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HUNTERIAN LECTURES.

LECTURES

ON

COMPARATIVE ANATOMY,

DELIVERED AT THE

ROYAL COLLEGE OF SURGEONS,

IN 1843;

BY

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FROM NOTES TAKEN BY

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AND

REVISED BY PROFESSOR OWEN.

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and whether the *Trichina spiralis* may not belong to the same category. But how these embryos (if they be embryos) are diffused through the intermuscular cellular tissue, can only be known after long and laborious investigations: and nothing is more true than that a particular enquiry will be required for each particular species.

LECTURE VII.

POLYPI.

THE two great divisions of the sub-kingdom *Zoophyta,*—viz. the *Infusoria* and *Entozoa,* which have hitherto engaged our attention, approximate to the vermiform type; and each ascends by rapid steps to the confines of the articulate sub-kingdom. The remaining classes of the *Zoophyta* are constructed on the radiated type, and some of them, as the *Bryozoa* and *Acalephæ,* conduct to the molluscous series.

To-day I have to request your patient attention to the history of a race of animalcules as widely diffused, almost as numerous, and some of them hardly less minute than the *Infusoria,* with which we commenced the survey of the vermiform zoophytes. Our present subjects form at least three classes of radiated zoophytes, which have been grouped together under the common name of *Polypi,* on account of their external resemblance to the many-armed cuttle-fishes, which were so denominated by the ancient Greek naturalists. But the knowledge of the organised beings now called *Polypi,* as members of the Animal Kingdom, is of comparatively recent introduction: it cannot be dated further back than the time of Imperato * and Peyssonel.† Amongst those naturalists who have subsequently contributed to improve and extend the history of the Polypes, our countryman Ellis will always take a high rank.

A polype generally presents a cylindrical or ov l body, with an aperture at one of its extremities, which is surrounded by a coronet of long tentacula. In most of the class this aperture leads to a simple digestive cavity, consisting of a stomach without intestine: in the higher organised species, the digestive sac is prolonged into an intes-

* Historia Naturale, fol. 1599.

† Traité du Corail, Phil. Trans. 1756; communicated to the French Academy, 1727.

tinal canal, which is bent upon itself, and terminates by a distinct anus opening upon the external surface. The organisation of the polypes is in general very simple, and their faculties or vital phenomena seem feeble and inconspicuous. Nevertheless, the influence of their combined powers in modifying the crust of the earth, is neither slight nor of limited extent.

This great division of the radiated animals is divided into three groups or classes, according to the modifications of the alimentary canal. In the first and lowest organised class, which I have called *Hydrozoa* *, digestion is performed by the secretion of a simple sac, excavated in the gelatinous and granular parenchyme of the body. In the second class, called *Anthozoa*, the digestive sac, which, like the first, throws out the rejectamenta by the same aperture as that which receives the nutriment, is suspended by a series of vertical folds of membrane in a distinct abdominal cavity, to the outer parietes of the body. In the third and highest class, called *Bryozoa*, the alimentary canal, which is likewise suspended loosely in an abdominal cavity, is provided, as has been already stated, with a distinct mouth and anus.

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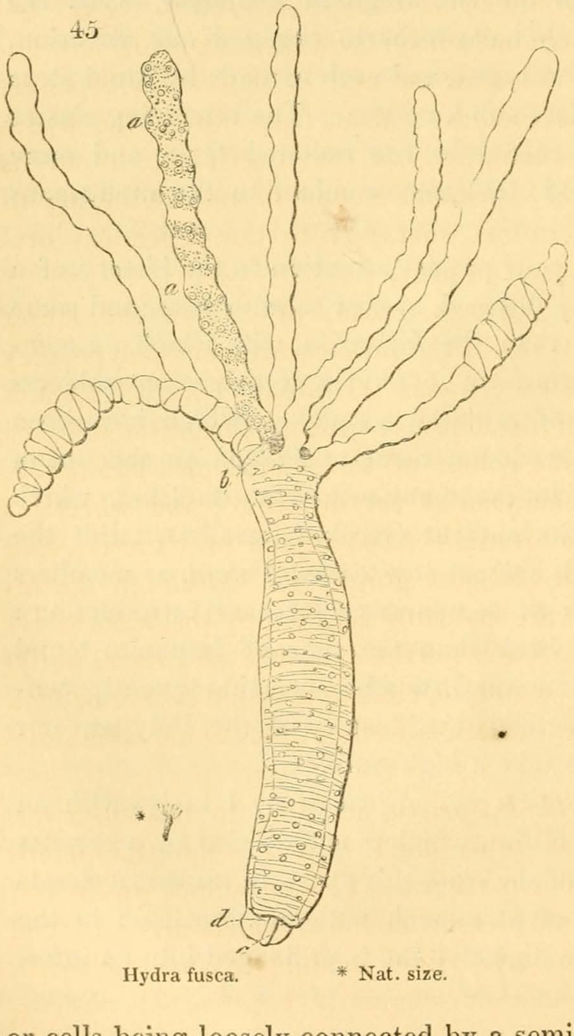

Hydra fusca. * Nat. size.

It is remarkable that the most locomotive of the Polype tribe, is at the same time the type of the lowest organised group. The *Hydra*, or common freshwater Polype (*fig.* 45.), consists, when magnified even with a moderately high power, apparently of a granular substance of a greenish or reddish hue, the granules or cells being loosely connected by a semifluid matter. The external

* *Dimorphæa* of Ehrenberg; *Sertulariens* of Milne Edwards; *Nudibrachiata* of Farre.

cells are condensed, and elongated in the axis of the body, so as to form two tegumentary layers: the internal cells are elongated transversely to the axis of the body, and form a stratum of villi, projecting into the abdominal cavity: the thick intermediate mass of nucleated cells seems to fulfil the ordinary functions of muscular or contractile tissue.

The hydra commonly adheres by a small prehensile disc or rudimentary foot (*fig.* 45. *d*), situated at the extremity of the stem or body opposite to the mouth. When the little animal would change its position it slowly bends its body, and, fixing one or more of its tentacula to the supporting surface, detaches the posterior sucker, approximates it to the head, and advances by a succession of these leech-like motions. The hydra can make progress in water, as well as on a solid plane; when it would swim it suspends itself to the surface of the water by its foot or terminal sucker, which it expands, and exposes to the air: the disc soon dries, and in this state, repelling the surrounding water, it serves as a float, from which the hydra hangs with its mouth downwards, and can row itself along by means of its tentacula. Its ordinary position is one of rest, adhering to an aquatic plant by its terminal sucker, with the dependent oral tentacula spread abroad in quest of prey.

Should a small Näis or Entomostracan, or any of the larger Infusories, come within the reach of the little carnivorous polype, they are immediately seized, pulled towards the mouth (*fig.* 45. *b*), and swallowed. The rapidity of the digestive process is manifested by the diffusion of any characteristic colour of the animalcules swallowed, through the gelatinous parenchyma of the devourer; and when this process is completed, the indigestible *débris* of the prey are rejected by the same aperture which had just gorged it. Although the indigestible parts of the food are palpably rejected by the mouth, yet a careful investigator, Corda*, affirms the existence of an anal outlet (*fig.* 45. *c*), and figures it of small size, close to the hind sucker or foot. It may give passage to certain excretions of the villous lining membrane of the alimentary cavity.

Each tentaculum in the *Hydra grisea*, acording to this observer, is a slender membranaceous tube, filled with a fluid albuminous substance mixed with oil-like particles. This substance swells out at certain definite places into denser nodules, which are arranged in a spiral line (*fig.* 45. *a*, *a*). Each nodule is furnished with an organ of touch, and another singularly constructed one for catching the prey. The organ of touch consists of a fine sac,

* Nova Acta Physico Medica, &c. Bonn, vol. xviii, 1836, tab. xvi.

inclosing another with thicker parietes, and within this there is a small cavity. From the point where the two sacs coalesce above, there projects a long spine, which is non-retractile. The seizing organ consists of an obovate transparent sac, immersed in the nodule with a small aperture. At the bottom of the sac, and within it, there is a solid corpuscule, which gives origin to a calcareous sharp sagitta or spine, that can be pushed out at pleasure, or withdrawn until its point is brought within the sac. When the hydra wishes to seize an animal, the sagittæ are protruded, by which means the surface of the tentacula are roughened, and the prey more easily retained: Corda believes that a poison is at the same time ejected. The nodules of the tentacula are connected together by means of four muscular bands, which run up, forming lozenge-shaped spaces by their intersections: these are joined together by transverse bands. There is no communication between the tube of the tentaculum and the cavity of the body. The lip of the mouth is armed with spines, similar to those of the tentacula; but the rest of the body is destitute of them.

That the tentacula have the power of communicating some benumbing shocks to the living animals which constitute the food of the Hydra, is evident from the effect produced, for example, upon an Entomostracan, which may have been touched, but not seized, by one of these organs. The little active crustacean is arrested in the midst of its rapid, darting motion, and sinks, apparently lifeless, for some distance; then slowly recovers itself, and resumes its ordinary movements. These and other active inhabitants of fresh waters, whose powers should be equivalent to rend asunder the delicate gelatinous arms of their low-organised captor, do, nevertheless, perish almost immediately after they have been seized, and so countenance the opinion of Corda of the secretion of a poison; unless, indeed, the little polype may have the power of communicating an electric shock.

The most extraordinary properties of the Hydra are, however, those which best accord, and might be expected to be associated, with its low and simple grade of organisation; although they excited the greatest astonishment in the physiological world when first announced by their discoverer, Trembley, and are often still called wonderful.

If a polype be transversely bisected, both halves survive; the cephalic one developing a terminal sucker, the caudal one shooting forth a crown of tentacula; each moiety thus acquiring the characters of the perfect individual. But in a healthy and well-fed *Hydra*, the same phenomena will take place if it be divided into ten pieces. The *Hydra*, notwithstanding the want of a nervous centre thus indicated, and the absence of any hitherto recognised nervous filaments, manifests an obvious predilection for light, and, when confined to a glass, always moves itself to the brightest side. Trembley succeeded in inverting one of these delicate animalcules, and the creature soon accommodated itself to this singular change in its condition: digestion being effected as actively by the surface which before was external, as by that which had been the digestive surface; whilst this as readily assumed the ordinary gemmiparous function of the skin.

The Hydræ are not less remarkable for their power of generation than for that of regenerating mutilated parts. They have been observed to multiply by spontaneous fission, dividing themselves transversely: but the most ordinary process of generation is by the development of young polypi, like buds, from the external surface of the old one. It is, however, most probable that in these cases the gemmation is preceded by the development and fecundation of the true ovum, beneath the integument. The Hydra unquestionably presents a periodical development of sexual organs of two kinds: one, at the anterior or oral extremity of the body consists of small nodules or sacs, which Ehrenberg discovered to contain moving filaments, or seminal animalcules: another series of cells, developed in the posterior part of the stem, contain ova, which, after impregnation, are discharged, but sometimes are retained, and then grow out like buds. Sometimes one individual Hydra developes only the male cysts, or sperm-vesicles; sometimes only the female ones, or ovisacs; but the rule is generally to have both kinds.

The seas which wash our own shores are tenanted by numerous forms of minute *Polypi*, having essentially the same simple organisation as the Hydra; but which are protected from the dense briny element surrounding them by an external horny integument. Now these likewise develope new polypes by gemmation; but, as the external crust grows with the growth of the soft digestive sac, the young polype adheres to the body of the parent, and, by successive gemmations, a compound animal is produced. Yet the pattern according to which the new polypes and branches of polypes are developed is fixed and determinate in each species; and there consequently results a particular form of the whole compound animal or individual by which the species can be readily recognised. This hydriform polype-animal, or association of polypes, resembles a miniature tree; but consists essentially of a ramified tube of irritable animal matter, defended by an external, flexible, and frequently jointed, horny skeleton; fed by the activity of the tentacula and by the digestive powers of the alimentary sacs of a hundred polypi, the common produce of which circulates through the tubular cavities for the benefit of the whole animal. These currents of the nutrient fluid have been observed and described by Cavolini, and more recently by Mr. Joseph Lister. The genera *Sertularia*, *Campanularia*, *Tubularia*, &c., which form the principal subjects of Ellis's beautiful and classical work on Corallines, compose the present division of the compound *Hydrozoa*, or hydriform polypes.

The peculiar external horny defence prevents, as I have just observed, the exercise of the gemmiparous faculty from effecting any other change than that of adding to the general size, and to the number of prehensile mouths and digestive sacs, of the individual coralline. It is equally a bar to propagation by spontaneous fission; so that the ordinary phenomena of generation by ova are more conspicuous in the composite than in the simple *Hydrozoa*. At certain points of these ramified polypes, which points are constant in, and characteristic of, each species, there are developed little elegant vase-shaped sacs, which are filled with ova, and are called the "ovigerous vesicles." These are sometimes appended to the branches, sometimes to the axillæ, of the ramified coralline: they are at first soft, and have a still softer lining membrane, which is thicker and more condensed at the bottom of the vesicle: it is at this part that the ova are developed, and for some time they are maintained in connection with the vital tissue of the polype by a kind of umbilical cord. The ova undergo a certain amount of development in this situation, and acquire a ciliated surface. By virtue of those primitive and universal organs of motion, the vibratile cilia, they detach themselves from the umbilical stem, and effect their escape from the cell. Having rowed to a convenient distance from the parent, the ciliated bulb subsides into an amorphous depressed mass, which shoots out its tissue in irregular rays upon the supporting body, to form the roots of attachment, and sends upwards a pyramidal process or stem, which, at a little distance, expands into a hydriform polype. The supporting stem continues to ascend, divides, and proceeds to develope other polype mouths, according to the prescribed pattern, and finally the ova and ovigerous sacs. In some species the ovigerous cell is provided with a distinct lid or operculum, which defends the ova from the sea-water in their tender stages of development; then drops off, and, allowing ingress to the water, occasions an increased activity in the ciliated gemmules. Sometimes a small polypus is developed from the mouth of the ovigerous cell, in which state they have been described by Lowen as the female polypes, the smaller and ordinary food-catching and digesting polypes being regarded as the males. In all the compound *Hydrozoa*, the ovigerous sacs are deciduous, and, having performed their functions in relation to the development of the new progeny, drop off like the seed-capsules of plants. This phenomenon afforded to the early botanists an additional argument in favour of the relation of these ramified and rooted animals to the Vegetable Kingdom.

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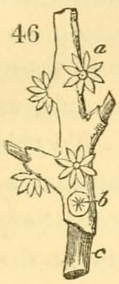

Corallium rubrum.

The *Anthozoa* (*fig.* 46.), or polypes of the second great class, characterised by a distinct abdominal cavity in which their simple digestive sac is suspended, constitute the most numerous and important part of the whole race, and include the largest individuals. They are principally the inhabitants of the warmer or tropical seas.

They are subdivided according to the number of their oral tentacula. Most of the species have only eight of these radiated prehensile organs: the rest have a greater number. To this latter group belong the soft-bodied and solitary species called Sea-Anemonies or *Actiniæ*, which are common upon our own coasts.

In the species here dissected, you will see that the skin is thick and opake: in the living Actinia, it is lubricated by a mucous secretion: the disposition of the muscular fibres by which it is acted upon, is indicated by the superficial striæ. In the middle of the circle of the tentacles is situated the mouth, from which a short œsophagus leads to a large gastric cavity, the parietes of which are connected by a great number of membranous vertical folds with the external wall of the body. The tentacula are tubular; they are perforated at their free extremity, and communicate with the interspaces of the mesogastric lamellæ. They absorb the sea-water into these spaces, and are elongated by the injection of that water into their interior. The extended surface of the abdominal cavity is beset with innumerable minute cilia, through the action of which it is bathed by a constant current of the admitted medium of respiration, the sea-water.

The ova are formed within the mesogastric folds: beneath the folds is situated an equal number of sacs or bodies composed of convoluted tubes which contain granules and spermatozoa, demonstrating the androgynous nature of the Actinia. The impregnated ova are developed into ciliated gemmules in the abdominal reservoir of sea-water: then make their way by the small inferior aperture of the stomach into that cavity, and escape by the mouth of the parent.

Many of the large actiniform polypes of the tropical seas combine with a structure which is essentially similar to our own sea-anemonies, an internal calcareous axis or skeleton, which, penetrating the interior of the mesogastric folds, presents the lamellated and radiated structure which we recognise in the enduring support of the large *Fungiæ* and in the polype cells of the skeletons of the *Caryophilleæ, Madreporæ,* &c.

The species of polypes which take the most important share in the fabrication of the coral islands and reefs, belong to the present group, and have esentially the organisation of the sea-anemony, which has just been described.

To the eight-armed division of the Anthozoic Polypes belong those species which have an internal ramified calcareous or jointed axis, as the red coral polype (*fig.* 46. *c*), the gorgonia, and the isis. To this division likewise belongs our common *Alcyonium,* or dead-man's-toes, in which the hard axis is wanting; and the phosphorescent Sea-pens, the *Veretillum,* and other *Pennatulidæ,* in which it is in detached pieces.

These are all examples of compound *Anthozoa,* differing from the compound hydriform polypes in having an internal instead of an external skeleton. The body of each polype (*fig.* 47.) is relatively longer than in the *Actiniæ;* the prehensile tentacles (*a, a*) are broad and pectinated: at the centre of their base is situated the mouth (*b*), which leads to a straight membranous alimentary cavity, fixed by vertical septa (*d, d*) to the external integument; which septa are continued down the general visceral cavity. The digestive canal communicates with this cavity by a small orifice (*e*) at its inferior part. Ovaria and tortuous filamentary secreting organs (*f*) analogous to the testes in the Actinia, are developed in the common visceral cavity. A delicate network of vessels conveys the nutrient fluid to the common connecting parenchyma of the entire compound animal.

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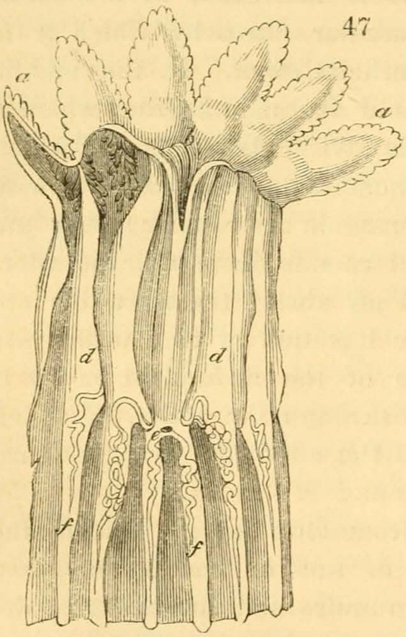


Polype of the red coral.

This parenchyma is strengthened in our common *Alcyonium* by numerous minute calcareous spiculæ. Analogous spiculæ, but of varying and characteristic forms, strengthen likewise the animal crust of the red corals, jointed corals, and Gorgoniæ; but to these is superadded the internal branched axis, which, according to its composition and structure, characterises the different genera of this group. In one genus, the external position of the skeleton which characterises the hydriform compound polypes is repeated, viz. in the *Tubipora* *musica;* but the organisation of the polypes, protected by the crimson pipes of this beautiful coral, is essentially the same as in the *Alcyonium, Gorgonia,* and *Pennatula.*

The most important productions of the apparently insignificant race of Polypi are the accumulations of the calcareous skeletons of the *Anthozoa,* which form the coral islands and reefs;—the dread of the navigator,—the admiration of the lover of the picturesque,—the subjects of the closest and most interesting speculation to the naturalist and geologist.

That masses of rock many leagues in extent should be founded in the depths of the ocean, and built up to the height of hundreds of feet by minute, frail, gelatinous animalcules, is indeed a phenomenon calculated to stagger the unversed in zoological science, and which has demanded the repeated observation of the most accomplished and enlightened voyagers to render intelligible.

These zoophytic productions have been recently classified by Mr. Darwin * under three heads: 'atolls,' 'barrier reefs,' and 'fringing reefs.' The term *Atoll* is the name given to the coral-islands, or lagoon-islands by their inhabitants in the Indian Ocean. An atoll consists of a wall or mound of coral rock (*fig.* 50. *r″, r″*), rising in the ocean from a considerable depth, and returning into itself so as to form a ring, with a lagoon, or sheet of still water (*fig.* 50. *n*) in the interior. The wall is generally breached in one or more places, and when the breach is deep enough to admit a ship, the atoll affords it a convenient and safe harbour. The outer side of the reef usually sinks to a depth of from two to three hundred fathoms, at an angle of forty-five degrees or more: the internal side shelves gradually towards the centre of the lagoon, forming a saucer-shaped cavity, the depth of which varies from one fathom to fifty. The summit of the exterior margin of the reef or wall is usually composed of living species of *Porites* and *Millepora.* The *Porites* form irregularly rounded masses of from four to eight feet broad, and of nearly equal thickness; other parts of the reef are composed of thick vertical plates of the *Millepora complanata* intersecting each other at various angles, and forming an exceedingly strong honey-combed mass. The dead parts of these calcareous skeletons are often cemented over with a layer of the marine vegetable called *Nullipora,* which can better bear exposure to the air.

This strong barrier is well fitted to receive the first shock of the heavy waves of the fathomless ocean without; and what at first appears surprising, instead of wearing away at its outer edge, it is here only that the solid reef increases. The coral animals thrive

* Structure and Distribution of Coral Reefs, 8vo. 1842.

best in the surf occasioned by the breakers. Through this agitation an ever-changing and aërated body of sea water washes over their surface, and their imperfect respiration is maintained at the highest state of activity. Abundant animalcules, and the like objects of food, are thus constantly brought within the sphere of the tentacula of the hungry polypes. Their reproductive gemmules are rapidly and extensively dispersed amongst the crevices of the calcareous mass.

By the force of unusual storms this outer reef is occasionally breached, and huge masses are torn off and driven towards the lagoon, where they form an inner barrier or reef. The broken surface becomes the seat of attachment of the young of the neighbouring corals, the successive generations of which, by the rapid growth and development of their calcareous skeleton, soon repair the damage of the storm. The masses of broken coral thus driven inward towards the lagoon, accumulate in time to the height of some feet above high water. These fragments are mixed with sand and shells, and form a favourable soil for the development and growth of vegetables, as cocoa palms, the large nuts of which may be borne hither by currents of the ocean, from Sumatra or Java, 600 miles distant. Turtles likewise float to the nascent island, browse on the sea weeds which grow in the lagoon, and breed there. Numerous species of fish and shell-fish flourish in the same still water, which abounds with animal life. Man comes at length and takes possession of the island; and the cocoa-nut, the turtle, and the fish afford him abundant and wholesome food. But you will ask how he supplies himself with that necessary of life fresh water? This is obtained in a very simple and unexpected manner from shallow wells, dug in the calcareous sand, which ebb and flow with the tides, yet are almost wholly free from the saline particles of the ocean. Some have supposed that the sea water lost its peculiar salts by infiltration through the calcareous mass. Mr. Darwin thinks that it is derived from the rain water, which, being specifically lighter than the salt, keeps floating on its surface, and is subject to the same movements: howsoever this may be, the fact is certain. A fit and convenient abode for the human species is fabricated by the action of the feeble, gelatinous polypes, and a wild and almost boundless waste of waters is enlivened by oäses which navigators have described as earthly paradises.

A Barrier Reef (*fig.* 49. *r′*, *r′*) is essentially similar to the Atoll or Coral-Island. It runs parallel with the shores of some larger island or continent; separated, however, from the land, by a broad and deep lagöon channel (*n*, *n*), and having the outer side as deep and steep as in the Lagoon Islands. Here likewise the skeletons of the Zoophytes, of which the reef is composed, are found on the outer precipitous wall as deep as sounding line can reach.

The third class of coral productions which Mr. Darwin terms "Fringing Reefs" (*fig.* 48. *r*, *r*), differ from the Barrier Reefs in having a comparatively small depth of water on the outer side, and a narrower and shallower lagöon channel between them and the main land.

These differences in the characters of the wonderful fabrications of the coral animalcules are explicable by the following facts in their physiology. The animals of the *Porites* and *Milleporæ* cannot exist at a greater depth than twenty or thirty fathoms; beyond this the stimuli of light and heat derived from the solar beams become too feeble to excite and maintain their vital powers. On the other hand, their tissues are so delicate, that a brief direct exposure to the sun's rays kills them; and unless they are constantly immersed in water or beaten by the surf, they cannot live. Thus, in whatever position the calcareous skeleton of a Madrepore or Millepore, may be found it is certain that it must have been developed within thirty fathoms of the surface of the ocean. If it coats the summit of the lofty mountains of Tahiti*, it must have been lifted above the sea by the elevation of the rock on which it was originally deposited. If it is brought up from the depth of 200 or 300 fathoms, as at Cardoo Atoll or Keeling Atoll, it must have been dragged down to that depth by a gradual subsidence of the foundation on which the living madrepore once flourished. It is by these movements of upheaval and subsidence of the earth's crust, that Mr. Darwin explains the different forms which characterise the extraordinary productions of the coral animal. The *Atolls* or Lagöon Islands, according to this author, rest on land which has subsided, and part of which was once dry. *Barrier reefs* indicate the islands or continents, which they encircle, to be the remains of land now partly submerged, and perhaps in progress towards final disappearance. *Fringing reefs*, on the contrary, indicate either that the shores are stationary, or that they are now rising, as in most of the Sandwich Islands, where former reefs have been raised many yards above the sea.

Elizabeth Island, which is eighty feet in height, is entirely composed of coral-rock. The coral animals, thus progressively lifted above their element, are compelled to carry on their operations more and more remote from the former theatres of their constructive energies, but cannot extend deeper than their allotted thirty fathoms: the direction of their submarine masonry is centrifugal

* Mr. Stutchbury here found a regular stratum of semifossil coral at 5000 and 7000 feet above the level of the sea.

and descending. Where the land that supports them is, on the contrary, in progress of submergence, they are compelled to build their edifices progressively higher and in a narrower circuit; in other words the direction of their growth is centripetal and ascending. The terms ascending and descending of course only here apply to the relation of the coral-builders to the land, not to the level of the unchanging sea.

The formation of an atoll by the upward growth of the corals during a gradual sinking of the land forming their supporting base is illustrated by these diagrams from Mr. Darwin's work.

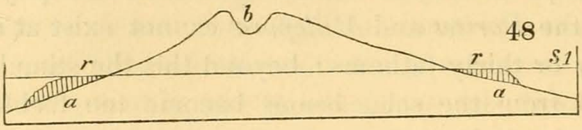
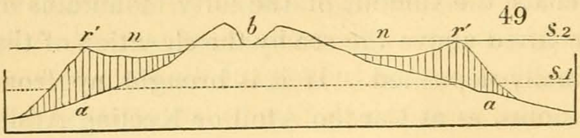
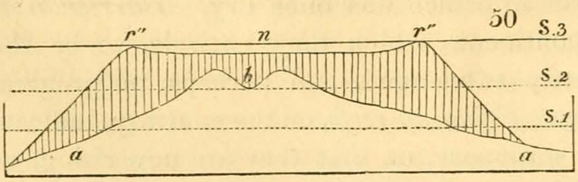


Figure 48. represents the section of an island (a, b), surrounded by a fringing reef, r, rising to the surface of the sea, s. 1. As the land sinks down, the living coral, bathed by the surf on the margin of the reef, builds upwards to regain the surface. But the island becomes lower and smaller, and the space between the edge of the reef, r, and the beach proportionately broader. A section of the reef and island, after a subsidence of several hundred feet, is given in figure 49.



The former living margin of the reef, r, is now dead coral, dragged down to depths at which the polypes cease to exist; but their progeny continue in active life at r', now the margin of a barrier-reef, separated by the lagoon channel n, from the remnant of the land b. Let the island go on subsiding, and the coral reef will continue growing up on its own foundation, whilst the water gains on the land, until the highest point is covered, and there remains a perfect atoll, of which figure 50. represents a vertical section.



In this diagram r'' is the living and growing outer margin of the encircling reef, and the lagoon channel is now converted into the calm central lake n, of the atoll. Thus by the process of subsidence the fringing reef (*fig.* 48.) is converted into the barrier reef (*fig.* 49.), and this into the atoll (*fig.* 50.).

If the movement of the land should now be reversed, and the level of the sea be again brought back by elevation of the island, to the line (s. 1, *fig.* 50.), an island apparently composed exclusively of coral rock, like Elizabeth Island, would be the result.

The prodigious extent of the combined and unintermitting labours of these little world-architects must be witnessed in order to be adequately conceived or realised. They have built up a barrier-reef along the shores of New Caledonia for a length of 400 miles, and another which runs along the north-east coast of Australia 1000 miles in length. To take a small example, a single atoll may be 50 miles in length by 20 in breadth; so that if the ledge of coral rock forming the ring were extended in one line it would be 120 miles in length. Assuming it to be a quarter of a mile in breadth, and 150 feet deep, here is a mound, compared with which the walls of Babylon, the great wall of China, or the pyramids of Egypt, are but children's toys; and built too amidst the waves of the ocean and in defiance of its storms, which sweep away the most solid works of man. The geologist, in contemplating these stupendous operations, appreciates the conditions and powers by which were deposited in ancient times, and under other atmospheric influences than now characterise our climate, those downs of chalk which give fertility to the south coast and many other parts of our native island. The remains of the corals in these masses, though similar in their general nature, are specifically distinct from the living Polypes which are now actively engaged in forming similar fertile deposits on the undulating and half submerged crust of the earth, washed by the Indian and Pacific Oceans. Again, those masses of limestone rocks which form a large part of the older secondary formations, give evidence, by their organic remains, that they are likewise due to the secretions of gelatinous polypes, the species of which perished before those that formed the cretaceous strata were created. As the polypes of the secondary epochs have been superseded by the *Porites*, *Milleporæ*, *Madreporæ*, and other genera of calcareous Anthozoa of the present day, so these, in all probability, are destined to give way in their turn to new forms of essentially analogous Zoophytes, to which, in time to come, the same great office will be assigned, to clothe with fertile lime-stone future rising continents.

LECTURE VIII.

BRYOZOA.*

If a deeper and truer insight into the structure and vital properties of the low-organised, ramified, composite, hydriform polypes, which,

* *Ciliobrachiata*, Farre.