ones, with the smaller spots crowded closely together, are those along which the suckers were placed.

There is a great variety among the Sea-Urchins, as well as among the Star-Fishes. They do not all burrow in the rocks. Some of them are flat in form, and live on sandy flats, burying themselves in the sand; so that they are only discovered when left bare after storms, or in very still days, when, in changing their place, they have left tracks along the sand.

There is another animal, which, though it differs strikingly in appearance from the Sea-Urchin and the Star-Fish, is yet constructed on the same plan. It is commonly called,

from its form, the Sea-Cucumber.\*

(No. 46.) It may be a little difficult to show you how this soft elongated



No. 46.

animal, resembling a worm more than any thing else, is related to the Star-Fish with its extended rays, or to the Sea-Urchin with its round outline; but I will try to explain it to you. Imagine that the Sea-Urchin were elastic, and that taking him at the mouth on one side, and at the spot just opposite to the mouth where the rays meet on the other side, you could stretch him out till, instead of being a round, compressed ball, he would

\* *Holothuria*.

have a long cylindrical form like a large worm : you would then have an animal like the one of which I speak. The rays would of course be stretched out also, and would extend from one end of the body to the other. This is the case with the Sea-Cucumber. It has no spines, being soft throughout ; but the suckers are arranged in rows along the body, alternating with spaces having no appendages, but corresponding to those on which the spines are arranged in Star-Fishes and Sea-Urchins. The mouth is at one end of the body, and is surrounded by a wreath of tentacles ; and the animal, resting on one side, moves along like the Star-Fish and the Sea-Urchin, by means of the suckers, always turning that end of the body at which the mouth is placed in the direction of its motion. Its body is, as I have said, soft throughout, and can contract and expand, making itself broader and shorter, or longer and narrower, by taking in or letting out the sea-water, which enters at the opening opposite the mouth, at the other end of the body. The main tubes for the circulation of food and water throughout the body, answering to those which in the Star-Fish run along the arms, and in the Sea-Urchins along the rows of suckers, extend in the Sea-Cucumber from one end of the body to the other, while the sieve through which the water is filtered is within the body instead of being on the outside, as in the two others. The animals of this kind found on our coast are very small. Larger kinds, however, abound in the Bay of Fundy and upon the mud-flats of the Reef of Florida. Some of those from Florida are as large as your arm, and more than a foot long.

This curious animal furnishes a very important arti-

cle of food to the Chinese. They call it the Trepang, and they send every year large fishing fleets to the islands in the Pacific, and to the coasts of New Holland, for the express purpose of collecting it. When dried and preserved in a particular way, they find it a great delicacy, though I doubt whether you or I would like it very much.

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As there is one general name, that of *Polyps*, including all animals of the kind which I first described, like the Sea-Anemone, and another, that of *Medusæ* or *Acalephs*, including all of the second kind, like the Jelly-Fishes, so there is also a general name for all animals like the Star-Fishes, Sea-Urchins, and Sea-Cucumbers, that of *Echinoderms*. Each of these, — the *Polyps*, the *Acalephs* or *Medusæ*, and the *Echinoderms*, — form what is called by naturalists a class, and these three classes are included under another name, that of *Radiates*. In other words, Radiates form one great division of animals, embracing Polyps, Acalephs or Medusæ, and Echinoderms. Now, if you look in your dictionary for the definition of the verb “to radiate,” you will find this: “To send out rays from a centre.” This explains the structure of all the animals belonging to this division, and the reason why they are called by this name. Whether they are round or long or star-shaped, they are all so constructed that their parts diverge from a centre; and at that centre is an opening, which is the mouth.

This is the end of my stories about Radiates, dear Lisa and Connie; and I hope you will forgive this little

bit of science and the hard names at the close. If the account of them has interested you, you will not find it difficult to keep many of these animals, about which we have been talking, alive in your Aquarium next summer, and to learn a great deal of their habits.



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