RARE AND REMARKABLE ANIMALS

OF

SCOTLAND,

REPRESENTED FROM LIVING SUBJECTS:

WITH

PRACTICAL OBSERVATIONS ON THEIR NATURE.

BY

SIR JOHN GRAHAM DALYELL,
BARONET.

VOLUME SECOND.

CONTAINING

FIFTY-SIX COLOURED PLATES.

LONDON:
JOHN VAN VOORST, PATERNOSTER ROW.
MDCCCXLVIII.

EDINBURGH: PRINTED BY MACPHERSON & SYME, 12 S. ST DAVID STREET.

CONTENTS

OF

VOLUME SECOND.

FOLIACEOUS ZOOPHYTES.

INVESTING ASCIDIAN ZOOPHYTES.

MISCELLANEOUS ZOOPHYTES.

CALCAREOUS ZOOPHYTES.

LUNATE ASCIDIAN ZOOPHYTES.

ASCIDIA.

ASTEROIDAL ZOOPHYTES.

ACTINIA.

ERRATA.

Page 82 line 28, *for* Plate XXV. *read* Plate XXVI.
...... 211 .... 12, *for* fig. 4, *read* fig. 5.
Plate XXIV. *for* Lapralia *read* Lepralia.

RARE AND REMARKABLE ANIMALS.

CHAPTER I.

FOLIACEOUS ZOOPHYTES.

We have been chiefly occupied hitherto with animal products resembling flowers, or shrubs, or trees—with those participating of vegetable formation, while demonstrating the nature and the properties of animals. As the carnation is borne on its stalk, so does the living head crown the fistulous stem of the zoophyte: the hydra falls pendulous from its site, as roses droop from the twigs sustaining them,—thousands of active beings adorn the inorganic parts, rivalling the richest efflorescence which imparts luxuriance to plants.

But there is another great and numerous tribe of animal products, resembling foliage only; while distributed in like proportion, their tenants dwell in different combinations and arrangement.

Here, though associated in thousands, does each preserve its own peculiar place; living solely for itself, independent of the life, the death, and the circumstances of its nearest neighbour. Among the multitudes restricted to limited space, we discover no reciprocal bond or connection, nor any common channel of communication between them: neither any internal pith or medullary substance pervading the polyparium.

Nevertheless, as if by a fatality incident to the race, that single being which lays the foundation of an entire colony, is doomed to perish, that posterity may be reared beyond it.

Our observations, however, on such subjects, must of necessity be more imperfect than when directed to corresponding products. They are conducted with less facility than on the *Tubulariæ* and the *Sertulariæ*, bearing the kindred of simple hydræ. All the animals combined with the foliaceous genera, are of infinitely higher organization, thence, less tractable by experiment than those which stand lower in the scale.

Neither has any means been hitherto devised of distinguishing productions of this kind by general nomenclature, sufficiently characteristic of their properties, farther than comparison of their appearance to mosses, as generated by nature, or portions of matting interwoven by human art.

But, here are discovered the most curious textures, far transcending imitation: an order, an arrangement, a total configuration, which no sublunary faculties could attempt to execute. Their origin, their progress and perfection, all presented before us, are admirable to behold. Here are innumerable edifices, crowded in the closest approximation, while affording the most convenient accommodation in each for the tenant's abode.

We may draw a parallel between their utilities and those of our own works, for we too must be sheltered by dwellings. But such edifices as I shall try to describe, have been planned and constructed by a higher power than man.

Persons frequenting the sea-shore cannot fail to have remarked the whitish, brown, or yellow fragments, resembling the finest network of meshes, almost invisible, often strewing the beach after tempests. Therein is seen an agreeable series of numerous distinct specks, opening as so many orifices to cellular cavities within. All these fragments are portions of the foliaceous zoophytes, whose structure is better exposed from having lost their animated tenants and from decay, than when they grew in full vigour.

Fewer varieties occur, however, in this particular genus than in the *Sertularia*, at least in our northern climate. They are rarely to be obtained in a strong and healthy condition; and all seem liable to perish speedily when withdrawn from their native abode. Hence, in studying their history, they demand unremitting care. All this may result from the delicacy concomitant on the foliaceous structure of the product, for the leaf of some is as thin as paper. The higher organization of the animal may render it more susceptible of injury, or life itself, subsisting under such peculiar conditions, may be virtually of shorter duration. Liable to recurring embarrassments, therefore, a series of connected observations on the origin, the increment, permanence and decay of the *Flustra*, as the genus is denominated, together with the mode of perpetuation,—its perfect history scarcely comes within the scope of those opportunities which individual naturalists may hope to enjoy.

The earlier authors having failed to select the characteristics sufficiently prominent for distinguishing such products as should be comprehended within certain limits, circumscribing the genus *Flustra*, has allowed the gradual accumulation of a very miscellaneous assemblage.

I shall not adventure on any critical correction, but confine my remarks, in the first place, to those species which are strictly foliaceous, that is, composed of leaves penetrated by cells on one or on both surfaces, and occupied by living hydræ.

§ 1. Flustra carbasea—*The Lawn Sea Mat.*—Plates I. II.—This is a thin foliaceous product, which may be considered perhaps as only a single subdividing leaf, constituting the subordinate parts. It rises by a short flattened stem, diverging to both sides in somewhat dichotomous formation, not dissimilar to the cleaving of the *Sertulariæ*, formerly described. The portions of the leaf are separated by curvatures, not by angles, and the outlines of the whole edge are also larger or smaller curvatures throughout. But great irregularities prevail, among a number of specimens, in the partition and proportion of the parts. Its common form exhibits few divisions, or little subordinate organization. When the leaf is entire, the edge is deeply waved: and sometimes, though rarely, it consists of a long plain arc, instead of several different curvatures.

The finest specimens are towards three inches in height, and diverge about four and a half in breadth. They are generally founded on empty shells, likewise on some with living tenants.

In referring to specimens as the finest, I mean those selected from many occurring in the Scotish seas.—Plate I.

The leaf of this zoophyte is as thin as paper.—Plate II. fig. 1. One side only is composed of slipper-shaped cells, which are not all of equal dimensions, but presenting a remarkable and an agreeable arrangement to the eye. The opposite side or back of the leaf, exhibits convexities corresponding with the bottom of the cells, also arranged with considerable regularity, as circular arcs; but the peculiar order and form not being alike evident as in the cells of the surface. The shape of the cell itself may be compared to that of a violin, consisting of back, breast, and sides, with an internal vacuity. Its figure is best exposed when empty, or when the leaf is partly in decay. A short circular arc, level with the surface, shews the orifice of the cell near its broader end.—Plate II. fig. 4. An ascidian hydra, provided with about 22 tentacula, inhabits the cell, to the side or bottom of which it is affixed by a number of ligaments.

In younger specimens, where the leaf is clear and transparent, nor exceeding four or five lines in height, the short circular arc, near the broader end, distinctly marks the orifice, and the form and position of the animal are admirably displayed. While quiescent it is seen doubled on itself, like an intestine; if rising to the orifice of the cell, the tentacula are unfolded as the ribs of a cup of variable width and depth, according to their purpose, or the animal's sensations. Much vehement action follows. They clasp together in various forms; and exercise a lively percussive faculty; or the whole head strikes gently, as if against the water.—Fig. 5.

Now, the entire surface of the leaf seems animated from numbers and vivacious activity: but, during the highest vigour, and the obvious enjoyment of the hydræ in full display, amidst their element, a sudden collapse ensues, they vanish from our sight, and the leaf remains smooth and inanimate.

The safety of this product is obviously endangered by removal from its native site, even during the short interval of transmission to another, because the retention of more humidity is essential, than is admitted by

Flustra Carbasea

the plain and delicate texture of such a leaf. All the hydræ of zoophytes being revived by the freshness of the surrounding medium, as already seen, so are those of Flustræ most induced to protrude on a renovated supply. But here also do some continue so long in pertinacious retreat, either to cast the skin, or for some other purpose, that recent sea-water proves insufficient to rouse them from their dwellings; while on different occasions, what was so stale as ten days old has been effectual.

The best, the largest—likewise the most numerous specimens falling into my hands, have been obtained by means of those employed in the skate fisheries. The rest were always of inferior dimensions, and commonly impaired. But, although more abundant in particular places, fine, entire, and ample specimens are rare; and it was long before I could procure one of the quality of that which is represented in Plate I.

The structure of this product seems less adapted to resist the turbulence of the waves, from the dimensions and fragility of the parts; but Nature has provided a yellow marginal band, of different texture from the rest of the leaf, apparently to secure the stem, which is the part in greatest peril of rupture.

Perpetuation.—Prolific specimens occur at most seasons of the year, even in the depth of winter. They are found, likewise when the cells are occupied by vigorous hydræ. Then the leaf is studded with bright orange corpuscula in the empty cells, while others are tenanted by living hydræ, fig. 3. We know that in different zoophytes the parent hydra perishes, as the elements of its offspring advance to maturity: I cannot affirm that the same is concomitant on the propagation of the present subject, because it has not been actually witnessed.

During my earlier observations, a fragment of a shell bearing a specimen was detached, and for convenience, affixed with sealing-wax to a piece of polished carnelian as an artificial sole.

Having transferred it to a capacious vessel of recent sea-water, the protrusion of numerous hydræ at night, proved the healthly condition of the whole, which ought to be always the primary care of the naturalist in conducting his experiments.

On March 14. many yellow, solid, and consistent-looking spherules occupied the cells, one in each, and filling the greater part of its cavity. At the same time, animalcula of corresponding colour, dimensions, and general aspect, were observed swimming in a different vessel, with later specimens, while yellow spherules also remained in the cells, filling about half their capacity.

To the naked eye these moving beings were beautiful yellow globules, evidently of considerable specific gravity; they were conjectured to be about the fifteenth of a line in diameter, but of unequal size. Their motion was rather quick, and they remained chiefly near the bottom of the vessel, seldom ascending much in the water.

Under the microscope this creature singly, proved of great opacity, such as precluded any view of its internal organization. Externally, however, it clearly exhibited a circle of short cilia, instrumental for locomotion. The shape of some was variable, as confirmed by future observation, though its tendency in all is globular: and in some there appeared longer organs, indistinctly exposed from below, fig. 6. One remained stationary on a hair, where the moving cilia resembled the spokes of a revolving wheel; others free, described an orbit of various extent while revolving on their own axis; fig. 7.

Such was the general result of observations on March 15 and 19; I am induced to be so specific and minute in all concerning the propagation of zoophytes, from having found certain learned naturalists disposed, in conversation at least, to deny the animation both of similar corpuscula, and of the planulæ before described.

On the 20th of the same month seven or eight of these beings, so recently in activity, lay motionless at the bottom of the vessel; fig. 8; likewise six or seven yellow spots, the highest about three inches above the bottom, had formed on its transparent sides. From an enlarged view, the latter proved a bright yellow spherical segment as a nucleus, environed by a paler margin, irregular and broader at one end, approximating a slipper shape, or the form of a shuttle; fig. 9.

Further diffusion of the margin advances as the nucleus undergoes proportional diminution, and it becomes of a dark orange colour. At length an embryo hydra is obscurely visible below, with the originating tentacula directed towards the toe or point of the slipper, which are exposed either through the finest film above, or by an orifice; figs. 10, 11.

On March 31, six hydræ had originated from six yellow spots upon the side of the vessel. Had their element been renovated, they might have appeared earlier. But the period requisite for attaining maturity is not uniform or definite. Nature is modified in these lower animals, after a manner unknown in the higher.

A similar process, having advanced with the yellow spots seen at the bottom of the same vessel on March 20, they were subjected to the microscope on the 1st of April. Their hydræ had evidently sprung from that substance, whose residue appeared, as the diminished nucleus amidst a diffusing margin. One issued from this substance considerably aside of the nucleus, with about 20 tentacula, testifying lively activity, and a percussive faculty; besides closing frequently by reciprocal incurvature of the extremities, so that the whole head, usually campanulate, now became spherical.

The yellow nucleus had wholly disappeared in another day. One end of the diffusing margin was rising as a prominence, at the base of which lay the cell with its tenant, a yellow tinge distinguishing the body of the latter. The extremity of the body was affixed below, at a point farthest from the prominence.

These early observations, confirmed by some of subsequent date, indicated the young Flustræ as the progeny of the old. Yet to the inexperienced naturalist, had his observations terminated here, one noted peculiarity tended to subvert this conclusion, in the opposite arrangement of the parts. Every adult specimen rose vertically as usual with most zoophytes of unobstructed growth, and the side of the leaf was studded with cells whose hydræ protruded horizontally. Likewise the whole cells were high above the root, nor were any to be discovered either on the stem, or on its yellow margin. But among the young, the relative position and arrangement of the parts were altogether different. The nascent hydra issued vertically from a horizontal cell and orifice. Hence to identify the offspring with the parent, both conditions should have been reversed.

On April 3, a hydra was found in each of three original cells selected for observation; all of the palest grey, approaching transparence, and provided with 20 or 22 tentacula. The yellow nucleus was almost entirely dissipated, and from one end a thickish projection rose vertically, or somewhat inclining, as is the case, at various degrees; fig. 12.—Hydra *a*: cell *b*, *c*; prominence *b*; fig. 13. Such is always the aspect of the original Flustra under slight modifications; figs. 14, 15, 16, 17, 18, 19.

As the prominence advanced, a cell had formed on the inner surface, whence a second hydra, resembling its elder companion in parts and properties, protruded on the 9th of April. But their reciprocal position was at variance with the structure of the adult Flustra, for the second issuing at right angles to the first, overhung its fellow; fig. 20.

Many second hydræ were exhibited in like manner from second cells on April 11.—While the first or original cell gained no horizontal accessions, as might have been expected. But on the 13th, those of almost all the latter, that is, the original hydræ of the nascent Flustræ, were dead; the sole of twenty-four nascent specimens, all under observation in the same vessel, became soon after thin and transparent, the central nucleus gradually vanishing away; figs. 21, 22, 23, 24.

Nevertheless, the vertical prominence still advanced, and while the second hydra survived, a third was generated in a week, from a new cell formed above it. This third animal had come to maturity in about twelve or thirteen days after the evolution of the second, as the second had matured in nine days after the evolution of the first; fig. 25.—Some were vacant of both first and second.

This projection was recognised as the leaf of the Flustra. On April 23, several exhibited two hydræ, which, independently of the common tentacular action, exercised a general percussion to right and left. The habits of animals frequently prove a useful guide to the identity of species.

The upper edge of the leaf had advanced still higher on April 25; and on May 4, it was evidently broadening; a third cell, collateral with the second, had formed, which was the fourth in order of time, including the sole. The tallest specimen might be two lines high on May 17.

In eight days, many of the hydræ had perished, though the lowest on one or two specimens survived. But none protruded when replenishing the vessel on the 30th, nor did any obviously survive that period; nevertheless, the parts were still rigid and elastic even in the middle of July.—Now the nascent product resembled a flattened club to the naked eye; the upper part, from recent formation, white.

No alteration having ensued, further observations on the subjects of this course were abandoned in September.

But the preceding, together with subsequent observations, afforded many interesting facts. During the survivance of the hydræ of the older Flustræ, numerous yellow corpuscula appear in other cells, so numerous, that the specimen sometimes seems coloured by them. At the same time, those having attained earlier maturity, are discovered swimming below, generally near the bottom of the vessel, as if their specific gravity, bearing an unequal preponderance against the power of their natatory organs, restrained the facility of ascent. These corpuscula are soft, solid, and consistent, of variable form, tending to rotundity; some spherical, others a flattened spheroid, or a short, thick, obtuse pear. One may assume all different forms. The motion of the corpusculum is quick, without velocity, tumbling over in the water, ascending or descending, following a regular course, revolving on the axis, or describing an irregular orbit. The external organs are short, erect, flexible cilia, with perhaps some others casually displayed below in front. Motion of the corpusculum ceases in several days; but a yellow spot with a diffusing margin marks the place where it dies. This becoming a central nucleus, diminishes gradually, as a cell is formed for an originating hydra, in no respect resembling the animated corpusculum, but identified with the living hydræ of the Flustra whence the corpusculum had issued. Next a projection from one end of the cell rises as a germinating leaf, wherein the formation of a second cell is accompanied by the evolution of a second hydra. But, as if the existence of the first were only preparatory for that of the second, the decay of the one, follows the maturity of the other. Meanwhile, prolongation of the leaf promises a companion to the survivor; it broadens, and the symmetry of the product is preserved by the generation of other cells.

According to this process, the purpose of Nature is obvious; the original cell is necessarily horizontal to afford a secure foundation for the future colony, which is to people a vertical leaf.

The originating Flustræ, in various stages, are represented as they have appeared under slightly diversified form, the result of various experiments and observations.

In as nearly as could be ascertained, the corpuscula issuing from specimens, obtained on February 28, had become motionless, and adhering on March 20. The first nascent hydra from one had attained maturity March 31; the second on April 9; and the third on April 22. Therefore, nine, ten, or eleven days seemed to bring each to perfection.

But many irregularities will disturb the observer's conclusions. Sometimes a mature leaf, studded with corpuscula, produces them within twenty-four hours of being set aside, and the corpuscula may become motionless in a few days, when the fundamental hydra will appear more speedily than the preceding. Numerous orange corpuscula in the cells, apparently mature on November 19, issued forth, became motionless, and from the sole of some a hydra was displayed on January 22. Yet, even now, an interval of sixty-four days, none had been generated in the rising leaf, nor were these hydræ above two or three days old. But on February 4. two cells were on some of the rising leaves. Nevertheless, about eleven days, or from nine to eleven, seem to bring the hydræ successively to maturity.

It is very rarely, however, that the nascent Flustra survives to generate three hydræ. Perhaps it depends partly on the season; a genial temperature being more favourable for speedy evolution. Experiment is sometimes utterly abortive. The corpuscula or gemmules either do not attain sufficient strength and maturity to quit the leaf, or having done so, and become motionless, the originating product decays after some diffusion. Neither when the gemmule does germinate are two cotemporary hydræ to be often obtained.* In March 1839, being desirous of confirm-

* In compliance with modern fashion, I call these bodies gemmules, though, in the strictest sense, they do not come under the precise definition applicable to a gemmule or bud. They are more properly ova advanced to an embryonic or rather fœtal condition.

ing some preceding observations, I procured a number of prolific Flustræ, which afforded at least 150 nascent specimens from the orange corpuscula. The first hydra bred readily enough from the sole; but before evolution of one from the leaf it decayed. I could not obtain the two together. Many bred a single hydra from the leaf, but none bred two.

However, the true intent of Nature seems to be the foundation of the product by a horizontal cell, whatever may be the subsequent progress.

On contemplating the corpusculum itself, we cannot view it otherwise than as an organic body, endowed with vigorous animation; and void of any reference to the preceding history, the observer would denominate it an animalculum *sui generis*, though an indefinite character, and applied to that of which we must profess to know the least.

The origin of this embryonic corpusculum is in itself obscure: the whole nature of zoophytes is obscure; only scintillations of it are now beginning to elucidate the arrangements of Nature, and the advance of science. Certainly, to reason from analogy, it is generated within the body of the parent, but whether liberated, as in other zoophytes, by decay of that parent, I have not yet been able to ascertain.

The cells are forsaken by the corpuscula very irregularly, whether in respect to time or numbers; they do not quit them in succession, as if coming one after another to maturity. Sometimes they seem to be elicited from their site by exposure of the specimen to the light. Nothing farther has been understood of the duration of life and activity when they are free, than that it has not exceeded five days.

The death of the corpusculum does not necessarily generate the nascent Flustra, but the origin of the latter certainly depends on that event.

From so copious a detail, the mode whereby the race is perpetuated will be easily understood. The originating product is secured by the fundamental cell, and the rising leaf is at length strengthened by a marginal band. Spite of its reinforcement, however, this adult appears very often mutilated on recovery from the deep.

The figure of a perfect specimen, young or old, is a leaf enlarging upwards, with a circular edge. Every young specimen consists of only a single leaf, fig. 26. This leaf sometimes subdivides in an early stage, fig. 26, *a*. Sometimes it attains large dimensions, fig. 1. Here an entire specimen consisted of only three large leaves, originating from the stem. If adults have advanced so far that subdivision ensues, a corresponding form always results by enlargement of the parts with a curving edge. The sole and overhanging cell being single, the next cells above the latter are two, situated vertically; every higher row augments in number, and thus the leaf broadens. But the exterior circular edge seems always generating new cells with hydræ. Herein the young may be discovered in various immature stages. They are contracted, and perhaps invested by an integument. In those farther advanced the tentacula are so disposed as to be compressed in a narrow ellipse, where the tips of the row may be enumerated with tolerable accuracy. Those hydræ higher in position, or furthest from the root, seem the least mature.

The newer parts of a leaf, always with a curving edge, are distinguished by a clean, clear, transparent aspect, greatly differing from that of the older portion, fig. 2. Sometimes recent foliaceous accessions are seen united either to the entire, or to the mutilated edge of older formations, or with those in decay. The uniting boundary, which belongs to the recent part, consists of an indefinite number of cells, but they continue augmenting upwards after such a manner, that the new and generating product always tends by their aggregate to present the ordinary symmetrical conformation of a leaf enlarging; and the edge is circular. Three recent accessions of this kind, all with living tenants, sprung from the margin of an old leaf, the smallest consisting of about ten cells, the next with about twenty, and the third with more. This mode of increment advances conspicuously in all the foliaceous Flustræ. It is not so evident in the *Flustra truncata* from the lighter colour, as when the darker hue of the *Flustra foliacea* is contrasted with the newer portion.

The precise medium of union between the leaf, thus renovating, and the old portion, is not obvious; and it is still more difficult to comprehend how new cells and hydræ are generated beyond the apparent decaying line, intercepting their communication with the original portion of the leaf. I know not that any intermediate pith or medullary matter, like that so

Flustra Carbasea

conspicuous in the Tubularia, and what is less obvious in the Sertularia, has been hitherto discovered, whereby the simple enlargement of entire specimens may be explained.

Neither is the formation of the strong yellow marginal band of the yellow stem explicit. It is not ascertained to be generated through the medium of new cells, whence we should infer that it originates from some deposit of the old.

Under all these circumstances, however, though no connection or communication between the cells of the Flustra be discovered, there is a strong presumption of some imperceptible channel or medium traversing the leaf, whereby portions with new hydræ are generated from the older parts.

Still it is difficult to explain the fact. More protracted observations, under favourable circumstances, might afford a solution of these and other questions, at present very obscure.

PLATE I. *Flustra Carbasea.*

PLATE II. *Flustra Carbasea.*

FIG. 1. Leaf of a specimen.
2. Portion of a leaf.
3. Portion of a leaf with cells and hydræ.
4. Hydra quiescent in its cell.
5. Hydra displayed—front.
6. Corpuscula, free.
7. Corpuscula free, more enlarged.
8. Spots from the corpuscula become stationary.
9. Spot with a nucleus and diffusing margin.
10 Hydra originating from the nucleus.
11. The same more enlarged, shewing the position of the tentacula.
12. Nascent Flustra.
13. Another.
14–19. Nascent Flustræ.
20. Nascent Flustra, having generated a second hydra.
21–23. Nascent Flustra preserving the second hydra, after the first had decayed.

PLATE II.—*Flustra Carbasea.*

FIG. 24. Nascent Flustra wherein both hydræ had decayed.

25. Nascent Flustra having generated a third hydra while the second subsisted.

26. Young Flustræ become foliaceous.

All the figures except the first and last are enlarged.

§ 2. FLUSTRA FOLIACEA.—PLATES III., IV.—The leading features of the preceding paragraph, as illustrating the general history and character of this tribe of zoophytes, may be kept in remembrance along with further prosecution of the subject, by a few observations on another species.

The *Flustra foliacea* rises above five inches high, by a flat, narrow stem, and diverges to a still greater extent in breadth by subdivisions, all in the same plane, and tending to dichotomous arrangement of the parts. This pecular formation is satisfactorily demonstrated by their extremities, the whole of which are bounded by curvatures. Like the former, the *Flustra foliacea* may be compared to a single large leaf, partitioned into an indefinite number of subdivisions. It is somewhat thicker than writing paper.—Plate III.

Instead of a large and conspicuous specimen, rising singly from any substance whereon it is founded, numerous smaller specimens sometimes occur, within very circumscribed limits, which transient observation might ascribe to a common stem, while each is a separate and independent product. The *Flustra foliacea* generally grows erect and free, but, perhaps from accidental adhesion, a portion occasionally spreads over the same subjacent substance, whereon a specimen is rooted ; various nascent Flustræ then springing vertically out of that spreading surface. Here the cells consist of long and irregular hexagons, and are much better defined than those of the leaves.

Unlike the structure of the *Flustra carbasea* and *Murrayana*, both sides of the *foliacea* are wholly composed of cells, which, in general, bear some resemblance to a longitudinal section near the middle of a pear. At the wider end, two short obtuse white spines stand on the opposite edges of the margin, not exceeding an eighth part of its width. They are perceptible only when the object is thrown into the shade; and in certain positions I have thought other two could be indistinctly seen.—Plate IV. figs. 2, 3, 13.

Ascidian hydræ, which are whitish to the eye, issue from the cells, unfolding about 14 or 16 tentacula. Towards one side of the body, the returning tube of the excretory canal, which terminates under the tentacula, becomes very conspicuous. No farther peculiarities distinguish them, farther than their complex organization, besides the quick and lively action of all their race.—Plate IV. fig. 1.

The edges of the stem are somewhat more compact than the middle, but no distinct marginal reinforcement, like the yellow band so strong in the *Flustra carbasea*, guards it from injury.

The whole product is of wood-brown colour, darker towards the root, and lighter towards the extremities. It is generally founded on old shells, generating there most luxuriantly; and it occurs in vast profusion, greater perhaps, than any of our other northern zoophytes. In their meagre vocabulary of marine nomenclature, the Scotish fishermen denominate it *sea-caff*.—Whether to be interpreted chaff, or something *waste* and *worthless*, I know not. No other name than *sea-weeds*, *flowers*, or simply *growth*, is applied by them to the numerous tribe of zoophytes.

Ferruginous patches of various intensity overspread the leaves of some of the *Flustra foliacea* at certain seasons of the year. These are shewn by the microscope to be derived from large spherical corpuscula occupying the cells, as in the *Flustra carbasea*. Only one belongs to each.—Fig. 3.

In order to determine the precise nature of such patches, I consigned a fine specimen thus profusely stained with some of large extent, to a capacious vessel half full of sea-water, and next day shut it up in the dark.

Resuming inspection ten days afterwards, the specimen was found as it had been left; the water limpid, the subject in its place, every thing in *statu quo*.

However, I transferred the latter to another vessel, which was completely replenished, and now exposed immediately to the light.

In three hours, at least ten thousand yellow spherules had here quitted their cells, and were traversing the element at large. Many remained below and on the sides of the vessel; but many had ascended, forming a belt around much of its internal circumference. By far the greater proportion, almost the whole, demonstrated an evident propensity to seek the light, by the influence of which they had been undoubtedly stimulated to forsake their original abode so speedily. The motion of the water having carried up thousands to the curve formed by it with the side of the vessel, whereon they were in danger of being left to dry, I swept them off with a feather, to which they adhered by a tenacious glairy matter, until sinking it, they gradually liberated themselves and swam away.—Figs. 4, 5, 6.

In six hours this vast legion having descended to the bottom, rendered it yellow by their multitude; not one was to be discovered above, though many were moving to and fro below.

That the period when the corpuscula or gemmules should become motionless might be correctly ascertained, I removed the Flustra. Next day all had concentrated in a reddish coloured belt at the bottom of the vessel. Some were in motion forty-eight hours from removal of the specimen; absolute quiescence prevailed in seventy-two, the colour of the accumulated multitude being then very vivid. But the water was vitiated by so much animal matter in such limited space, which rendered farther observation abortive.

While remaining imbedded in the cells, the corpuscula are grey, brownish, or of reddish orange colour—the last their most common and permanent hue. They seem to require a considerable time for maturity; also their abode, for some time at least, is spontaneous; because it is improbable that above ten thousand such beings should have all attained perfection so as to admit their issuing forth as suddenly as above narrated; likewise they continue escaping during entire weeks, which seems decisive of the fact.

Part of a leaf subjected to the microscope exposed a single large corpusculum in each of many cells as usual.—Fig. 3. Several abandoned their site during inspection, and pursuing a regular course over the surface until free of it, swam away amidst the water.

Here their motions, in all possible variety, have appeared more

[illegible]

diversified, compared with the spherules of the preceding species,—ascending or descending, avoiding obstacles, or passing around them, diverging in wide excursions from a certain point, and the like. They haunt particular spots and objects. Something like a hair has proved very attractive, engaging several for a long time, as they come successively in contact with it. But the light is especially courted. When many have left their cells, in a darkened position, they are found to have congregated chiefly towards one side more illuminated, and, on turning this side in an opposite direction, they find their way again to the light. On treating the preceding great multitude thus, the like ensued; the whole returned to their position next the light. In these courses their motion is partly gyratory, partly progressive, much resembling that of the *Hydrachnæ* in certain respects, and of the *Animalcula infusoria;* or they tumble as misshapen masses in the element.

Their peculiar motions are affected, no doubt, by their peculiar figure. Considerable uniformity predominates among the planulæ of many Sertulariæ; but the animals before us are distinguished by great irregularity of conformation. Though spherical, or somewhat flattened, to the naked eye, and void of other external organs, they present a number of cilia in rapid action as a constant feature under the microscope.

It would be vain to attempt precise description of such beings, from the want of definite objects as the type of comparison; and to assume any one as the standard, it would be a fallacious emblem of the rest.

When moderately enlarged, no discrepancy of shape is sensible, fig. 4; but it becomes evident on encreasing the magnifying power; fig. 5. Nor can any thing be more singular and conspicuous than the variety exposed under great amplification. Then, amidst a group of corpuscula, some are nearly spherical, some irregular ovoids, some as if contracted in the middle; one resembles the union of several, another as if environed by prominences, and a third has shewn a projection identically like a person's thumb. Also there is a considerable difference in the intensity of colour.—Fig. 6.

The body of these corpuscula is certainly soft and variable. But however irregular the exterior outline, the whole is begirt by cilia. Either the same, or some particular organs, which could never be brought distinctly under observation, seem, as in others, to be below. When free their course is quick, perhaps not less than from ten to twelve feet in a minute. Sometimes on reaching the surface of the water, they accumulate there in stationary groups, as if incapable of descent, like the smaller *Crustacea*, and various other subjects. Though endowed with considerable vigour, perhaps their natatory organs fall into such a position, or so large a portion is dry, that their mechanical influence on the water is unavailing or lost. Then the corpuscula project partly above the surface. By a lens they appear smooth and shining; and when taken between the fingers the cluster feels soft, and is crushed without any sensible resistance.—Fig. 4.

After two or three days or more have elapsed, the motion of this corpusculum, which I cannot hesitate to conclude an animated being, relaxes; it becomes stationary, and adheres to the vessel below. Next ensues the prolongation of one part, rather pointed at first, fig. 7, but afterwards becoming obtuse, fig. 8. There are two prominences seen beside the prolongation, fig. 9, which are gradually moulding into form as the central yellow nucleus is refining; fig. 10. In seven or eight days from the deposition of an adult specimen of the product, the nascent Flustra, after the preceding modifications, has become a single hydra, together with three originating leaves, of which that in the middle advances more speedily than its fellows. The young animal is light grey, vivacious, provided with ten or twelve percussive tentacula. Its neck and body are of considerable length, but the darkness of the cell precludes observation of the interior: fig. 11. Still farther diffusion of the cellular portion ensues, but I have been unable to preserve the nascent specimens long enough to follow its progress.—Fig. 12.

When floating groups are brought before the microscope, prolongation of the extremity is discovered in some of the corpuscula; which shews that the germinating principle is not entirely dependent on adhesion below. But being now repressed by an unfavourable position, it ceases to advance.

Increment of the leaf proceeds by the cells advancing beyond the the margin.—Fig. 13.

Flustra Foliacea.

There is another product which, if not to be identified with the preceding, may be a variety. Besides having fewer subordinate parts, the only difference I have hitherto observed, consists in the greater breadth of the leaf in proportion to its height. Specimens are rare—one rose an inch and a half. It was broad above, like that represented by *Ellis*, Plate xxix. fig. 2.

PLATE III.—*Flustra foliacea.*

PLATE IV. FIG. 1. Hydræ protruding from opposite sides of the leaf.
2. Cells.
3. Ferruginous patch on a leaf.
4. Group of corpuscula swimming at the surface of the water.
5. Group of corpuscula more enlarged.
6. Corpuscula of various configuration magnified.
7. Corpuscula stationary, with an originating prolongation.
8. Corpusculum stationary; prolongation advancing.
9. Nascent Flustra with originating leaves.
10. Nascent Flustra farther advanced.
11. Nascent Flustra with a young hydra.
12. Nascent Flustra advanced still farther, the original hydra having decayed.
13. Margin of a leaf.
All the figures of this Plate are enlarged.

§ 3. FLUSTRA TRUNCATA.—PLATES V., VI.—In as far as I have seen, the subject of this paragraph is the most luxuriant of the genus Flustra occurring in the Scotish seas. Its resemblance is so great to vegetable foliage, that, from this alone, a cursory observer would incline to remove it from the animal kingdom. But the myriads of sensitive, vivacious, active creatures united to the inorganic parts, determine its true position.

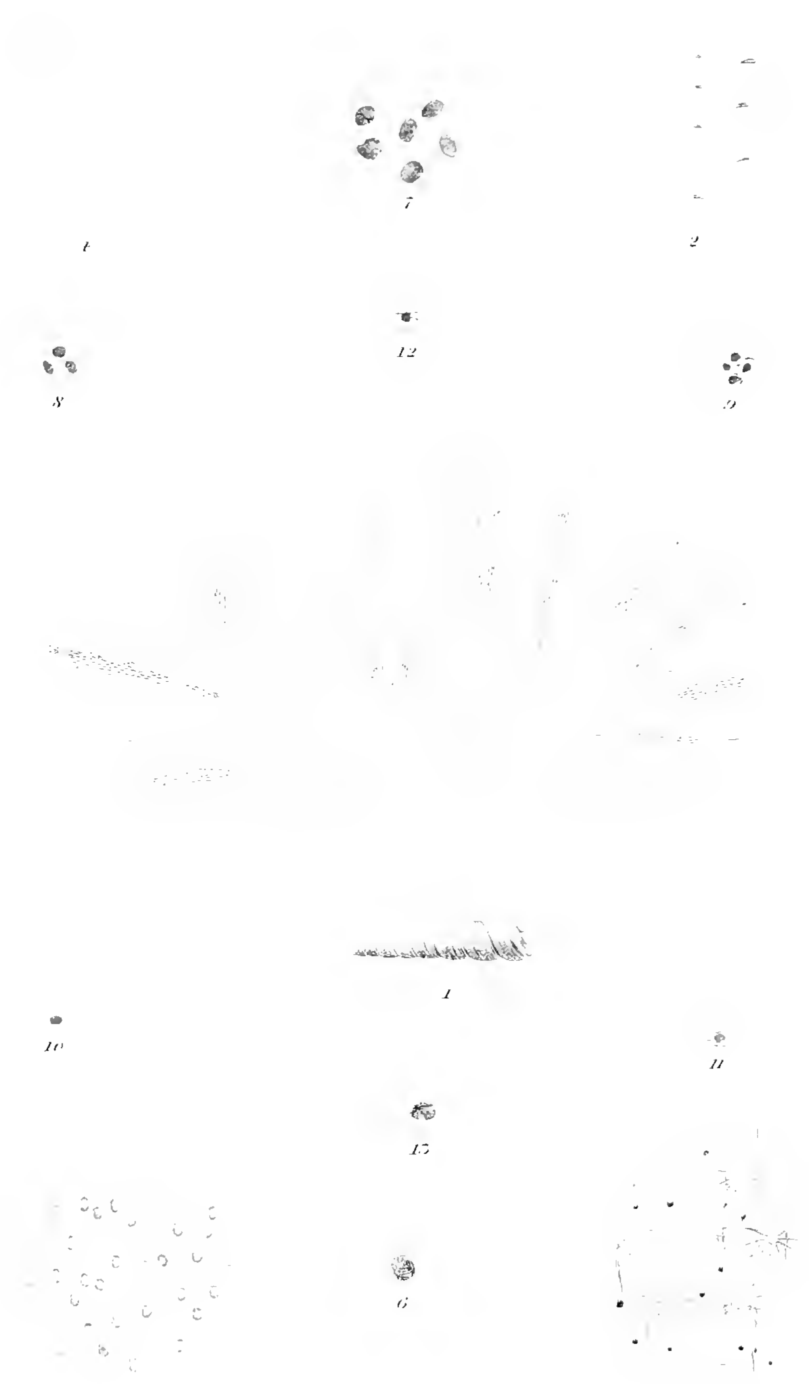
The *Flustra truncata* rises erect to the height of five inches, by a short, narrow, flattened stem, and diverges five or six inches by subordinate leaves and leaflets. According to dimensions, age, and place, it appears under considerable diversity of aspect. Smaller specimens exhibit the formation most satisfactorily; Plate V. fig. 1. Though all on analysis resolve into the same elementary character, this is not so clearly displayed by luxuriant specimens; Plate VI. Except at the extremity of the leaves, the dichotomous formation of the species is not evident. The leaves of many specimens are of a triangular form, especially when in early stages, as mere leaflets. They broaden as they rise. The whole specimen seems composed of a number of leaves; thence it is much richer than either the *carbasea* or *foliacea*. A specimen three inches and a half high, and occupying a vessel of about as much in diameter, had 140 extremities of leaves, these parts being conspicuous, while the remainder of many are concealed amidst the luxuriance. The leaf is long and narrow, some of them bearing five or six leaflets on one side, and several on the other. Therefore the preceding extremities were those of the leaves, to which in time would be added those of the leaflets. Large and luxuriant specimens have above 200 extremities. The outer edge is elliptical or hatched-shaped.

A faint yellow marginal band, much less evident than in the *Flustra carbasea*, borders the stem.

Spacious long cells, penetrating each side of the leaf, are occupied by ascidian hydræ, with twelve or fourteen tentacula. These animals are of light grey colour, much resembling the tenants of the preceding species. Their nature is lively, and they protrude the body as an inverted cone, to display their complement of tentacular organs; Plate V. fig. 2. The cells are so indistinctly separated in recent specimens, that the leaf seems traversed only with irregular waving longitudinal lines. But the hydra displaying itself from one side, or issuing from both, shews how much space it occupies.—Figs. 3, 4.

A specimen, wherein the whole were supposed to be dead, was put aside in a large vessel, and remained without renewal of the sea-water during three weeks. Yet, on replenishment with a supply of the element in a recent state, numbers protruded from their retreat. These animals were minute. In general their tentacula were twelve, some had more.

The leaves of prolific specimens are studded with numerous corpus-



Flustra truncata?

cula or gemmules, of a fine orange colour, occupying the cells. They appear at different seasons of the year, January, February, March, September, October, one in each; fig. 6. An irregular broad coloured belt, extending across the leaf, is frequently formed by them; and they are sometimes in such profusion, that a whole leaf, or even an entire specimen. appears orange from their multitude. On one occasion, a number of specimens of the Flustra occurred in September, chiefly of yellow straw colour, which is the more common hue. But among them some had an orange tinge, which was derived from the thousands of deep orange gemmules occupying the cells.

These gemmules have an intimate resemblance to those already described in the present section. They are discharged from the cells as begirt by cilia, Plate V., fig. 6; but under corresponding irregularity of shape and motions, fig. 7. When their activity ceases, and they are about to become motionless, they seem to have a disposition for clustering together, which renders the assemblage rather confused for inspection, nor can solitary adhering individuals be readily found; figs. 8, 9.—As a yellow nucleus forms in the centre of the stationary gemmule, one extremity extends as a peak, fig. 10:—which, in rising vertically, forms the originating leaf.—Fig. 11.

About twelve days subsequent to its escaping from the cell, the gemmule develops a Flustra with eight or ten tentacula, fig. 12; whose position and proportions are exposed sufficiently in the enlarged representation.—Fig. 13.

The date of production of the corpusculum or gemmule, the progress of evolution, and permanence of the original hydra, founding the future specimen, seem partly dependent on adventitious circumstances.

I have not found observations on these facts, attended with equal facility as in the preceding two species.

PLATE V. FIG. 1. *Flustra truncata.*
2. Hydræ protruded from the opposite sides of a leaf.
3. Portion of the surface of a leaf with hydræ.
4. Cells, as bounded in the leaf.
5. Portion of a leaf with gemmules in the cells.

Plate V. *Flustra truncata.*

Fig. 6. Ciliated gemmule or corpusculum free.
7. Group of gemmules of variable form.
8. Cluster of three become stationary.
9. Cluster of four become stationary.
10. Stationary gemmule, extending with a peak.
11. The same farther advanced by the leaf rising at one end.
12. The same farther advanced by developement of a hydra.
13. Nascent hydra in its cell, forming the foundation of a specimen.
All the figures, except fig. 1, are enlarged.

Plate VI. *Flustra truncata*—luxuriant specimen.

§ 4. Flustra papyracea?—Plate VII.—Had it not been for the correct representation of a beautiful subject, I should have omitted this species, because I find nothing sufficiently illustrative to offer along with it. Besides, when obtained, it received very transient notice, owing to various circumstances.

The specimen which reached me in October was four inches high, and expanded six inches. It rose by a stem, not unlike that of the *Flustra truncata*; but the whole product was of very different appearance. The proportions were much larger, the leaves less numerous, and the extremities, in particular, infinitely fewer than belonging to a specimen of the *truncata* half the size. Both sides of the leaf were of fine, soft, silky, or lawn-like aspect; both occupied by hydræ, and some parts by ova or gemmules. The colour of the whole product was a little darker than wine-yellow.

No other specimen having ever occurred, I can only conjecture its position among the Flustræ.

Plate VII. *Flustra papyracea?*

The reader will find much interesting matter regarding the preceding Flustræ, in the observations of Dr Grant, the learned Professor of Com-

Justic. [illegible]

parative Anatomy in the University College, London. These are inserted in the third volume of the Philosophical Journal, New Series.

§ 5. Flustra Murrayana?—Plate VIII.—Though entertaining some doubts of the identity of my specimens, with the species thus named by Dr Johnston, I deem it expedient rather to prefer his denomination in the meantime, to shun the inconvenience always resulting from innovation.

But, the precise position of this zoophyte appears to be questionable. Perhaps it should stand nearer to the ramified *aricularian* Flustræ, while approximating the foliaceous tribe. It rather seems to be a link between them, as will be seen on viewing its different parts and properties.

When specimens were first obtained, which was a number of years ago, I proposed to distinguish the species as *infundibulum*, or the *Funnel flustra*, from the evident tendency of the product to this form in its recent living state.

By comparing the various figures presented here, with what has been offered by the preceding learned naturalist, the correspondence or the difference may be perhaps discovered. Observers may reach the same point, without following the identical track pursued by each other.

The subject before us rises an inch and a half in height, generally by a short flattened stem, and expands two inches in breadth. The usual formation of the most perfect specimens is dichotomous, more decidedly seen in the subdivision and shape of the parts; the summit of the leaves being cleft, and bounded by a straight edge. Plate VIII. figs. 1, 2, 3, 4. represent entire specimens after Nature.

By a peculiar kind of elastic incurvature, the general figure of the whole subject bears some resemblance to a funnel, so that the longitudinal section of a portion would correspond with a similar section of a hollow cone.—Fig 5.

The foliaceous structure, the figure, proportion, and arrangement of the parts, are best exposed from a limb, spread out and extended by compression between two watch-glasses, a position rather difficult to be satisfactorily effected, from the elasticity of the incurving edges.—Fig. 6.

Only one side—the inner surface of the leaf—is cellular, wherein this product approximates the *Flustra carbasea*.—Fig. 7.

But the position of the cells is indistinct in front.—Fig. 8. They are rather better defined behind, shewing them to be disposed collaterally, in so many rows, across the leaf. The number of rows is determined by the breadth of the leaf: I have not observed more than seven.

Although the entire leaf consists of several parallel rows, a new cell from the extremity sometimes prolongs its own individual row, while the row on each edge affords no such extension by generation. Thence the edge of the extremity is no longer even, but irregular. One of three rows, issuing from the centre, its fellows on each side remaining stationary, impairs the natural uniformity.

An active, lively ascidian hydra, with fourteen tentacula, dwells here, whose rise and fall distinctly expose the body through the thin sides of the cell.—Figs. 7, 9, 10.

I was long disappointed of a satisfactory result, from all the expedients adopted for discovering the mode whereby this species of Flustra was perpetuated, and what might be the aspect of the nascent animal. This is invariably one most essential subject for illustration, in pursuing the history of zoophytes, and, comparatively, seldom elucidated to the satisfaction of the naturalist.

Three specimens, obtained on September 24, were consigned to suitable vessels. Minute white corpuscula were swimming among the water in one of them, two days afterwards, and many more on the 3d of October. When the vessel was emptied, a number of small, white, distorted objects remained adhering to the side, just as high as the place which the water had reached, therefore close to its surface. I conjectured them to be originating Flustræ, as ultimately proved the fact. The vessel was, therefore, replenished.

It had been remarked of the planulæ of the *hydraoid* zoophytes, first, that they manifested a disposition to seek the light; and next, that an

Flustra

earlier brood would affix to the side of the vessel, immediately under the surface of the water, and that, on farther replenishment, any second or later brood, attaining maturity, would be found affixed in a higher position than that which had preceded it.

A series of experiments on the propagation of the present species was attended with a similar result. The corpuscula preferred the lighter side of the vessel, and the later brood became affixed above that which was produced previously.

No remarkable peculiarities distinguish these gemmules or corpuscula. A curving prolongation, apparently for securing the foundation, extends one of the extremities after their adhesion, fig. 11; and from the opposite part rises an originating leaf, wherein the hydra is generated, figs. 12, 13, which may succeed in eight days from the liberation of the gemmule.

Now it is discovered that the cell has an oval orifice, and that it is guarded by five spines. But they did not appear in all which had been bred from gemmules: also their number is variable, and their presence uncertain in the adult. The nascent hydra has about twelve tentacula.

The young product appears forking from the same root, as with two hydræ, probably from two approximated corpuscula adhering to the surface of the vessel.—Fig. 12.

A second nascent hydra originates on the same side of the leaf, higher than the spot where the first has decayed.—Fig. 13.

A number of filaments, affixing themselves, shot forth from the extremity of two specimens that had been severed from the stem, which must be rather considered analogous to the spinous vegetation so often generated from zoophytes, than as natural roots designed for security.

Many avicularia, such as above described, are seen on this product, which may possibly affect its precise position among the Flustræ. Some remained active during nearly three weeks.

This species is usually founded on solid substances. The lower part of fig. 2. had been rooted near a sponge, now advancing beyond it.

Fine specimens, or indeed specimens of any quality, are uncommon.

The following conclusions result from the preceding observations:—

I. The foliaceous Flustræ rising erect are penetrated by cells on one or on both sides of the leaf, according to species.

II. The genus is propagated by a ciliated gemmule, generated in the cell, which is discharged at various seasons, to demonstrate the utmost activity amidst the water.

III. The motion of the gemmule relaxes after some days; it becomes stationary, and forms a fundamental cell, from which a hydra, the first of a new colony, is generated.

IV. The original cell of the *Flustra carbasea*, with its hydra, is horizontal; but a vertical leaf rises at one end wherein the second cell with its hydra is formed, overhanging the first.

V. The leaves of mature Flustræ are enlarged by a border of successive rows of cells containing young hydræ.

PLATE VIII. FIG. 1. *Flustra Murrayana.*
2. Another specimen.
3. Another specimen.
4. Another specimen.
5. Longitudinal section, shewing the arrangement of the parts.
6. Portion compressed between two watch-glasses.
7. Hydræ on the front of a leaf: avicularia on the side of the cells.
8. Back of the leaf.
9. Hydra from the end of a leaf.
10. Hydra.
11. Gemmules stationary.
12. Nascent Flustræ.
13. Nascent Flustra, having lost the first hydra, generated from the leaf.

All the preceding figures, except 1, 2, 3, 4, are enlarged.

Flustra Murrayana

CHAPTER II.

INVESTING ASCIDIAN ZOOPHYTES.

If the various classifications proposed by authors be exposed to animadversion, it is from the insufficiency of the characters adopted. None are so definite and exclusive as to prove the permanent foundation of many of the different sections.

Naturalists may prefer some of various features, by the combination of more than one, as their predominant guide. They may select the form and the substance of the polyparium, the figure or position of the cell, the genus of the hydra by which it is occupied, or the mode of perpetuation. Each of these may be assumed at will, according to their importance in the view of observers. All are prominent features.

But they are not such as to exclude others, which the learned will deem alike important in detail, or perhaps paramount to the rest. Hence do different and sometimes very incongruous arrangements ensue, which may be of difficult or equivocal correction, until common consent shall interpose an authority for the characters to be chosen.

Some of the zoophytes are so intimately connected, by corresponding organization, that their kindred is undisputed. Simple inspection decides the question, but protracted study makes us waver. The hydra of the fresh waters, and the *Hydra tuba* of the sea seem in the nearest alliance from aspect and habits. But patient investigation proves their ultimate nature, separated by an insurmountable chasm. The Sertularia, the Virgularia, and the Medusa, all perpetuate their race through the medium of a planula. No products can have less reciprocal resemblance than the respective parents. The preceding Flustræ are allied by their foliaceous formation, by leaves of cellular structure, and in originating from a ciliated gemmule. But we discover no analogy between them and the Actinia perpetuating its race by a ciliated gemmule also. The *Flustra hispida* spreads in adhesion, the *Alcyonium gelatinosum* rises erect. They have no common resemblance. But both originate from ciliated gemmules, which becoming stationary are converted to cells; and additional cells form in union with the first. The Botryllus, a compound ascidia, discharges the spinula, a minute active animalculum, like a tadpole, which becoming stationary, adheres to a foreign substance, and metamorphoses to an Ascidia, from which others originate, as with the Alcyonium.

Which of all the preceding features ought to be selected as the foundation of the character? It would perplex even those deeply versed in natural history to be satisfied with a choice.

Thus our arrangements must always remain of uncertain permanence, at least until the subject be infinitely better understood; and our business ought meantime to be assuming those predominant appearances which shall preclude any difficulty of recognition.

§ 1. Flustra hispida.—Plate IX.—The introduction of this species here, is more from the difficulty of finding a proper place for its reception, than from conviction of having assigned it the true position in the natural scale of zoophytes. Indeed, were it not for assuming a certain provisional latitude, much inconvenience might result from prematurely endeavouring to bring certain subjects within the sphere of a precise definition. Thus, let us now take but a general view of an ascidian hydra, combined with a peculiar gelatinous substance.

The properties of individual products determine their place.

The *Fucus serratus*, or sea-ware, so common on our rocky shores, is frequently invested by dark brownish gelatinous-like consistent patches on one or both sides of the leaf, also occasionally encircling the stem. These are sometimes in such profusion that the leaf is weighed down, or if reft from its site it feals heavy in the hand.

The numerous inequalities of the surface, both to the naked eye and when viewed by a magnifier, bear some resemblance to artificial manufacture, whence it has perhaps been called the *Rough Sea-mat.* But it is said that the naturalist must beware of confounding this product of our own coast with another zoophyte, passing by the same name, which belongs to the Mediterranean Sea, and does not correspond in form.

If the *Flustra hispida* of Scotland be plunged amidst recent sea water, during genial temperature of the atmosphere, a thin pale blue cloud will be speedily interposed between its dark irregular surface and the spectator's eye. Let the vessel receiving it sustain a shock; the cloud is instantaneously dispelled, while the brownish fleshy substance remains prominent as before.

This illusion may be frequently repeated. The semblance of a cloud arose from a multitude of hydræ elicited from the cells, whither they had retreated, now returning to enjoy the freshness of the renovated element. Their numerous pale tentacula in motion over the darker ground produced a misty shade.

These minute and active beings are so timid, yet at the same time endowed with such caution, that they sink in concealment from apprehended danger, and then show by their return when they are relieved of alarm. Plate IX. fig. 1.; specimen : 2. the same enlarged

From the consistent brownish, gelatinous or fleshy aspect of this product, some naturalists, with considerable plausibility, call it *carnosa.* It is united in firm adhesion to the leaf, whereon the outline adopts various forms, regular or irregular. Viewed by a lens, the surface exhibits numerous projections, indicating the position of cells inhabited by as many hydræ. Each is beset by five spines, but no distinct and satisfactory inspection is practicable, unless the object be brought into a very particular position.—Figs. 3, 4.

The rough, dark surface of the Flustra remains undisturbed until the summit of the cell projects, to announce the approaching evolution of the hydra. First, a very short white cylinder protrudes, and then the integument of the body, unfolding like the inverted finger of a glove, displays the exterior of the animal, crowned by about 35 tentacula, in campanulate arrangement, as if with a reflected lip, formed by their extremities. None of the marine ascidian hydræ have shewn me a complement alike numerous. This animal is likewise among the larger species, being about a line and a half in height, and the tentacula composing its bell expanding nearly as much. Its form is elegant, light, and beautiful. It rises very leisurely and gradually from the cell; but its retreat is most precipitate, vanishing in a moment; and thus is the cloud composed of multitudes dissipated from before the observer.—Fig. 5.

This is a vivacious animal, as evidenced by the tentacular movements and action. Sometimes their extremities close over the mouth in the centre, while the circumference of the lower portion enlarges like the swelling of an orange; and their curvatures may be then compared to fingers, endeavouring to seize or to confine substances contained in the grasping hand. Buoyant particles are tosssed about among the cilia of the tentacula, and those of considerable size absorbed by the mouth in the centre. They are visible passing downwards, on deglutition, until obscured below.

Removal from darkness induces the protrusion of the hydra to the light. When perishing by impurity of the water, it drops from its site, with the organs expanded.

The natural position of leaves of the *Fucus serratus*, invested by the *Flustra hispida*, is chiefly pendent, whereby its increment remains less disturbed than on those inclined or horizontal. Its earlier formation is circular, or in elliptical patches: and on advancing, free of obstruction, it is always with a curving margin. This margin is thin and transparent, within which the hydræ in retreat are seen disposed with considerable regularity, like so many short lines directed from the interior towards the circumference.

The higher margin of pendent specimens seems of lighter colour, being possibly newer. The older parts are of very dark olive. As the Flustra, in the progress of increment, reaches the edge of the leaf of the fucus invested, and projects slightly over, it becomes somewhat more transparent.

I have always found the largest, most vigorous and luxuriant specimens abound at low water-mark, of a muddy shore. Some are seen considerably higher; but proportionally deteriorated, as remote from the sea.

Here is a ready example of how much the luxuriance of such products depends on their situation.

Perpetuation.—The quality of this subject, so unlike the elementary combination of other zoophytes, and of the Flustræ in particular, induced me to search very earnestly after the mode whereby the species is perpetuated. I conjectured that some analogies might be recognised between it and the *Cristatella*, or rather the *Alcyonella* of the fresh-waters, from the obvious parallel of various features in their history,—I sought in vain —numerous seasons elapsed, all unsatisfactorily,—and here is one noted instance where the profusion of specimens proved of no avail.

But the hydræ are of difficult preservation. Constant renewal of the agitated waves, appears to be an indispensable lotion, otherwise a thin mouldy film covers the surface of the Flustra, and the hydræ drop from their cells.

Hence may be discovered the purpose of Nature in placing the abode of this zoophyte within the flux and the reflux of the tide.

The reader accustomed to observations on points of obscurity, will find no exaggerations here.

Having selected several vigorous specimens, in the end of May, and committed them to suitable vessels, I soon discovered an *animalculum* there, quite different from any that had been previously observed amidst all the varieties seen, either in fresh or in salt water. From its external aspect, I was inclined to class it with some of the more uncommon *Infusoria*. Others, in sufficient number, were produced in June, which is the principal period of their maturity.

This creature, the gemmule of the *Flustra hispida*, is pure white, elliptical, thin, and fringed by a border of active cilia,—all which renders it a beautiful object under the microscope. It traverses the water readily everywhere, ascending, descending, and following various courses: and some perform a kind of revolution, as if on an axis, towards the front.—Fig. 8.

In a few days this gemmule remains stationary, and becomes affixed to the spot whereon it has rested; and in a few more a hydra is generated.

displaying itself from a short tubular orifice at one extremity.—Figs. 9, 10. Next, a wing is formed, by addition to the side, which is the source of a new cell; fig. 11: and wherein a second hydra originates. This having attained maturity, is displayed along with its elder companion, issuing from the orifice of the first.—Fig. 13.

The cell continues still so transparent as to expose the form of the nascent animal completely within,—an advantage never to be derived from the darkness and opacity of the adult. Here the extremity of the body below is free. About twelve ligaments, a little above the extremity, connect the body of the hydra with the bottom of the cell. Thence does the rise and fall of the tenant admit of an easy explanation, from their gradual relaxation and sudden contraction.

At this early stage also, internal pulsation, or the semblance of a peristaltic action below, is sensible, and substances seem vehemently and quickly tossed about in the stomach.

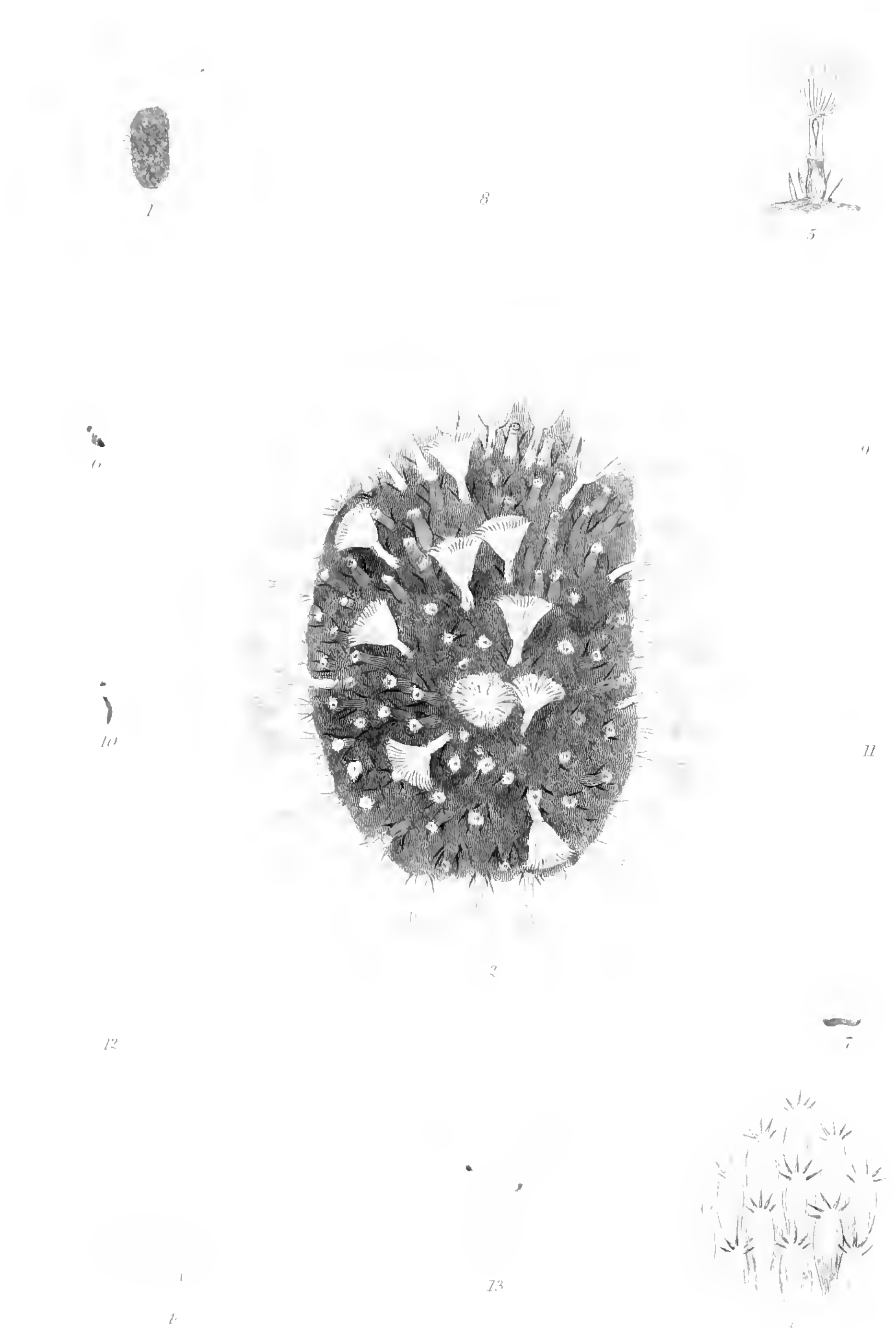
There is no regularity in the number of tentacula generated from the nascent hydra. They range between 18 and 24.

I was disappointed of ascertaining the precise period occupied by metamorphoses. Gemmules observed on May 26, had become stationary on the third day following, and on the sixth, a hydra was displayed from the cell then generated. Until the end of June, hydræ were produced from spots. These, after having come of stationary gemmules, have somewhat of a shelly aspect.

The young hydræ are extremely minute. By microscopic power, magnifying the object sixty diameters, the cilia bordering the tentacula of fig. 13, were not rendered visible.

Dr Johnston proposes to denominate this species *carnosa*, which would distinguish its substance, instead of the present name *hispida*, derived from the surface. This substance is certainly very peculiar. I know of none among the zoophytes to be compared to it. When cut asunder, it proves a thick, gelatinous, ropy, brown matter, which draws out after the knife.

The liability of specimens to mould is a great embarrassment to con-



Flustra Hispida

tinued observation. Perhaps it might be averted by dashing recent water over them very frequently, whereby the wonted tendency would be checked, and at length the moulding prevented.

PLATE IX. FIG. 1. *Flustra hispida.*
2. The same, enlarged.
3. Slice of the surface of a specimen, shewing the spines.
4. A different view of a group of cells.
5. Hydra.
6. Hydra quitting and falling from the cell.
7. Hydra having fallen from the cell.
8. Elliptical ciliated gemmule.
9. Cell and hydra from the gemmule.
10. The same, farther advanced.
11. Nascent Flustra, with a second cell originating.
12. The same, still farther advanced, by the development of a second hydra.
13. The same, in maturity.

All the figures of this Plate, except the first, are enlarged.

§ 2. ALCYONIDIUM PARASITICUM.—PLATE X.—This, like the former, is an investing zoophyte, but the difference between them is such, that they ought certainly to stand much farther asunder. I am unacquainted, however, with the intermediate species, if there are any, which should be interposed. Whether there is a chain of connecting links, binding all animated nature in close alliance, I cannot affirm. There is great reason to conclude, that the different tribes of animals which have inhabited the world since the creation, are not separated by extraordinary intervals. We behold some nearly approximated, and we know that there are numbers whose race is at this day extinct. The kindred of animals will be best ascertained, from the long and patient study of a profusion of species, and of specimens in vigorous life.

The present section being devoted to *investing ascidian zoophytes* in general, may be perhaps accounted a sufficient reason for introducing the

Alcyonidium parasiticum here—premising that by the generic *Alcyonidium*, is merely to be understood a product related to the *Alcyonium*.

Dr Fleming proposes that the present species shall be annexed, provisionally, to the genus *Alcyonium* of modern authors. Dr Johnston seems to doubt whether that is its particular place.

I shall not presume to dissent so far from these two accomplished naturalists, as to infringe on the name recognized by them. But it appears to me, that the difficulties attending the position of the product, originate in the nature of the polyparium, and the fashion of its growth. 1. The Alcyonium, at least any falling under my observation, is not an investing or spreading zoophyte. 2. It always rises independently, in an erect or vertical direction, or in some cases, the same is inverted; and it has a tendency to subordinate ramification. 3. The polyparium is of a consistent, subgelatinous matter. 4. The suceeding generation overwhelms that preceding it.

On the other hand, the *Alcyonidium parasiticum* is truly what its name expresses. It never grows erect from its own foundation; it is always an investing zoophyte, as the bark covers the wood beneath; or it may form a thin stratum over some portion of an old shell, a fact whereof I cannot speak as decisively as I could desire.

In its perfect state, the Alcyonidium is to external appearance, a meagre shrub, growing vertically, all the parts irregularly cylindrical, with obtuse extremities: The whole of spongy aspect, and dark hair-brown colour.

By this, the inexperienced observer may be completely deluded, for he has nothing before him but a stratum of parasite matter, investing some other substance by a thin covering. It follows the whole lines and curvings of the surface, and at length reaching the extremities, it extends about a line beyond them. But now, the investing complete, it bears the narrowest resemblance to an erect, or other independent production of vegetable formation.—Plate X., figs. 1, 2.

A long time seems to be occupied by its growth, which is very gradual, portions of the substance invested, a coralline, for example, fig. 1. remaining free at the extremity.

The progress is rather by ascent where investing zoophytes; and the stratum scarcely exceeds the thickness of a line, where prolonged over the extremity. But in highest perfection, a very vigorous specimen may exhibit some short obtuse branches from each side of the portion apparently extended beyond the substance invested. Then the surface seems cellular. the cells tending to a circular figure, and the interior porous.

The cell is inhabited by a small pale grey ascidian hydra, with about 15 tentacula, as enumerated in several individuals. The body is extremely flexible, protruding far, and curving over the dark brown stratum with much vivacious action when displayed. In retreat, it leaves the site of its cell denoted by a papilla.

This animal is probably of delicate nature. Though of frequent occurrence, it is not often alive. Multitudes drop from their cells, as the purity of the water becomes impaired.

On one occasion, several weeks after those of an entire colony had perished; others, which I was induced to consider their successors, issued from the polyparium.

Among the zoophytes, there are several whose hydræ drop readily from the cells. Perhaps this is from greater delicacy, rendering them susceptible of injury by the impure element; and, farther, the ligaments binding the ascidian species to the interior of their cells, may be also more easily ruptured.

Another Alcyonidium, of a greyish colour, likewise invests corallines. in a thin stratum. Possibly the substance of the coralline may affect the hue of the zoophyte: or the colour may be partly dependent on the age or the density of the stratum. The hydræ of both appear to be in absolute correspondence; of the two, the dark brown, sometimes almost black, is the more common.

Whether there be distinctions constituted, by papillæ covering the surface of this zoophyte, or by its consisting wholly of depressions; and whether the latter be accidental, merits investigation. Likewise, some attention should be devoted to a substance much resembling, if not identified with the dark *Alcyonidium parasiticum* investing shells.

Plate X. Fig. 1. *Alcyonidium parasiticum* investing the *Sertularia falcata*. The extremity of the latter still free.

2. Portion of another specimen.
3. Part of an extremity of the same, enlarged.
4. Extremity of another specimen.
5. Hydra of the same, enlarged.
6. Specimen, dingy white, investing a slender twig.
7. The same, enlarged.
8. Yellowish-brown specimen investing the *Flustra carbasea*.
9. Higher edge of the same, with hydræ, enlarged.

§ 3. Alcyonidium mytili.—*Mussel Alcyonidium.*—Plate XI.—The precise position of this product is far from obvious, and it is placed here provisionally, for I entertain little doubt of its removal to one more appropriate. If the Flustra were denominated as a superficies of cells containing an ascidian hydra, the product might be allied to it, for the polyparium resembles a woven texture. Possibly it may prove a transition species to the *Flustra membranacea*, or an approach to the *Lepralia*. But being unable to identify it with any of these, its position is qualified as provisional.

I have scarcely seen this zoophyte under any aspect, or anywhere, otherwise than as a thin patch, of indefinite figure and dimensions, investing the surface of shells, and chiefly those of the mussel.

It appears as a small spot, or spreads over a superficial area of various extent, until equalling two or three inches, according to the specimen. The diffusing edge is always curvilinear, the patch of dingy white, and seldom thicker than writing paper.—Plate XI. figs. 1, 2, 3, 4.

The upper surface is soft, wholly composed of numerous cells, apparently with an elliptical orifice ; and the lower or deeper part polyangular ; figs. 5, 6. However, the exact form of the adult is not to be easily discovered ; and, in general, the real figure of the cell seemed to me to be hexagonal.

During retreat of the hydræ, the surface of a specimen is covered by obtuse prominences, corresponding to those of various other zoophytes occupied by ascidian tenants.

Alcyonidium Coralloideum

These animals are of the ordinary form, provided with about 15 tentacula, whereof the cilia may be discovered by a magnifying power exceeding twenty diameters. The colour of the body is dark grey, but too opaque to allow distinct inspection of the interior. Yet in an early stage, and while the product is generating by diffusion in its native place, the whole is so transparent, that, unless from the hydræ, its presence can be scarcely detected. Without manifesting any peculiarities, they are vivacious and active.—Figs. 7, 8.

On detaching a spot of this Alcyonidium from its site, the under surface proves to be speckled with so many solid corpuscula-like darkish grains, tending to spherical shape, and of irregular size; fig. 9. Each of many compartments is occupied by one or two.—Fig. 6.

Propagation.—Among the modes of perpetuation incident to zoophytes, two may be contrasted, one the formation of a new organic being, which separates from the parent stock, to enjoy an independent existence, and to found a family of its own. The other is by formation also of a new being, which, instead of separating, remains in evolution, to augment the number of living inmates, and to enlarge the dimensions of the parent stock. It is by the preceding mode that a new colony among the Flustra is founded, and by the latter, that mature specimens rivetted permanently to their original site are extended.

A small specimen of the *Alcyonidium mytili* was detached from a mussel shell, which came off pretty clean, about the 2d of November. On the 13th, portions were diffusing from two different parts of the circumference, the smaller consisted of three new cells, disposed in a row, the larger consisted of three rows of cells, the innermost comprising twelve.

This latter portion, somewhat augmented next day, was delineated, fig. 10, along with several of the hydræ, then displayed from the edges of the older part of the spot, fig. 7. Now, the new cells, very distinct, seemed to be pentagons, and almost all contained a dark coloured nucleus.—Fig. 10.

On November 19, the generating margin of the spot or patch, fig. 3, consisted of four rows of cells, fig. 11, when the nucleus, previously observed, was clearly an embryonic hydra. Most of the cells, those of the interior row excepted, were occupied by one, the body of which appeared a solid globular substance, with the tentacula as an irregular appendage directed inwards to the old part of the specimen; fig. 12. It will be recollected that in other ascidian zoophytes, the tentacula of orginating animals have been observed as directed inwards.

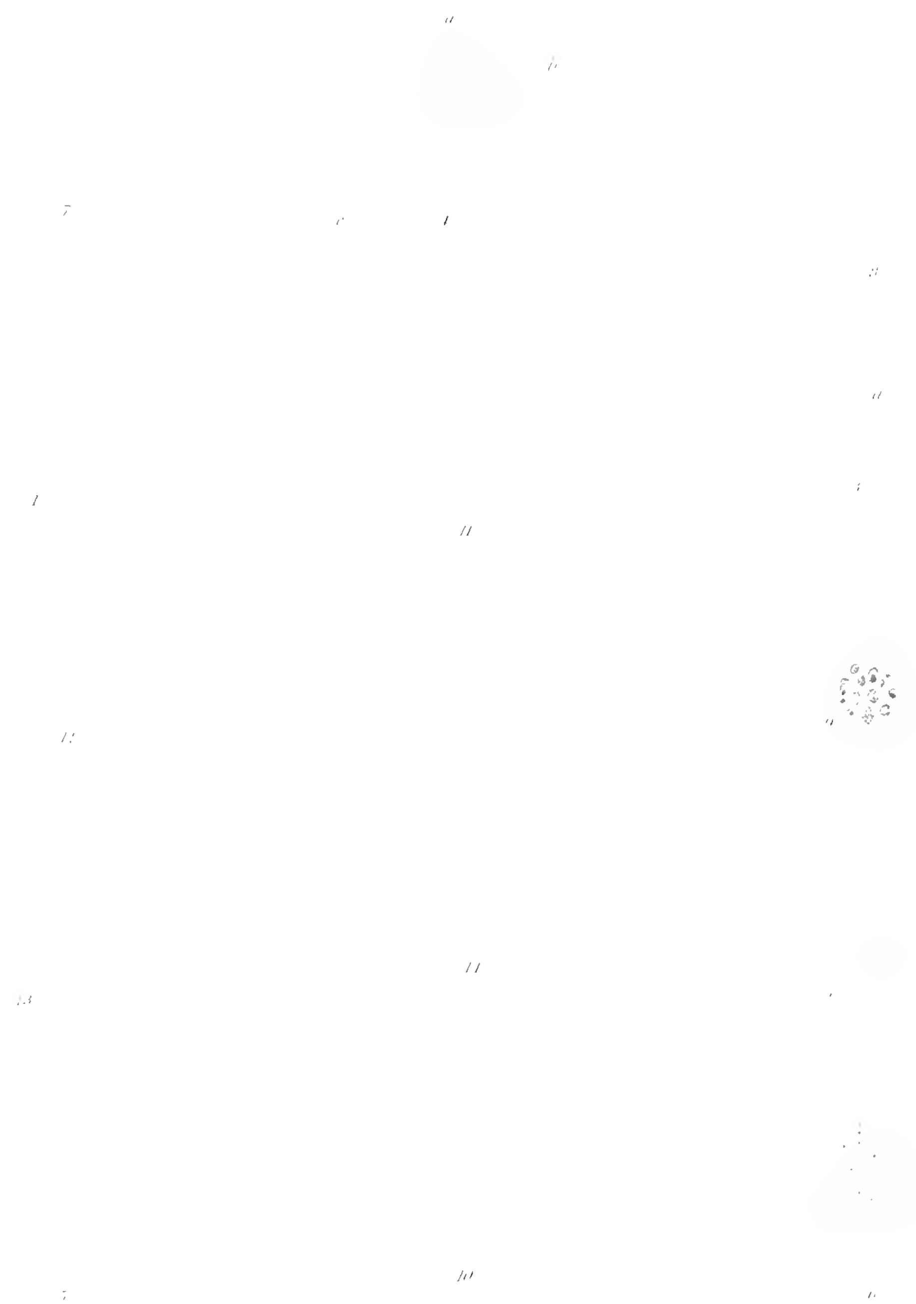
On November 23, the generating portion of figs. 10, 11, consisted of four complete rows. But the form of the cells was still imperfect, nor could the sides be discovered, unless by a high magnifying power; only the internal angle and two sides being visible. It is to be remarked that this is the portion of latest completion. The fourth row was now formed of hexagon cells.

The embryonic hydræ were here seen in various stages. By a powerful magnifier, the body of each of the two of the fourth, or exterior row, farthest advanced, was found to be obtuse, and lying outwards in the cell, while the tentacula, formed like a pointed pencil, were directed inwards.

For some time the number of embryos augmented in the cells, and the progress of individuals advanced as far as the two just specified; indeed, some of them farther, as I thought, for the ligaments uniting the body to the cell seemed perceptible. Likewise the number of the cells themselves increased, and these gained greater perfection, though the exterior row, yet too young, remained always incomplete.

In consequence of such progress, the exterior row of fig. 10, which, it will be recollected, was a new generation of fig. 3, consisted of sixteen cells on the 13th of November, and of forty-six in the end of December. In one or two places there were six new transverse rows. Most of the embryos had disappeared without coming to maturity as hydræ: the exterior row was now less mature than previously, nor was the external side of the cell well defined, though possibly almost mature.

These and other observations proved that the true figure of the perfected cell is hexagonal, and that the increment of the product advances after the same fashion as the growth of the foliaceous zoophytes. It is seen also, that the embryo in its earliest visible stage is a transparent spherule, next ovoidal, and that it is least advanced in the remotest or newest cells. Then the body darkens, and a triangular prolongation, directed inwards, denotes the pencil of tentacula still closed in that form.



On December 16, three new portions were generating from the old patch, fig. 4, the under surface being more distinctly exposed. At this time the vigour of the specimen seemed to be exhausted.

All the progress of the embryos and the cells above described, was admirably seen, the diffusion being over a very transparent watch-glass.

The preceding comments shew here, as elsewhere, the progress of what we characterise the inorganic parts, apparently depends on the evolution and the increment of those deemed organic, and that they advance together. It has been erroneously maintained, therefore, that the cell generates the hydra, for the hydra rather generates the cell, or both are involved by the same elementary principle.

PLATE XI. FIG 1. *Alcyonidium mytili.*
2. The same enlarged.
3. Another specimen detached November 2.
4. The same entire, with three new portions *a*, *b*, *c*, as generating on December 16. Under surface enlarged.
5. Specimen shewing the cellular formation in a portion of the upper surface, enlarged.
6. Portion shewing the angular formation below. Under surface enlarged.
7. Hydræ of fig. 3.
8. Hydræ of another specimen.
9. Gemmules? in the substance of fig. 6.
10. Generating border *a* of fig. 3, as on November 14.
11. The same as on November 19.
12. Embryonic hydræ in the new cells of fig. 11.
13. New border of cells generating from fig. 4 at *c*, as appearing on November 19.
14. The border, fig. 10, as augmented on December 2.

All the preceding figures, unless the first and third, are enlarged.

CHAPTER III.

ALCYONIUM.

Plates XII., XIII., XIV., XV., XVI., XVII.—The same disposition has been shewn by later naturalists for dismembering the genus Alcyonium of their predecessors, as for subdividing other zoophytic genera. There was ample room for it indeed, as many species, evidently of different genera, were incongruously associated. It is a common infirmity among men, however, to conclude, that the last age of science and the arts belongs to their own era, and to those subjects receiving their own notice. Thence, from the love of improvement, little is left of what has gone before. Thus a very small portion of the original stock constitutes the modern genus Alcyonium.

Here I think it better to retain this name, as the earlier which was bestowed on the subject of the present chapter, preferring it to *Alcyonidium* as proposed, especially from the probability that farther subdivision may be expedient ultimately.

But I am not so versant in the peculiar history of each species of the Alcyonium, as to appropriate the various properties pertaining to it without some farther investigation. Therefore I must speak more generally and provisionally of the genus, and of those parts of it falling under my view, than precisely and positively. Future opportunity may admit many explanations. Plurality of figures accompanying description will always enable other naturalists to determine whether the author is right or wrong, and where the deficiencies to be supplied.

The Alcyonium occurs of very different form and aspect. The principal shape wherein I have seen it under various modifications, has been a simple, elongated, round stem, rising some inches without subordinate

parts, or by a stem also round, with subordinate parts generated in its ascent, all roundish and pointed; likewise it appears with several more massy subordinate parts, yet somewhat flattened, but not pointed. Farther, with the whole parts palmate, quite thin and flat. Many grow in the fashion of a minute symmetrical pear, which may be conjectured an early stage, until finding what is the adult state.

Each of these peculiar forms, besides some others, might admit separate and distinct commentary, after sufficient experiment and observation.

The whole are rooted to solid substances; they are of a translucent, semi-gelatinous aspect, of yellowish or greenish colour. Their substance is rather soft and compressible, cutting like cheese or leather, and internally of considerable consistence.

Two kinds may be identified as the *Alcyonium gelatinosum* of the Linnæan system. Whether another may be the *Alcyonium hirsutum* of Dr Fleming, and represented by Dr Johnston among the British Zoophytes, Plate XLII. fig. 1., I cannot positively affirm. The product is certainly seen under many modifications, which leads me to speak of the latter with the greater hesitation, owing to certain embarrassing discrepancies.

Inability to obtain additional specimens at that precise moment, when prone to call our own observations in question, or to consider them imperfect, tends to aggravate our difficulties.

§ 1. Alcyonium gelatinosum—*Pudding Weed—Ragged Sea Staff.*—Plates XII., XIII., XIV.—This zoophyte is of various shape and dimensions; the colour always approaching yellowish or greenish-yellow, duller or brighter, or of different intensity. It appears either as a simple round stem, small at the root, and enlarging upwards to the middle, from which it declines to an obtuse summit; or with a meagre distribution of subordinate parts. A specimen of this description, eight inches high, was but an eighth of an inch in diameter near the root; and half an inch in diameter above where thickest. A single protuberance rose from the stem, at the distance of five inches above the base.

Perhaps some straggling branches, tapering to obtuse extremities, may be generated when farther advanced. The fact is not evident; but all the extremities of this species are obtuse, or nearly so.

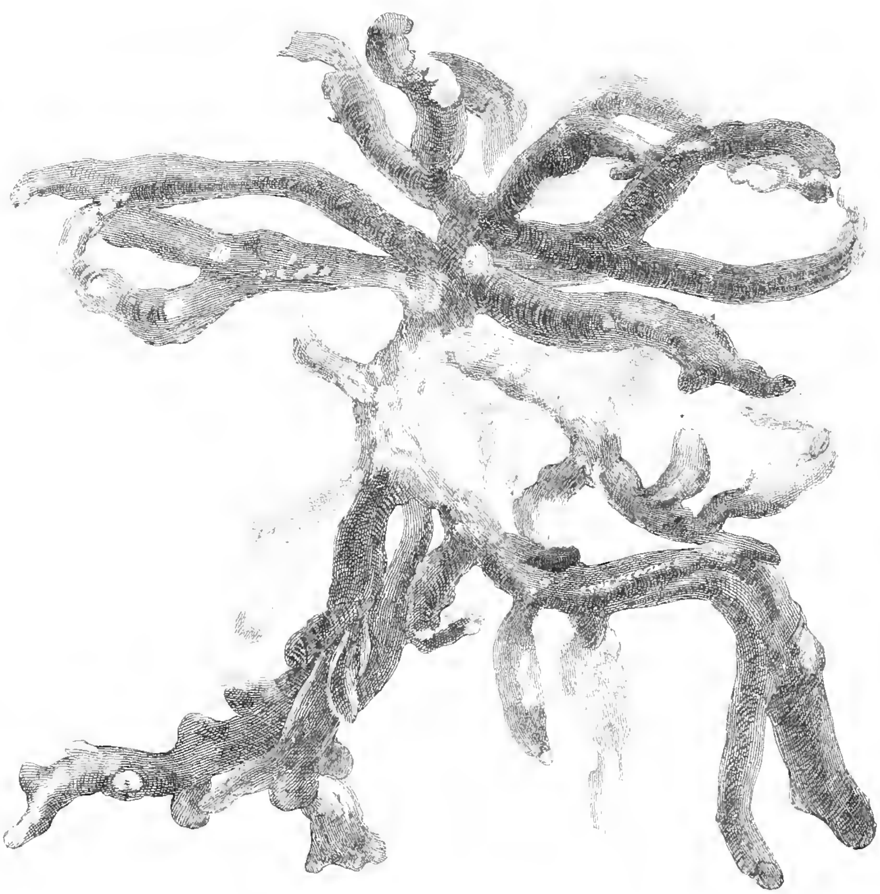
It is the second tallest of the zoophytes occurring to me in the Scotish seas; and few, if any, with which I am acquainted, unless perhaps the *Lobularia*, surpass it in the *quantum* of matter. The specimen represented Plate XII. rose twenty-four inches and a half in height; its greatest diameter being nearly an inch. When I say in height, I must acknowledge my ignorance whether the Alcyonium does not sometimes hang downwards like sponges.

The variety of form excites much uncertainty regarding the identity of species. There are few such determinate principles regulating the number and proportion of parts among similar products as prove a guide in the higher animals. Therefore, great latitude prevails. The specimen, Plate XIII., exhibited no less than twelve limbs or prolongations like boughs. Being detached before reaching me, I could not discover what or where was the stem: whether it might not have been ruptured at some inconspicuous spot near the centre. All the parts were nearly round, and the extremities obtuse. The total extent of the specimen was five inches and a half by three and a half; and it was generally of a yellowish colour. Hydræ with about 15 tentacula were displayed from the surface.

In many specimens the surface is too even and regular to shew any compartments—an embarrassment occurring in various zoophytes, from different causes, which deprives the naturalist of a very useful feature.

The same product, as I conjecture, assumes somewhat a flattened form, irregularly branched, with very obtuse extremities, and obscurely tending to dichotomous structure, as in Plate XIV. This, which is represented of the natural dimensions, resembled a very aged tree, with heavy boughs, mutilated, and yielding under the corrosions of time. The lighter and clearer hue of some of the remoter parts would have indicated, in such a tree, some revival of the vegetating principle.

The same translucent character, as more or less incident to the tribe, distinguished this specimen, whereon also, to the cursory spectator, none but the smoothest surface appeared.



Alcyonium Tuberosum ?

§ 2 Alcyonium (palmatum).—Plates XV., XVII.—I do not pretend, *hoc statu*, to constitute this a distinct species, though unable to identify it with any of those which I have seen described. There are perplexing anomalies continually occurring among the varieties falling under inspection, which nothing but time, patience, and opportunity, can explain.

The present subject tends more to a foliaceous formation than the rest of the genus. It rises about six inches high, by a very short stem, and diverges into an indefinite number of subordinate parts, of similar character. These are scarcely an eighth of an inch thick when recent; and, when dried, as thin as writing paper. The leaf, if it may be so called, is broad in proportion to the height; and a disposition of the parts towards dichotomous is sensible. The expansion of such specimens is usually about four inches; their colour yellowish or greenish.

Low papillæ cover the surface wherein the hydræ dwell, and there they remain after they retreat from issuing forth to display a complement of about twelve tentacula.—Plate XV.

Besides the preceding Alcyonia, which vegetate in more definite shapes, some of smaller dimensions are frequently recovered from the sea, whose form is less regular and compact. They either do not preserve the same figure in their growth, or are not enlarged with age.

A specimen once occurred which may be a variety of the *Alcyonium gelatinosum*, but I had not sufficient opportunity for strict and permanent investigation. This specimen rose nearly three inches and a half in height, from a narrow basis, founded on a valve of the *Cardium echinatum*. Its figure was extremely irregular, consisting, as it were, of several prominences throughout, the summit terminating obtusely. Though not round, it might have been contained in a cylinder an inch and a quarter in diameter. This aggregate of roundish pieces, was wholly of dingy white. After remaining a fortnight in my possession, some hydræ, bearing a general resemblance to those of the genus, appeared from the surface, but retreated before they could be subjected to the microscope: and, notwithstanding their presenting themselves once or twice again, it was too transiently to admit of the necessary inspection.—Plate XVI. A larger specimen is represented among the figures in the first edition of Dr Johnston's work.

Examples of the diversity of aspect and dimensions, are given in Plate XVII. figs. 1, 2, 3, 4, 5. It is problematical whether any one of them would be identified with the rest by the lapse of time.

Of these, the first was very minute, being scarcely an eighth of an inch in height, and resembling a fine, regular-shaped fig or pear. Small as it was, hydræ protruded from the surface. I felt disposed at the time to consider this the young of a species, which had once occurred, of much larger dimensions, alike symmetrical, growing as a perfect pear, nearly four inches high, from a shell of the *Venus Islandica*. Though exhibiting no hydræ, I long thought this fine subject an Alcyonium, but at length I concluded it to be a sponge. I shall take an opportunity of introducing its figure, along with a few sponges, in another place. The small Alcyonium, Plate XVII. fig. 1, which is better exposed as enlarged, fig. 2, proved an interesting object under the microscope.

Minute specimens, whether of regular or irregular form, are often sheltered in the empty cavity of bivalve shells. They then resemble diminutive fungi; but from supervening decay, their history could never be followed further.

If the larger Alcyonia vegetate in a pendent position, from submarine shelving rocks, their form may be affected as compared with those growing vertically. Many are more arborescent, and evidently of greater strength and consistence, perhaps owing to external causes.

Though participating so much of vegetable resemblance, they have nothing like a proper root.

A specimen ten inches and a half in height, was founded on a shell of the *Venus Islandica*. When detached, the base only about two lines in diameter, separated, with the under surface smooth, free of any kind of radicles securing its place, as seems always the case of the *Alcyonium gelatinosum*, which has none. Here the colour was of the palest green.

A numberless host of hydræ covers the entire surface of the Alcyonium, from the root to the extremities, rising like a thin cloud interposed between the subject and the eye.

Alcyonium (Gelatinosum)

But my observations on them have been inconclusive and unsatisfactory, so that I feel much embarrassment in assigning such peculiarities as may be due to each variety—farther than describing all as ascidian: the body long and slender, and provided with a circle of tentacula, ranging from 12 to 18 in the adult.

There must be undoubtedly an immense disproportion in the dimensions of the hydræ of different specimens comparatively, on reflecting that the minute specimen, fig. 1, exhibited several, as seen by fig. 2, where we should not have supposed there was room for any.

The surface of some specimens, certainly the *Alcyonium gelatinosum*, is composed entirely of polygonal, pentagonal, or hexagonal compartments, forming cells, each occupied by a hydra. Such was the structure of the specimen, Plate XIV.; whose compartments are seen, Plate XVII., figs. 6, 7. Also of another, just alluded to, as ten inches and a half high, seated on the *Venus Islandica*. This was of a fine translucent green, full of irregular white specks imbedded in the surface. On a favourable view the cells of the specimen Plate XIV., seemed to have prominent edges. Some were regular, others irregular. The hydræ had 15 or 16 tentacula. Those of a specimen, whereof all the parts were round, amounted to 12; and the hydræ of another, exactly resembling the Alcyonium represented by Ellis, Plate xxxii. *d*, had about the same number.

It rather appears that this particular number is peculiar to a papillar surface, such as authors ascribe to the *Alcyonium hirsutum*. In a specimen, Plate XVII. fig. 5, which I could neither identify with it, nor reject, the hydræ had 16, 17, 18. Those of fig. 3 of the same plate, had about 15. On the animals retreat, the surface of both these specimens, fig. 3 and fig. 5, the surface remained papillous.

Thus I am induced to entertain some doubt whether there is any strict uniformity in the number of tentacular organs among the Alcyonic tribes. At least I should wish farther opportunities of investigating the fact.

As the water becomes vitiated the hydræ drop from their cells, owing either to decay of the parietes, or of the connecting ligaments.

All the Alcyonia which I have seen were of various shades, of translucent green, frequently as transparent as common green glass, but less shining, or, as already said, they were yellowish or dingy white. Portions newer and later are clearer and lighter than the old. The whole product is of somewhat gelatinous aspect.

Recent accessions to adults are readily discovered. The specimen Plate XIII. above quoted, whereof all the parts were nearly round, was obtained on June 8. New prominences, paler and fresher than the rest, had arose on the 27th, Plate XVII. fig. 8, which were covered by numerous hydræ, with about 15 tentacula.

On June 22 two superficial slices were cut from the same specimen, for the purpose of examining what appeared granules in the flesh. But none could be now recognized.

On the 27th of July, however, innumerable hydræ were displayed from the surface of these slices, which I concluded to be the original animals still surviving.

The hydræ of the Alcyonium being distributed over the whole surface, from the root to the summit, they are in such vast multitudes, that the reciprocal exercise of their respective external parts is intercepted. They are extremely vivacious, and some have been so hardy as to appear on exposure to the light, though their element had not been renewed for eight days.

Such a great profusion of animals diffused from the surface indicates the reproduction of the hydræ; for considering the minute proportions of those to be deemed in early stages, it is obvious that the original generation must be overwhelmed, and those succeeding also obliterated successively by the increment of the subject.

Independently of the papillous and cellular formation above alluded to, much difference appears in the surface of specimens. In some it is scarcely possible to distinguish any prominences whatever while the hydræ are in retreat; a multitude of obtuse conical *frusta* covers others; or they are profusely interspersed with active hydræ, fig. 10, extremity of fig. 5; fig. 11 the summit of fig. 3.

Perpetuation.—The same general laws apply to the preservation of the Alcyonic race as govern the evolution and the increment of several

[illegible]

other zoophytes, proving, in a remarkable manner, the uniformity of that great design superintending the fabrication of the universe.

We must feel the more satisfaction when able to ascertain any definite facts illustrating this obscure portion of the history of such zoophytes, on considering our abortive attempts to elucidate them, where alike desirable.

Nevertheless, my personal observations on the subject are rather general than special, in as far as restrained by my inability to distinguish the precise limits of the genus of the Scotish Alcyonium, and its varieties. Whatever care I have bestowed upon them, and whatever confidence I myself may repose on the accuracy of my observations, I could desire an opportunity of repeating the whole, though the result has been brief, and might be so again.

At different seasons of the year numerous dingy white or yellowish granules, of various intensity, stud the fleshy substance of the Alcyonium. Probably they are generated below, and rise to the surface, but I have been hitherto unable to discover the peculiarities regulating their origin, progress, number, and variety.

Many whitish internal granules were conspicuous on March 1, in the small specimen represented Plate XVII. fig. 4. Some were soon discharged as ciliated gemmules or corpuscula, fig. 12, in which state they perished.

The specimen, Plate XVII. fig. 5, was occupied by hydræ, as above said, protruding, with 16, 17, or 18 tentacula, all these numbers being displayed. While these active creatures were withdrawn and quiescent, low papillæ covering the surface, denoted the place of their retreat.

On February 16, about 20 gemmules were swimming in the vessel containing the specimen, which, being transferred to another, about 30 more were rapidly traversing the latter on the 21st. All these corpuscula were pure white, opaque, solid, and moving somewhat heavily, though with considerable force. Their conformation was various and irregular; for the most part rudely elliptical, convex above, flattened below, and with a kind of projection from one extremity. Cilia begirt the whole circumference; also a circle of cilia of relaxed motion appeared to be under the projection, fig. 13. It is impossible to determine the precise description of the cilia, which, in several different species of animalcula, are obscurely indicated somewhere below, because their position is never freely exposed. Their view is always intercepted.

The shape of these alcyonic corpuscula, independently of reciprocal differences, is extremely variable, but their colour is uniformly white.

In a week the number of gemmules exceeded 100. The specimen had been locked up in the dark, but now, after an hour's exposure to a moderate degree of light, at least 150 more had left their nidus, and swam with great activity. These had been obviously elicited by the influence of the light, as I have had occasion to remark of some other zoophytes. The cilia were in rapid motion, whether serving as natatory organs in aiding the animal's progression, whether promoting respiration, or any different purpose, as this motion does not cease when the gemmules remain stationary, and are occupied about other objects. However, it is probable that when they tumble amidst the water, it is not by the exercise of the cilia, but from some different force.

Meantime numerous hydræ were now and afterwards displayed from this specimen, fig. 5, which was transferred to a larger vessel, that the gemmules might be left for observation, continued until the middle of April.

As these corpuscula seemed to escape through the skin of the surface, wherein I could neither discover a previous aperture, nor the site of the hydræ, the propagation here may be compared to that of the Cristatella or Alcyonella, as subsequently explained. Thirty or forty corpuscula would issue thus on exposure to the light.

Next their motion relaxes; they become stationary, and are affixed in adhesion to the surface, whereon they repose. A thin diffusing margin then enlarges the circumference, rendering their appearance very like minute, delicate, white shells, fig. 14; and they grow gradually more attenuated, fig. 15.

Those gemmules quitting the parent specimen, fig. 5, on February 20, had become motionless on the 27th of the same month; and on March 3, the first of the nascent hydræ was displayed from one of the diffusing spots, which much resembled a shell. Next day other three were

1. Blegenium.

2_6 Gemmules.

displayed from three such spots, and favourable observations on the day following, shewed their complement of tentacula as amounting to about 16. A row of stout cilia, rather towards the exterior of each tentaculum, and somewhat darker, maintained a regular rapid action, inclining upwards by ascent along it, and downwards by descent on the other side. Thus the whole border of cilia kept up a perpetual current.

The hydra protrudes laterally or obliquely from the side of the original cell, not vertically from the surface.—Figs. 16, 17.

As in some other species, the internal organization, the intestine forking upwards from below, together with what I concluded the dark contents of the stomach, agitated by a kind of revolution, were exposed by the transparence of the body.

Besides these nascent animals, then mature, and displayed from their cells, each of many spots shewed an immature hydra, with the tentacula in a contracted state.

The period required for bringing the nascent hydra to maturity equalled nine, ten, eleven, or twelve days, computing from the escape of the gemmule. Here the original spot following the stationary gemmule diffuses into compartments; or, to speak more correctly, these are generated or evolved from its existence. Had their preservation long enough been practicable, doubtless a hydra would have sprung from each. Three compartments were thus generated from some, but only a single hydra, the first, came to maturity.

No peculiarity of the surface distinguished the specimen, Plate XVI. fig. 1. But the enlargements were hollow. Having been twelve weeks in my possession, and hydræ ceasing to protrude, I cut several slices off different parts in the middle of winter. Numerous minute white corpuscula, of singular appearance and motions, were speedily discharged from them. All were of the most irregular shape, somewhat flattened; the largest portion begirt by a row of short cilia; one had a tendency to a circular form, another to elliptical, and a third seemed compounded of two in union. Interanea and a dark solid substance like an ovum were indistinctly seen through the integuments of several. They were active and vigorous, performing short excursions, or tumbling over in the water.

When in this transient passage, the under seemed different from the upper surface. Great disparity of size was sensible. The motion of some was continued to the third day; but most of them were quiescent in twenty-four hours.—Figs. 2, 3, magnified.

These are singular facts, rarely seen among the zoophytes. They seem peculiar to the ascidian hydra, denoting the relation, though remote, between the *Flustra hispida*, the *Alcyonium*, and the *Botryllus*.

All the larger Alcyonia which I have had an opportunity of inspecting were founded on solid substances, which rather argues that they rise vertically. I have seen but small specimens connected with sponges, fistulous corallines, and the like; and even when apparently in a very early stage, they are rooted on the outside or the inside of shells.

Perhaps they abound in the recesses or cavities of rocky places, for great profusion of some kinds have reached me occasionally from the crab fishers.

The following conclusions may be deduced from the preceding observations on the *Alcyonium gelatinosum*, and immediate congenera:—

I. The *Alcyonium gelatinosum* is a massy, solid, compact product.

II. It rises above two feet from a very contracted root or foundation.

III. Its form is extremely various, rounded, ramified, or wholly flattened.

IV. The surface is entirely overspread with cells containing hydræ

V. The adult hydræ are provided with from 12 to 18 tentacula.

VI. The Alcyonium propagates by ciliated gemmules, which, after great activity, become stationary.

VII. After an interval ranging between nine and twelve days from production, a hydra originates from the stationary gemmule, and next another hydra or cell from the side of the cell of the first.

Plate XII. *Alcyonium gelatinosum.* Specimen twenty-four inches and a half high. Reduced.

XIII. Another specimen.

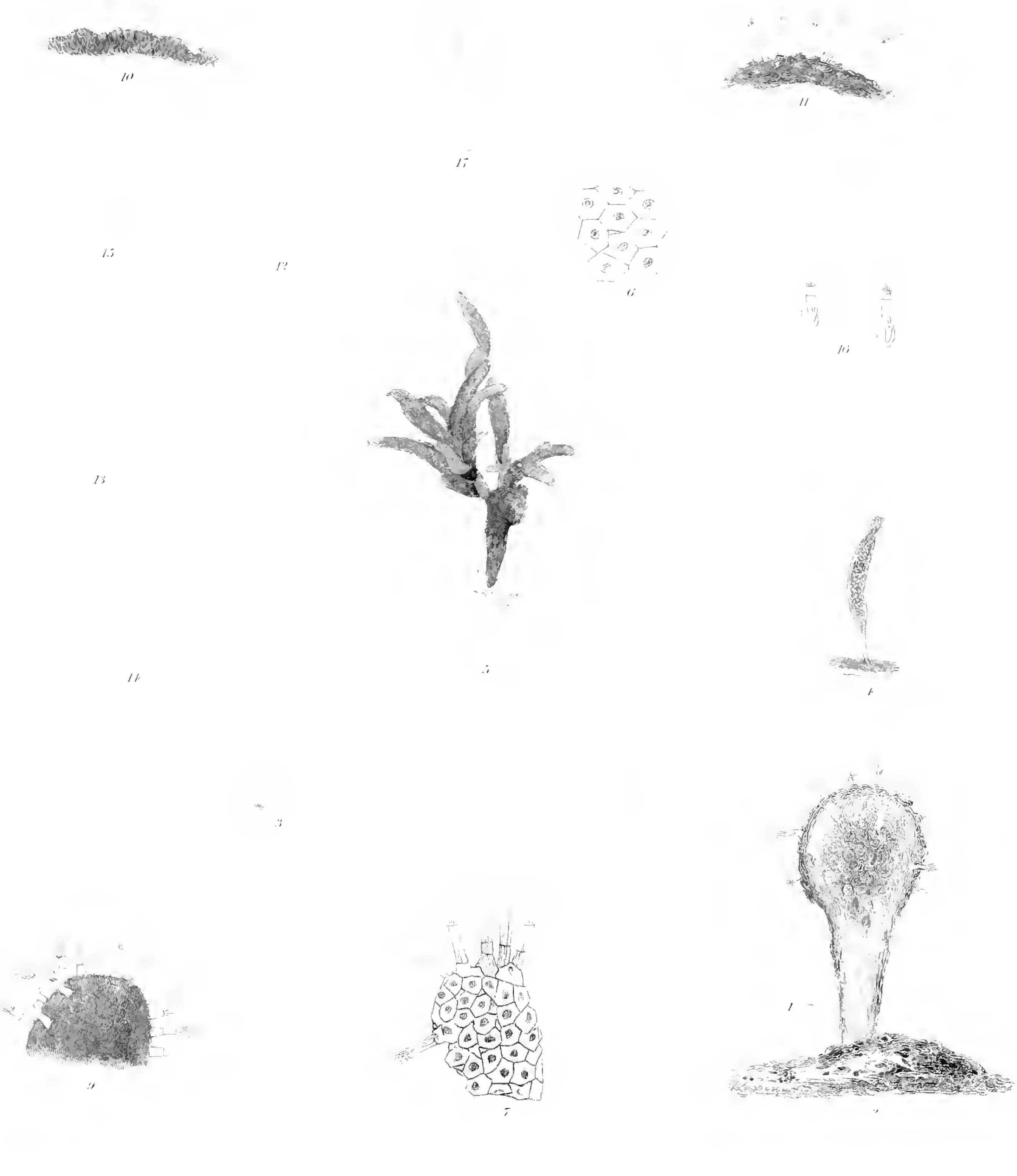

10
11
17
15
12
6
16
13
5
4
14
3
1
9
7

PLATE XIV. Another specimen, the surface evidently in polygonal cells or compartments.

XV. *Alcyonium* [*palmatum*].

XVI. FIG. 1. Alcyonium; conjectured a variety.

2. 3. Corpuscula or gemmules magnified.

XVII. FIG. 1. Minute pyriform Alcyonium.

2. The same with the hydræ displayed; enlarged.

3. Small specimen; conjectured to be young.

4. Specimen with granules imbedded in the flesh.

5. Prolific specimen.

6. Cellular superficies.

7. Cellular superficies with hydræ.

8. New protuberance generated from the specimen Pl. XIII.

9. Hydræ from the same; enlarged.

10. Hydræ from fig. 5.

11. Hydræ of fig. 3.

12. Ciliated corpuscula or gemmules from fig. 4.

13. Ciliated gemmules from the prolific specimen, fig. 5.

14. Diffusing spots from the same gemmules.

15. Diffusing spots farther advanced.

16. Nascent hydræ from these spots.

17. Nascent hydra more enlarged.

All the figures, excepting 1. 3. 4. 5. 8. are enlarged.

CHAPTER IV.

MISCELLANEOUS ZOOPHYTES.

I HAVE hitherto endeavoured to preserve a kind of connected narrative, though neither in the strictest form nor order, but such as might render the reader familiar with the hydraoid and ascidian zoophytes, in some variety. Although the nearest kindred may not be placed in immediate approximation, I felt desirous that they should not be very far asunder.

But a number of transient objects must always occur in a long course of observations, affording only insufficient materials for history, and from which nothing like a narrative of successive incidents can be framed. Nevertheless, however brief and unimportant they appear to the naturalist himself, they may fill up the chasms which accident has left to others, and thus render the science more complete; thence they will not be void of utility. Where my hopes of additional illustration have been disappointed, I propose to devote one or two chapters to a few detached supplementary observations, meantime trusting that future opportunity may enable me to advance them farther, if the more favoured and skilful have not already done so.

The mere corroboration of our enquiries, by even the shortest notice, will often suffice to remove ambiguity and establish truth.

Here, I mean to embrace those subjects whereon I consider my observations as yet incomplete.

§ 1. HYDRA (CORYNA) SQUAMATA.—PLATE XVIII.—It appears to me that Dr Johnston is the only author who has assigned this product its true position, namely, as interposed between the simple and naked hydra of the fresh-waters, and the Tubularia of the sea. It participates somewhat of the structure of both, and the mode of its perpetuation seems to connect it with the latter.

But I doubt whether more than fragments of finer specimens have fallen into my possession, though many of inferior dimensions have occurred.

This is one of the animals, however, after which it is vain to institute a special search, as after various zoophytes whose abode we may reasonably expect to reach. Yet here does one auxiliary sometimes come to assist us, namely, a creature the most opposite in form, in nature, and in habits—the Hermit Crab.

From the necessity of protecting part of its body, as we shall afterwards see more at length, the hermit crab is obliged to take possession of an empty shell, which is often brought to shallow water, or almost to the shore. Such shells, conveyed by the new tenant from greater depths, are often profusely invested by the hydra in question; therefore, the capture of a number of hermit crabs thus sheltered, will give the observer a fair chance of finding his object.

The *Hydra squamata* dwells chiefly in numerous colonies—which are always implanted on the empty shell of the Nerita, Tritonium, Murex, or others of the testaceous tribes—a peculiarity that, as I am informed, belongs also to those specimens found on the coast of Ireland.

In greatest luxuriance, the hydra consists of a stem with branches: but I have had such only on the rarest occasions, and in a diminutive state, none being above four lines in height.

The animals are single, though numerously associated, generally of the palest carnation, the palest grey, dingy or pure white. A portion of the largest volute of a decaying shell was invested by many hundred hydræ, resembling a snow-white fleece. The shell was occupied by a hermit crab.

The colony seems to be founded originally on the epidermis of the shell, whence the animal rises by a slender stalk, enlarging above, which, I presume, has obtained for it, the inappropriate name *coryna*. This enlargement or head is environed by from four to about twenty-five tentacula, arranged in successive stages,—the prominent summit probably containing the mouth. They are all, together with the summit, of muricate structure, very extensile and flexible, and endowed with an adhesive property. Their resemblance of the human fingers is such, that, before being aware of the name bestowed upon it, I had distinguished this subject as the *Hydra digitata*, an appellative which might be still conveniently adopted. —Plate XVIII. fig. 1. Colony on a shell. 2. Hydræ, enlarged. 3. Portion of a colony, enlarged.

Colonies in their contracted state, when recovered from the sea, resemble a gelatinous stratum investing the shell.

Amidst the profusion of hydræ, it is for the most part difficult to get a distinct view of individuals; and this difficulty is aggravated even beyond what has been said of preceding embarrassments, from occupation of the shell by such an animal as the hermit crab, which pertinaciously retains its place. It cannot be dislodged.

The product itself is liable to mould in still water, in the same manner as we have seen of the *Flustra hispida*. Whence it is probably a provision of Nature to insure frequent renovation, that the shell shall be occupied by so restless an animal as the hermit crab.

I do not recollect to have ever seen the *Hydra squamata* on any other substance than an empty shell, or on one occupied by that animal.

The profusion, conjoined with the peculiar position of this product, precludes the same minute observation regarding the process of reproduction, as in animals single, free, and distinctly exposed.

Perpetuation.—Several analogies between the mode of its perpetuation, are found with the Tubulariæ and Sertulariæ.

Clusters of ova are borne on the hydræ themselves, or in immediate approximation by the *Tubularia indivisa* and the *Tubularia ramea*, which latter, we have observed, might be almost incorporated with the *Sertulariæ*. As the ovarian contents advance to maturity, the hydræ themselves exhibit symptoms of approaching decay.

External ovarian clusters are borne in like manner by the *Hydra squamata*, in more resemblance of those of the *Tubularia ramea*, and similar exhaustion of the vigour of the organs attends their ripening, as well as in the nature of their contents.

On the upper side of the large volute of the shell above referred to, with the snowy fleece, the decay of many hydræ exposed a number of yellow corpuscula, close to the epidermis, in the end of October. The subject was carefully preserved, but nothing resulted.

Sometimes, in the months of June or July, part of the surface of a shell, still bearing a colony, appears yellowish, while the reason is not immediately obvious. But it is found to be from the accumulation of a multitude of yellow spherules.

I endeavoured to slice a portion of the epidermis off such a shell, whereby some of the hydræ were separated; having been rent or cut asunder near the root of the stalk. The upper part of the severed stalk now proved to be surrounded by clusters, composed of various numbers of yellow vesicles, apparently compressing the head, as in the *Tubularia ramea*. The head also, as seen there, seemed verging to decay. These vesicles were in different stages of maturity. Some of them evidently included one, two, or even four embryonic corpuscula, each in its own compartment.—Figs. 4, 5. A group of spherules, in their integuments, is represented fig. 6.

In a few days, many of the vesicles, figs. 4, 5, had discharged their contents in a watch-glass, as vivid yellow globules. Almost all were perfect spheres, and such as I should have rather expected would have produced planulæ. Another quantity, fig. 7, was obtained at a later period of the year. But, unfortunately, the whole perished and decomposed on both occasions. No sensible difference of the latter from the former could be recognised. The form was alike perfect, the colour equally vivid, with somewhat more consistence apparently.

On still another occasion, I suspended a shell in a vessel of sea-water, containing a watch-glass at the bottom. In four days, at least 150 yellowish globules had fallen into it, besides 50 or 60 on the bottom of the vessel; and a few were swimming in the water, fig. 8. Nothing illustrative resulted. Several much larger globules remained on the rough surface of the shell.

On the 6th of October, a colony which invested a shell of considerable dimensions was suspended in still another vessel of sea-water. After the lapse of fourteen days, several of the corpuscula from the colony were found below, elongated to minute hydræ of various extent. One of these exhibited twelve obtuse prominences, from an enlarging head.—Fig. 9. In three more days, another was adhering to a watch-glass, without any perceptible diffusing root. This was very minute, pure white, with seven originating tentacula, beyond which the summit was much prolonged.—Fig. 10.

The tentacula of adult hydræ are susceptible of such extension, that, owing to their slenderness, they assume almost a silky appearance. The summit is also susceptible of considerable prolongation.

Probably the complement of tentacula augments with age.

Nothing more satisfactory can be therefore said of the propagation of the *Hydra squamata*, than that the nascent animal comes of an ovum contained in a vesicle borne externally by the adult.

Interspersed with the hydræ of almost every colony, are many dark, rough, irregular substances, tending to a conical form, and much resembling the product denominated *Alcyonidium echinatum*. But no symptoms of animation being betrayed by any portion of them, I doubt much whether they belong to the animal creation.

Specimens of the *Hydra squamata* have survived during seven months.

If ever occurring in shallow waters, they seem to be always carried thither by the temporary occupants of shells.

PLATE XVIII. FIG. 1. *Hydra (coryna) squamata* investing a shell.
2. Hydræ enlarged.
3. Portion of the colony, fig. 1, enlarged; head *a*.
4. Prolific vesicles on a hydra.
5. Prolific vesicles on another stem.
6. Spherules from the vesicles.
7. Spherules from the vesicles.
8. Spherules.
9. Nascent hydræ.
10. Nascent hydra, farther advanced.
All the preceding figures, excepting fig. 1, are enlarged.

§ 2. SERTULARIA THUIA.—*Bottle brush.*—PLATE XIX. FIGS. 1–6.—Instead of reserving a few remarks on this zoophyte for an appendix, as the more suitable place, they are inserted here.

The peculiar structure of the product has attracted the attention of most naturalists.

It is almost always seen as a knotted stalk; as if crowned by an enlarged head, the summit of which is 12 inches above the root in the finest specimens.

The knots merely indicate the places which have lost former branches, and the enlarged head is composed of those still subsisting. Their arrangement is alternate on the stalk, and they subdivide dichotomously, the subordinate parts bearing a double row of cells.

These are occupied by a hydra with 12 or more muricate tentacula. But to judge by the difficulty of obtaining living specimens, this must be a very delicate animal; insomuch that I have found it not only of the utmost rarity, shewing itself transiently, nor surviving long.

Prolific specimens bear numerous vesicles, crowded together on the branches, which, at first sight, would be supposed the spawn of some animal confusedly deposited there. These vesicles generally contain one pure white spherical corpusculum, sometimes two. In the latter case, one side of each of the corpuscula is flattened, and the flat sides being next to each other, a slight interval appears to separate them.

Specimens laden with vesicles having been obtained in December, a number of extremely small white globules, which relaxed into planulæ, appeared from them on the 25th of that month. And on January 11, above 100 minute white planulæ were in the vessel along with the others.

In another week the planulæ in different vessels amounted to hundreds. They exhibited no peculiarities. Many had fallen into a watch-glass adapted for their reception, but nearly all were lost by supervening decomposition. The observer has not the choice of seasons, for he must avail himself of opportunities. Summer, however, or the prevalence of genial temperature, is the more likely to aid his enquiries, for then the advances of every thing to maturity are more speedy.

Some of the planulæ having become stationary, formed a small white spot, from which a spine rose in the centre above, and radicles diffused below, circumscribed by a perfect marginal circle. All the radicles were of a dark colour.

The progress of such nascent Sertulariæ is tardy. On January 5, many planulæ, at least 100, were in a vessel. A week afterwards, namely, on the 12th, one spot, with a spine, was on the side of the vessel, and another on the bottom about February 11. The former had generated three cells, from which very minute hydræ were displayed; and two afterwards appeared, one of them from the summit, on the 16th. On both occasions I was disappointed of microscopical observations, by their sudden and permanent retreat.

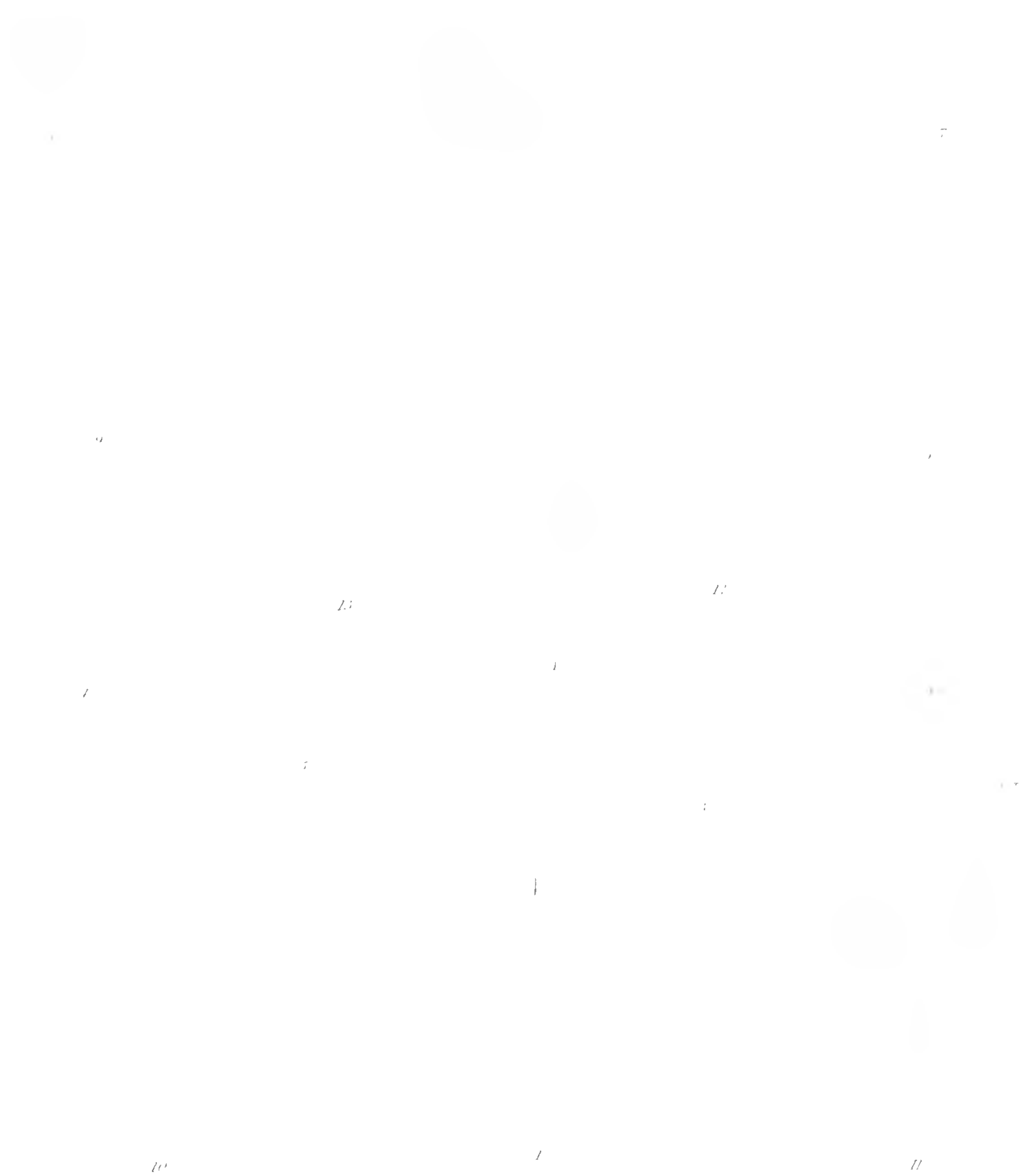
On another occasion, specimens appeared prolific also in the month of December. The vesicles were huddled together on the branches, 30 or 40 in one place.

The stem of this zoophyte is full of a medullary substance; and shoots have arisen from sections. These shoots are always white.

Roots have also issued, and with bifid radicles. I have been disposed to conjecture the reproduction in certain cases was inverted. Thus, a specimen about three inches long, having been ruptured below, was deposited in a vessel on January 27, where it remained undisturbed in an inclined position during fifty days. A new portion, much lighter than the old, had then generated from the extremity, of greater complexity than I should have expected of a root. Almost the whole parts were adhering to the glass, and to that part of it, which was the side of a narrow cylindrical jar.—Fig. 6.

No hydræ ever appeared on the specimen.

PLATE XIX. FIG. 1. *Sertularia thuia*, prolific specimen.
2. Twig with vesicles.
3. Vesicle discharging its contents prematurely.
4. Planulæ from the vesicles.
5. Nascent Sertulariæ from the planulæ.
6. Reproduction from the extremity of a stalk.
Figs. 2, 3, 4, 5, are enlarged.



Miscellaneous Zoophytes

§ 3. Pedicellina.—Plate XX.—Although this zoophyte was the subject of transient observation nearly a century ago, naturalists have been much perplexed regarding it, owing to indistinct notices, and imperfect representation. Nor, until very recently, has any one ventured to give it a name, or assign it a position.

We have already remarked how slight the influence enjoyed by most of the hydraoid and ascidian zoophytes over the inorganic parts; that it is commonly, but to the smallest extent, and chiefly confined to the immediate vicinity of the animated portion—the hydra or head.

It has been seen that should such zoophytes be stripped of their inorganic or cortical exterior, the organic portion, or interior, consisting of the pith, terminated by a multitude of hydræ, could not sustain itself amidst the water. Neither would it be capable of any voluntary flexures.

If such be the nature of the hydraoid genera, inflexibility, through the inefficiency of the animal over the inanimate organization, is still a firmer character of the vast proportion of the ascidian zoophytes.

But the subject of the present paragraph is a noted exception. There are no cells, no polyparium, for reception of the hydræ, and it can exercise complete control over all its parts.

Recalling what has been said of the *Vorticellæ* of the fresh-waters in the preceding volume, which, growing like single flowers, or luxuriant shrubs, whereof each extremity terminates by an animal resembling a bell with a ciliated lip, we may remember that these products can curve their different stems in all directions, or form them into spirals; that the whole of their numerous parts cluster together, and sink to the surface below in a moment; that this collapse relaxing, they rise and expand themselves anew, with the most lively action.—Vol. I., Plate XII.

The Pedicellina participates so far in the nature of such animals as also to exercise an influence, but in a minor degree, over the whole organization.

A faculty such as this, being so rarely enjoyed, is calculated to excite the more attention.

The Pedicellina is an ascidian zoophyte, to which can be scarcely ascribed any inorganic parts, for it seems throughout organic.

In an early stage it appears as a white globular head, crowning a short stem, one scarcely half a line high. When more advanced, it generally occurs, or, perhaps, more readily attracts notice, when in numerous colonies of individuals rising about a line and a half. Then it consists of a smooth white stem, crowned by a variable campanulate hydra, with fourteen ciliated tentacula. The stem of certain specimens has appeared prickly, sometimes invested by foreign matter; and I have thought a web uniting the roots of the tentacula discernible.

At this stage the Pedicellina generally dwells in numerous societies, implanted on the twigs of other zoophytes, or distributed profusely over shells.—Plate XX. Fig. 1.

The adult rises half an inch in height, by a smooth bare stem, with twenty or a greater number of hydræ, meagrely and irregularly disposed on branches or pedicles to right and left, on one or on both sides. But such luxuriance is very rare. Among a multitude of specimens, I have seldom found any with even a few animals.

It is only in early stages, when the hydra is solitary, that it can be most satisfactorily inspected. Then, the head is discovered to be of an extremely variable shape, frequently distorted in an uncommon manner, —such as I have not seen in any other zoophyte—and next restored to its symmetry. Sometimes it is flattened, or it is preternaturally enlarged on one side, swollen, contracted, or otherwise, at the will of the animal; and always presenting considerable diversity of aspect, either by one, or by the various specimens of a colony.

The action of the cilia bordering the tentacula is very distinct, whereby a vortex, or a current attracting buoyant particles, conducts them up the sides of the tentacula, or over their extremities, and then down into the cavity of the mouth, dilating for their reception. This dilatation is extraordinary, it equals almost the whole diameter of the head. Next, a dark mass is tossed about within, fig. 2:—and if now viewed from above, the active operation of numerous cilia lining the cavity is discovered. I recollect that, on exhibiting a favourable microscopic view of the various peculiarities displayed by this subject to a very accomplished naturalist, he testified greater surprise and interest than in those to be witnessed of any other zoophyte.—Fig. 8.

I have frequently doubted whether the semblance of a web connecting the roots of the tentacula, might not be an illusion. In such minute animals, the observer is apt to be deceived; and my opinion of the fact has vacillated, from inability to satisfy myself under what might be deemed favourable conditions. However, the learned Professor Van Beneden of Louvaine, if I be not mistaken, admits this as a portion of the organization. At the same time, some slight difference seems to have been between his specimens and mine.

I can say nothing from personal experience of the mode whereby the subsequent generations of this product are perpetuated. That belongs to others.

Its increment certainly advances by the evolution of new hydræ from the extremities, which are probably all tubular, after the fashion of the Tubularia and Sertularia. Early accessions by the adult, that is, by a specimen composed of several hydræ, consist simply of a globular head, connected to the preceding parts by a short neck or pedicle. When a little further advanced, it is more of an elongated figure The progress of increment in its later stages is better shewn by larger specimens. There, the highest germination in point of position, is the last to originate, fig. 12. An obtuse bulb, seated on a pedicle, developes as a new hydra. What was a mere stump or prolongation on June 7, fig. 10, *a*, had become a perfect hydra on June 12, fig. 11, *a*. At this time a new prolongation was advancing beyond it.

A very frequent character of this product in maturity, is the evolution of subordinate parts from only one side of the stem. It is always meagre.

A course of observations is hardly practicable, from the rarity of mature specimens, and from such subjects being encumbered with extraneous matter. The Pedicellina is readily procured as a single animal, growing erect from a solid substance, and then it is in an early stage. In later stages it is pendent, from some edge or extremity being too weak and flexible, like the *Sertularia cuscuta*, to sustain itself vertically. Now, it is white, very small, with some hydræ on twigs or pedicles. The lowest are unfolded first, being the most mature; those above them are regular smooth ovoids, on twigs of considerable length; and still higher on the specimen, are buds less advanced, the highest merely irregular enlargements. As the ovoid attains perfection, it developes in the form of a hydra, with incurving tentacula.—Fig. 7.

Among the peculiarities of this product, may be noted the singular voluntary distortion of the head, and the spontaneous deflection of the stem, and of the subordinate parts. While yet in an early stage, the head, with its short stem, can, by inclining, actually describe a circle around the root as a centre. Similar movements are indicated by the adult bearing a number of heads. Nay, the like is seen of the hydra, while yet comparatively an embryo, for the pedicle then bends with it in various directions; and where several buds are together, their united influence can twist the main stem, curving it over almost to the root.

A habit equally remarkable merits notice; though quiescence always prevails during the earlier part of the day, among a colony of single animals, that is, those consisting of only a head and stem, all are observed in motion as the hours advance, and as the sun begins to decline. The tentacula closing over the mouth, the heads become globular, nod, and strike against each other, which they are enabled to do by flexibility of the stalk. Where many are arranged in a row, they seem literally to pass a blow along the whole line, as if in sport. Singular it is, that all animals, even the humblest, seem to have moments happier than others of their existence; and testify, by unequivocal demonstration, their present enjoyments in conscious security.

Uncommon agitation is shewn by these creatures on transference from one vessel to another. Indeed, their nature is distinguished at all times by restlessness, thus aggravating the embarrassments of microscopical observation. The agitation of several individuals together is so great, as to disturb the substance whereon they are seated from the focus of the instrument; and the extraordinary distortion of adults, not only removes them entirely from its field, but it is incessantly changing the configuration of the parts. Thus, all artists evidently labour under particular embarrassment, in endeavouring to produce accurate delineations—which is the real cause of Ellis's figures having been of such late recognition by modern naturalists. The observer himself may watch long before the globular head shall relax from its frequent contraction, to shew the minutiæ of unconstrained organization.

This zoophyte seems to dwell in society, when multitudes in their earlier stage are huddled together, in such limited compass, that they have no room to stretch themselves. Probably the stiller and shallower parts of the sea are favourable to their nature.

The precise position of the Pedicellina in the Systema Naturæ is not quite obvious.

PLATE XX. FIG. 1. *Pedicellina nutans.*
2. Hydra containing dark substances tossed about.
3–7. Hydræ.
8. Disc, mouth, and tentacula, viewed from above.
9. Specimen with branches from both sides of the stem.
10. Adult specimen generating young hydræ; bud, *a*.
11. The same farther advanced; the bud, *a*; fig. 10, being now a hydra, *a*; new enlargement, *b*.
12. Summit of a stem, with budding hydræ in different stages.
All the preceding figures, except the first, are enlarged.

§ 4. TUBULARIA SULTANA.—VOL. I. PLATE XII. FIGS. 12, 13.—A distinguished author, Blumenbach, has incorporated this zoophyte with the genus Tubularia, to which it does not properly belong, and he gives a rude representation of a specimen.

The *Tubularia sultana* is one of the few zoophytes inhabiting the fresh-waters of Scotland, but it is of excessive rarity; nor, amidst the researches of above forty years, has more than a single specimen occurred to me. From this, under certain disadvantages, the following description is taken, yet, with the benefit of accurate delineation by an excellent artist, before mentioned, Mr John Welch. Besides, it is always gratifying to be enabled to contribute even the smallest accessions to the Scotish Fauna.

The specimen rose about five lines high by a short stem, diverging into several branches, about six lines across, and subdividing rather dichotomously, so as to terminate in more than ten tubular extremities. Its irregular curvatures, distorted appearance, and umber-brown colour, presented a narrow resemblance to the wonted object of comparison, a minute, microscopic, decaying fragment of some shrub or tree.

A pure white ascidian hydra issued from each of the extremities, provided with a circular row of 22 or 24 tentacula, as enumerated in two, expanding like a funnel, half a line in diameter. These organs are completely flexible, endowed with percussive action, clasping across each other like so many fingers of both hands, attracting and repelling particles in their vicinity, all indicating a ciliated structure. Sudden exposure to the light invites the ascent and display of the hydræ, the tentacula surrounding a low projecting lip in the centre.

No cellular enlargement distinguishes the extremity of the branch, which is both there, and somewhat lower, sufficiently diaphanous to expose the animal's body, descending as far within the tube as equal to thrice the length of the tentacula. The extremity of the branch being simply tubular, closes as an ovoidal bulb when the hydra is retracted, and relaxes as it protrudes. During its retreat, the bulb is susceptible of slight inflexion to either side. The hydra is very vivacious, it withdraws instantaneously, when the ovoidal summit closing above ensures its safety below.

This specimen occurred in the beginning of August, on the under surface of a stone, in a brook flowing through the parish of Foulden into the river Whitadder in Berwickshire.

Ten hydræ were displayed at the same moment, though the specimen might have been circumscribed by a circle of six lines in diameter. Seven of them survived during five weeks. Meanwhile it was suspended by a hair, as its delicacy required, in a vessel of water.

But it suffered such injury by conveyance fifty or sixty miles, that only a portion remained entire for microscopical inspection and delineation.

Notwithstanding an anxious search, repeated during several successive years, both in the same place and in the vicinity, no other specimen could be discovered.

VOL. I. PLATE XII. FIG. 12. *Tubularia sultana.*
13. The same enlarged.


8
2
5
4
3
12
1
9
6
7
10
11

§ 5. Avenella fusca.—Vol. I. Plate XII. Fig. 11.—In the preceding volume we have seen that among the ascidian zoophytes there are two which sometimes bear straggling single cells, with their animals on the inorganic parts. These are the *Valkeria cuscuta* and *Bowerbankia repens.*

The hydra of the former is provided with eight tentacula, that of the latter with ten.

In certain respects the subject of the present paragraph admits of being compared with them, in as far as concerns the polyparium, if such can be said to belong to it.

This product, the Avenella, which may be held a provisional name, occurs as a parasite, either on other zoophytes, or on slothful animals, such as that species of crab called the *Hyas araneus.* It is commonly very much matted and interwoven, and intricately confused with spurious vegetation. On the extrication of short single specimens, each is discovered to consist of several cells, perhaps six or seven, set at irregular intervals on a slender flexible stalk, not in the same line however, but rather around the circumference.

The cell is towards the sixteenth part of an inch long, either a straight or a bent cylinder, curving even considerably more than any of the specimens represented. On the whole, it bears some resemblance to a grain of corn.—Vol. I. Plate XII. fig. 11.

An ascidian hydra inhabits the cell, protruding from 18 to 20 long ciliated tentacula, disposed in circular arrangement, much in form of a funnel. These cilia are not easily seen. The animal is quick and lively, rising cautiously to view, and retreating abruptly below.

The whole product is of a brown or horn colour. It is rare. I have obtained it thrice. On the second occasion, after a long interval, there might be 100 cells dispersed among various specimens. On the third occasion, several hundred cells were dispersed amidst tufts.

Vol. I. Plate XII. Fig. 11.—*Avenella fusca*, enlarged.

§ 6. Triticella flava.—Plate XIX. Fig. 7.—In the course of many years, occasional opportunities have afforded the inspection of a number of zoophytes, but some of them so imperfect, others so transiently, or their occurrence has been so rare and accidental, as to restrain any confidence in conjectures, either regarding their ultimate form, or their permanent habits. I could quote a multitude of examples, though, I fear, they would be little to the edification of the reader; nor have my perplexities been relieved by the works of those learned authors coming within my reach.

The only method whereby naturalists can preserve each other from a similar dilemma, or can aid reciprocal researches, is to multiply accurate delineations of the subjects which they find in their research. It matters not though many superfluities should be among them; as from that, science will suffer nothing.

Whether any compound zoophyte, that is, the organic combined with an inorganic part, or with a cell, exists in our Scotish waters, as restricted to a single hydra, I cannot pretend to affirm; because, in as far as my experience extends, this peculiarity belongs only to those in the earliest stages, that is, while the product to which it belongs is immature. The latter exhibit more or less numerous societies, when their history can be followed, all sustained as the flourish of plants or otherwise.

But it is not necessary that animals thus growing in the semblance of plants, should be rooted on inanimate substances, for the quiescent habits of various creatures afford as sure and undisturbed a foundation upon them. Colonies of zoophytes, and the most luxuriant vegetation, alike invest and overspread the surface. Many curious and interesting specimens of living creatures, thus bearing a load of parasites, may be obtained. Such are implanted on the languid and inactive crustacea and testacea, scarcely ever quitting the cavities of the rocks or the pools on their surface. I have seen one of the former wholly covered by a profusion of the Sertularia, which even invested the limbs.

The skin of the ascidia, which is an animal affixed immoveably to the same spot, from its origin, admits the reception of similar elements, affording a nidus for development from the origin to maturity.

An instance of this appeared from thirty or forty single hydræ in their cells, resembling so many spines, about two lines high, to the naked eye, seated on the skin of an animal which I was inclined to associate with the Ascidiæ.

I have had various specimens of this animal, chiefly from the confines of the German Ocean, but none so perfect, so recent or vigorous, as to determine its certain position. However, it seems to be a cognate of the *Polyclinium aurantium*, represented by M. Milne Edwards, in his Treatise *Sur les Ascidies composés*, the only portion of that author's observations on the Ascidiæ which I have seen.—Plate XXXVI. fig. 1.

Under the microscope, this zoophyte was found consisting of an ovate cell, sustained by a cylindrical, smooth, transparent pedicle, about half its length, and a fifth part of its diameter. Within the cell, the hydra at rest remains folded on itself, like similar ascidian tenants, with the orifice above closed over it. But the fold relaxes as the hydra rises to protrude its pencil of tentacula through the orifice, which are soon expanded as twenty long, ciliated, percussive organs, endowed with the wonted faculties of the race. The neck, when protruded, is so transparent, as to expose deglutition of the buoyant particles tossed about among the tentacula.

The cell is apparently somewhat of membranaceous texture; it becomes distorted, and it stands awry on its pedicle. The orifice rises with the protruding animal, and contracts on its retreat. From the disproportion between the cell and the pedicle, this zoophyte waves with the slightest motion.

The form of the cell bears some resemblance to a grain of wheat, and the whole colony tended to faint yellowish colour.

As the substance of the Ascidia sustaining the zoophytes seemed in a short time verging to decay, I separated a thin slice of the skin, which, pierced with a needle, was suspended by a thread in a convenient position among sea-water.

The skin now remained entire; the hydræ upon it were also preserved, but none of them survived above eleven or twelve days from the time when they were taken, which was in the end of June. They died in the cell, the body being attached to the lower part.

Thus, if these hydræ shall be considered nascent animals, as is probable, their genus can be ascertained only from the mature or adult specimen, on the ultimate form and appearance of which it would be vain to speculate.

Plate XIX. Fig. 7. *Triticella flava.*

§ 7. Crisia eburnea. — *Tufted Ivory Coralline.* — Plate XIX. Figs. 8–13.—So many different elements are combined in this zoophyte, as to render its precise place in the Systema questionable, until determined by the additional light which may be thrown on its nature. But it is one of the smaller and more delicate species, and its aspect is so well defined, as to preclude any mistake in regard to identity.

The tufted ivory coralline rises nine lines or little more in height, and diverges as much across, by subdividing boughs and branches, all the parts incurving over its short stem. A double row of cells in semi-alternate arrangement, and considerably apart from each other, clothes the inside of the branches. Owing to the effect of this disposal, the exterior of the specimen is of irregular convexity. The subordinate parts are articulated; each articulation comprehending several cells. The whole is of the purest white, and of shelly consistence, brittle to the touch.—Plate XIX. figs. 8, 9. A portion enlarged, fig. 10.

An ascidian hydra, with eight tentacula, inhabits the cell, which has a low projecting lip; and as all project inwards, they are difficult to be seen, unless the subject be reduced to fragments. A very minute portion, thus obtained, is magnified, fig. 11, and the hydræ, figs. 12, 13. The tentacula issue forth as a pencil; they recurve slightly when unfolded: they are of slender proportions, and exercise the percussive faculty of their kind. The higher extremity of the body scarcely protrudes beyond the orifice of the cell. In as far as the rest can be observed, the whole animal is small and pellucid, or of the faintest grey. A dark reddish internal object is visible, far down the cells, as in other species.

Ovular bodies, of considerable size, with an orifice in the summit, are

sometimes seated on the branches singly, or six or seven in a row, but without occupying any uniform or determinate position. I do not recollect the occurrence of vesicles on any of the ascidian zoophytes, nor have I been able to ascertain the nature of the substances in question. One seemed full of dark triangular objects; some are shaped like a cup, but the general form is ovular.

This product appears always as a parasite, profusely dispersed over other zoophytes. However, it is very seldom to be found alive, in a suitable state, and, above all, in a proper position for delineation.

PLATE XIX. FIG. 8. *Crisia eburnea.*
9. Another specimen.
10. Portion of fig. 8, enlarged.
11. Portion of a specimen with hydræ.
12. Hydra enlarged.
13. Hydra enlarged.
Figures 8, 9 of this Plate natural size, the rest are enlarged.

§ 8. CORYNA GLANDULOSA—HERMIA GLANDULOSA, Dr Johnston.—PLATES XXI., XXII.—It is difficult to discover why former naturalists, in general, should have approximated this zoophyte to the hydraoid zoophytes, for there is no immediate relation between them: as little can it be associated with the ascidian tribes, from which its position is equally distant. In fact, there is none of this country, known to me, bearing it any kindred. The most prominent feature distinguishing it, from all others, is the absence of hydræ, which precludes its reception, as much as that of sponges, among the race of zoophytes, with which naturalists are familiar. Yet the *Coryna glandulosa* is capable of exercising certain active functions, though nothing to be compared with the part which is borne by that most essential part of organization, the hydræ, belonging to so many genera of the lower animated products. I have had a number of specimens, undergoing careful examination, also, at all times. Therefore, I can only say, that the product, which at present seems to be entirely *sui generis*, may have exposed to others what I have unsuccessfully sought.

It is one of the smaller zoophytes, rising about an inch in height, by an erect stem, meagrely provided with branches, irregular in dimensions, position, and intervals, and likewise in their subordinate parts.—Pl. XXI. fig. 1. The same enlarged, fig. 2.

The stem and branches are faintly annulated, and all the extremities are obtuse.

It will be recollected that the hydræ of the *Campanularia verticillata*, are borne on sets of pedicles.—Vol. I. Plate XII. fig. 1. Here, in lieu of hydræ, sets of four spherules, standing on pedicles, nearly at right angles to each other, are dispersed over the product. Under a powerful magnifier, the surface of these sperules appears rough or papillous, composed of prominences. They have an adhesive quality.—Fig. 7.

The stem is a cylindrical tube, remaining vacant on decay of the pith. The summit is obtuse, wherein if there be an orifice, I never saw it open. But small muddy rolls have appeared in vessels containing no other animal perceptible.

Like the adult Pedicellina, the whole parts of the Coryna are capable of spontaneous inflexion. Moreover, the spherules on their pedicles have a slight percussive faculty, though nothing to be compared with that of the zoophyte just named. It is in the upper part of the stem that the flexible property chiefly resides. There, a complete recurvature can be made downwards, so as perfectly to resemble a shepherd's crook, while the plain or lower part of the stalk, free of the series of spherules and pedicles, remains quite erect. The summit is sometimes bent down, almost to the root: and the motion is such as to prove inconvenient for delineating the subject.

Some specimens are very pale, the finest are red.

Spherules of a different character from those above described, and either solitary or in clusters, are connected by the shortest pedicles with different parts of the product. Nine such spherules, red, of irregular size, with a darker nucleus, constituted the most numerous cluster that was observed. Probably they are gemmules, containing the embryo Coryna. But, spite of every precaution for their suitable preservation, and the development of the young, should it be so, I have been unable to verify my conjecture, which others may have done with facility. Without leaving

any visible result, these objects have disappeared successively from the specimens bearing them. The group of Corynæ, fig. 4, of which figs. 5, 6 are clusters enlarged, was delineated along with them on June 24. Scarcely any of the gemmules composing them remained on this group on July 3, when the stalks were sufficiently vigorous. Next day, 20 or 25 corpuscula, bearing resemblance in every thing to the corpuscula originating from the Actinia, lay in the bottom of the vessel. They were, for the most part, of a rude ovoidal figure, several nearly spherical, of reddish brown colour, and consistent solid aspect. Some, besides, swam heavily in all directions, their motion being, apparently, effected by means of cilia.—Fig. 8. In four days they became stationary, but nothing more decisive followed.

I have twice observed a number of corpuscula, as if suspended amidst transparent jelly, at the summit of adult specimens. However, the spawn of various minute animals is frequently seen of such a form.

This product always resembles a meagre and distorted shrub in miniature. It is founded on rocks, on shells, and sometimes appears as a parasite on other zoophytes. Its position is usually above, and its growth vertical; but, on removing portions of shelving rocks, at about half-tide, I have seen numbers growing inverted, with the summit downwards. Under these conditions, the Coryna is less exposed to that adventitious matter, often rendering it very foul in other situations,—so much so as to obscure the parts.

PLATE XXI. FIG. 1. *Coryna (Hermia) glandulosa.*
2. The same, enlarged.
3. Another specimen, bearing gemmules.
4. Group of Corynæ, invested below by foreign matter.
5. Summit of a branch, bearing gemmules.
6. Summit recurved, bearing gemmules.
7. Summit, shewing the arrangement and aspect of a set of spherical heads and their pedicles, magnified.
8. Corpuscula.
All the preceding figures, except the first and fourth, are enlarged.

PLATE XXII. Group of *Coryna (Hermia) glandulosa*, enlarged.

CHAPTER V.

CALCAREOUS ZOOPHYTES.

All the preceding zoophytes, the naked polypi or hydræ excepted, are compounded of two distinct principles, one of them evidently organic, or carrying on the active vital functions.

The office performed by the other is not alike evident, and as we have said, it is called inorganic, as much in contradistinction to the former, as from the belief of its defective vitality.

This second portion consists of different elements, according to the nature of its tenant, as would be found on chemical analysis. Whence, zoophytes are combined with gelatinous, membranaceous, and calcareous formations, as the most obvious principles. Some others, less decided, also enter the inorganic parts.

The present chapter, miscellaneous like the last, contains a few general notices on zoophytes, whereof the polyparium is strictly calcareous.

§ 1. Flustra membranacea.—Plate XXIII.—As an introduction to the subject, a product which is classed with the Flustra, may be described, while the polyparium, to external appearance, is wholly calcareous, and thence, perhaps, it may be found closely allied to the Lepralia.

In our present state of knowledge, the precise position of some zoophytes becomes embarrassing; first, because the leading features of organization do not seem to be definite; secondly, because no practical observer can possibly enjoy the opportunity of inspecting and studying all the intermediate links connecting genera. These points will always render the place of many zoophytes provisional, more especially such as are of recent occurrence.

The present subject is diffused as a single stratum, for the most part investing the leaves of the *Laminaria digitata*, or common tangle.

It may be easily recognised by its whitish colour, and stellate form, extending by irregular prolongations, which terminate in some orginating cells. Specimens are of very various dimensions, from a small spot to a considerable superficial area, equalling several square inches.—Pl. XXIII. fig. 1.

This zoophyte spreads its single stratum of cells over the leaf, under slight modifications of form, sometimes oblong, and with curving sides.

The cell itself, when apparently in greatest perfection, tends to an elliptical shape, and is guarded by six marginal spines; the whole, however, are not peculiar to each single cell, but are set on the margin or partition common to two cells. The figure of the cell may be more liable to modification, according to the difference of specimens.—Figs. 2, 3.

They are partially covered by each other in their respective rows.

An ascidian hydra of such transparence as to be indistinctly seen when stretching over the others, is the occupant of the cell. It is the posterior portion of the body which is covered by the cell behind. Nothing peculiar distinguishes the hydræ from the ordinary nature of their race, figs. 4, 5. But I have had considerable difficulty in obtaining them alive, fig. 6. On contamination of the water many drop from their cells.

The increment of the product seems to be effected by an embryo advancing between two perfect cells with their hydræ. Thus the central cell between two in maturity with their hydræ displayed, is advancing at the upper extremity of fig. 7.

The naturalist should be warned that the noxious principle speedily imparted to sea-water by the *Laminaria digitata*, though seeming in the freshest condition, becomes fatal to all zoophytes within its influence.

PLATE XXIII. FIG. 1. *Flustra membranacea* on a leaf.
2. Perfect cells.
3. Cells of modified form.

Plate XXIII. Fig. 4. Hydræ, profile.
5. Hydræ protruding from their cells.
6. Hydra fallen from its cell.
7. Increment of the *Flustra membranacea.*
All the figures, except the first, are enlarged.

§ 2. Lepralia.—*Sea Scurf*, Dr Johnston.—*Berenicea*, Dr Fleming.—Plates XXIV., XXV.—On this section, treating of the Calcareous Zoophytes, I can offer but a few of the most general observations; nor, perhaps, will they prove very satisfactory to those in quest of minute and special information. None of the race, I am induced to believe, has yet undergone such accurate and permanent investigation as is indispensable for illustrating the subject. Hitherto the skeleton alone having been the principal object of consideration, more remains to be said of the Lepralia by those enjoying favourable opportunity, than perhaps of the majority of zoophytes.

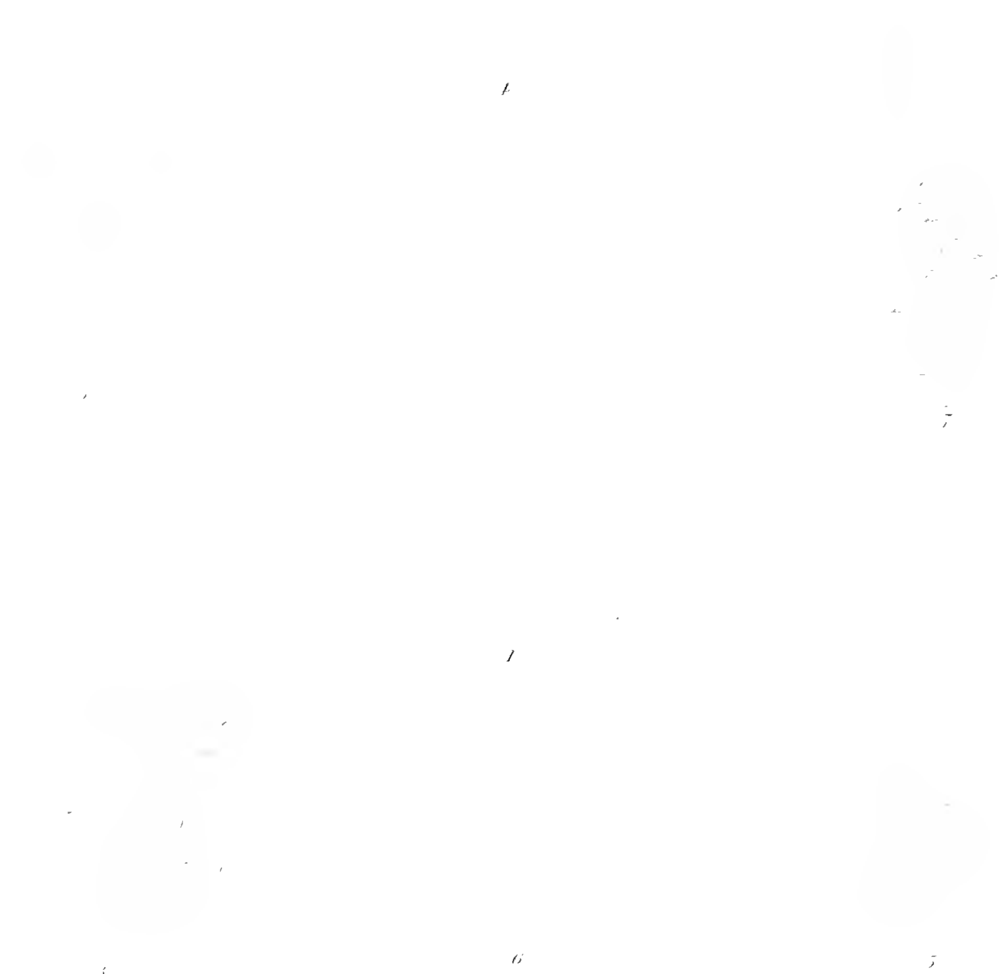
We shall be somewhat aided in this obscure branch, by recurring to the preceding paragraph regarding the *Flustra membranacea.*

If I rightly comprehend what naturalists understand by the Lepralia, its formation in the living state seems equally indistinct and indefinite; it is neither clearly seen, nor of determinate figure. This may probably result from its increment advancing in unequal rate and proportions from different parts, at different times, but not from all the circumference at the same time. Farther, it is generally after increment of a specimen has ceased, and after its hydræ, the authors of it, have perished, that the actual shape is sufficiently exposed to view.

I do not infer from the substance of this remark, however, that the hydra is the actual fabricator of the substance of the Lepralia, more than that the hydra of the fistulous zoophyte fabricates its own cell.

Possibly in the Lepralia, as in some of the preceding, which partake more or less of calcareous nature, the polyparium results from an animal secretion.

While a specimen appears as an orange or a carnation patch, with a kind of fullness, as viewed by the naked eye, the surface proves rugged,



Flustra Membranacea

irregular, and void of symmetry under the microscope. Next, as spreading like a black patch over the pearly inside of shells, the cells when cleansed of impurities are discovered advancing to decay.

Until we can speak of the origin and progress of increment of a specimen, whereby its mode of enlargement shall be understood, its real formation cannot be satisfactorily elucidated.

Probably the cell alters soon after the decay of the tenant, whence there cannot be a strict correspondence between the living specimen and the dead.

Many are found in the interior of bivalves, apparently promising a long period of security, yet they are rarely surviving.

Let us assume, in general, that the Lepralia may be defined an investing, calcareous, cellular scurf.

(1.) Lepralia pustula.—Plate XXIV. Fig. 1.—If the prolific ovum or the gemmule of the Lepralia could be obtained, we might discover how its original adhesion is effected, and next how the augmenting cells are developed or acquired, and thence ascertain the circular, quadrangular, or irregular figure exhibited in greater maturity. Nearest to this is the selection of some specimen, whose growth to appearance is unrestrained and unobstructed.

A patch, of what I shall denominate, provisionally, the *Lepralia pustula*, was diffused on the inner surface of an old oyster shell of large dimensions. The whole seemed to radiate from a common, perhaps the original centre, and on reaching the circumference, was terminated in several irregular curves.—Plate XXIV. fig. 1. The same enlarged, fig. 2.

The surface of this specimen was composed of half ovoid cells, with a plain semi-elliptical orifice near the summit. A serrated circle, with a small semi-elliptical aperture behind it, begirt the base of each cell. Intervals separated the cells, which themselves inclined inwards, the orifice being directed towards the centre of the specimen, figs. 2, 3.

The serrated circle is to be discovered only by a high magnifying power, fig. 4.

Other specimens seemed to correspond with the preceding conformation; all apparently diffusing from an original central point.

The aspect of the circumference indicates that increment ensues after the fashion witnessed in the Flustra. New cells are preparing on the exterior of fig. 5, *a*, *b*.

The direction of the cells shewed that there was much correspondence between the generation and evolution of the hydræ with those of the *Alcyonidium mytili*, as betrayed by the advancing embryo of the latter.

This product is rare, nor have I been able to procure it alive. But the subject is introduced principally to evince that its enlargement is probably by diffusion around an original cell.

All those occurring to me have been seated on mussel and oyster shells.

In three months, the specimen represented became white as snow, and penetrated by numerous minute punctures.

PLATE XXIV. FIG. 1. *Lepralia pustula*.
2. The same enlarged.
3. Cells, profile.
4. Cells with a serrate circle environing the base.
5. Portion of the circumference of figs. 1, 2.
All the figures, except the first, are enlarged.

(2.) LEPRALIA EDENTATA.—*Toothless Sea Scurf*.—PLATE XXV. FIG. 1. —A specimen of this Lepralia spread irregularly as a white crust on an old oyster shell, and turned over the edge, in which respect the genus resembles some of the Flustræ. It was composed of cells, apparently smooth, and without teeth; of unequal dimensions, nor of true elliptical or ovoidal form, though seemingly oval. The cells were not arranged in reciprocal order. Pale grey, very lively, ascidian hydræ, with about twelve tentacula, occupied them.

PLATE XXV. FIG. 1. *Lepralia edentata*, portion with hydræ enlarged.

No suitable representation after nature is admitted by many of such diffusing products. They cannot be rendered intelligible.

(3.) Lepralia punctata.—Plate XXV. Fig. 2.—A specimen spreading in no definite form, invested both sides of an old oyster shell of small dimensions. One portion of faint orange colour, consisted of cells fashioned as a conic frustum, with an orifice in the summit, and in position inclining slightly on each other. An ascidian hydra, with about 15 tentacula, resembling some of the alcyonic hydræ, dwelt in the cells, fig. 2. The orifice is not exactly circular; and the base of the cell is environed by many minute apertures, penetrating the incrusting substance of the Lepralia, as best exposed in a portion, fig. 3, which had lost its tenants.

Plate XXV. Fig. 2. *Lepralia punctata;* portion enlarged.
3. Another portion, having lost the hydræ, enlarged.

(4.) Lepralia nitida, Dr Johnston.—Berenicea nitida, Dr Fleming.—Plate XXV. Fig. 4.—The decay of a specimen of the *Botryllus*, covering part of a shell, exposed this product as investing a portion which had been under its site.

The *Lepralia nitida* consists of approximated ovoidal cells, somewhat resembling a cask, with a wide orifice. Several ribs from each side joins a broad vertebral-like line.

Plate XXV. Fig. 4. *Lepralia nitida*, enlarged.
5. Cell more enlarged.

(5.) Lepralia lineata.—Plate XXV. Fig. 6.—The form wherein this product spreads over other substances is no farther limited, than assuming somewhat of a fan shape. But the cells are indistinct. Where plainest, they seem an ovoidal segment with an irregular orifice, on which one or more spines are seated. Rows of cells, as if radiating from a central or interior part of the patch, and extending outwards, are separated by lines. The exterior marginal portions probably indicating what were originating, abortive or decayed cells.

Soft-looking orange corpuscula are dispersed irregularly in the cells during the month of July; and in one specimen, they occupied almost the whole of those of the margin. Though kept a long time, nothing resulted from them.

More satisfactory inspection of such Lepraliæ is obtained by moderate magnifiers, than by those of higher powers.

Plate XXV. Fig. 6. *Lepralia lineata.* Portion enlarged.

(6.) Lepralia margarita.—Plate XXV. Figs. 7, 8, 9, 10, 11, 12.—Under a lens, this species resembles so many rows of pearls. It is pure white; but not of any definite form.

The surface of a patch is composed entirely of irregular cells, with a wide orifice, guarded by one or two spines.

Many of the cells contain a large orange spherule.

This Lepralia invests mussel shells.

Plate XXV. Fig. 7. *Lepralia margarita* on a mussel shell.
8. Part of the same, enlarged.
9. Another specimen.
10. Part of the same, enlarged.
11. Corpusculum or gemmule, apparently mature, in one of the cells, enlarged.
12. Another.

(7.) Lepralia spinosa.—Plate XXVI. Figs. 1, 2.—A specimen occurring to me might have been contained in a rude quadrangle, each side extending about five lines. The surface rose in slight convexity, but the thickness of the Lepralia, a mere scurf, did not exceed the depth of a single cell. The whole was distinguished by a reddish-purple colour.

The surface of this species is composed entirely of cells, interspersed with spines, one of these probably rising from the base of each.

The cells have a circular orifice.

Apparently the specimen had diffused on a shell originally, and spread over some depressed or adhering stalks of the *Tubularia indivisa.*

Plate XXVI. Fig. 1. *Lepralia spinosa.*
2. Portion enlarged.

Lobularia Pustulosa

(8.) Lepralia trispinosa.—Plate XXV. Fig. 13.—A specimen of this Lepralia was irregularly circular, about four lines in diameter, and of reddish colour. These cells were of a broad oval shape, with a peculiar orifice towards one extremity, the edge of the lip as if projecting over it. Most of the cells have three, and some of them four long spines, guarding the exterior part.

Probably the reddish colour results from corpuscula or gemmules occupying the cells.

Plate XXV. Fig. 13, *Lepralia trispinosa*, portion enlarged.

(9.) Lepralia squama.—Plate XXV. Figs. 14, 15.—A specimen which invested a living *Ascidia rustica*, precisely as a large scale, might have been circumscribed by an ellipse extending eight lines by six. Its figure was irregular, and the surface, following the convexity of the ascidia, rose in corresponding form.

The cells of this product tended to a circular shape, with a large, flattened triangular tooth inclining over each; and on the opposite margin seemed to be two short stumps. Red and white colour variegated the whole.

The Ascidia having died from previous injury, or from some other cause, admitted of the Lepralia being detached entire, as the skin of the animal softened. Then it separated as a large thin scale. Two or three weeks subsequent to removal, the colour was converted to pure white, and the substance had become very brittle, now exposing the configuration more distinctly.

Plate XXV. Fig. 14. *Lepralia squama.*
15. Portion enlarged.

On the whole, my observations on the Lepralia have been far from satisfactory. The object is always microscopic, seldom plain and definite, and commonly impaired, or in decay.

Many original specimens, and accurate delineations, are still indispensable to render the subject explicit.

§ 3. CELLEPORA.—PLATE XXVI. FIGS. 3–14.—The uncertainty of the real condition of the calcareous zoophytes when recovered, the difficulty of preserving them alive, the unknown circumstances tending to their welfare, added to the mutilated state wherein they are usually found. all conspire to render this branch of our enquiry as obscure as the last.

Both in association and in description a certain latitude of conventional expressions must be allowed, for we are neither so familiar with the nature of the subject, nor is language as yet sufficiently copious to convey what is required to be understood regarding it.

The name *Cellepora*, like the appellative *Cellularia*, is of too indefinite a character, could we find a proper substitute, for in truth nothing is explained by either. They carry no distinct signification along with them.

However, overpassing such an imperfection, and leaving it to future rectification, I shall, from necessity, offer little on the subject, unless the representation of a few species, along with some very general observations.

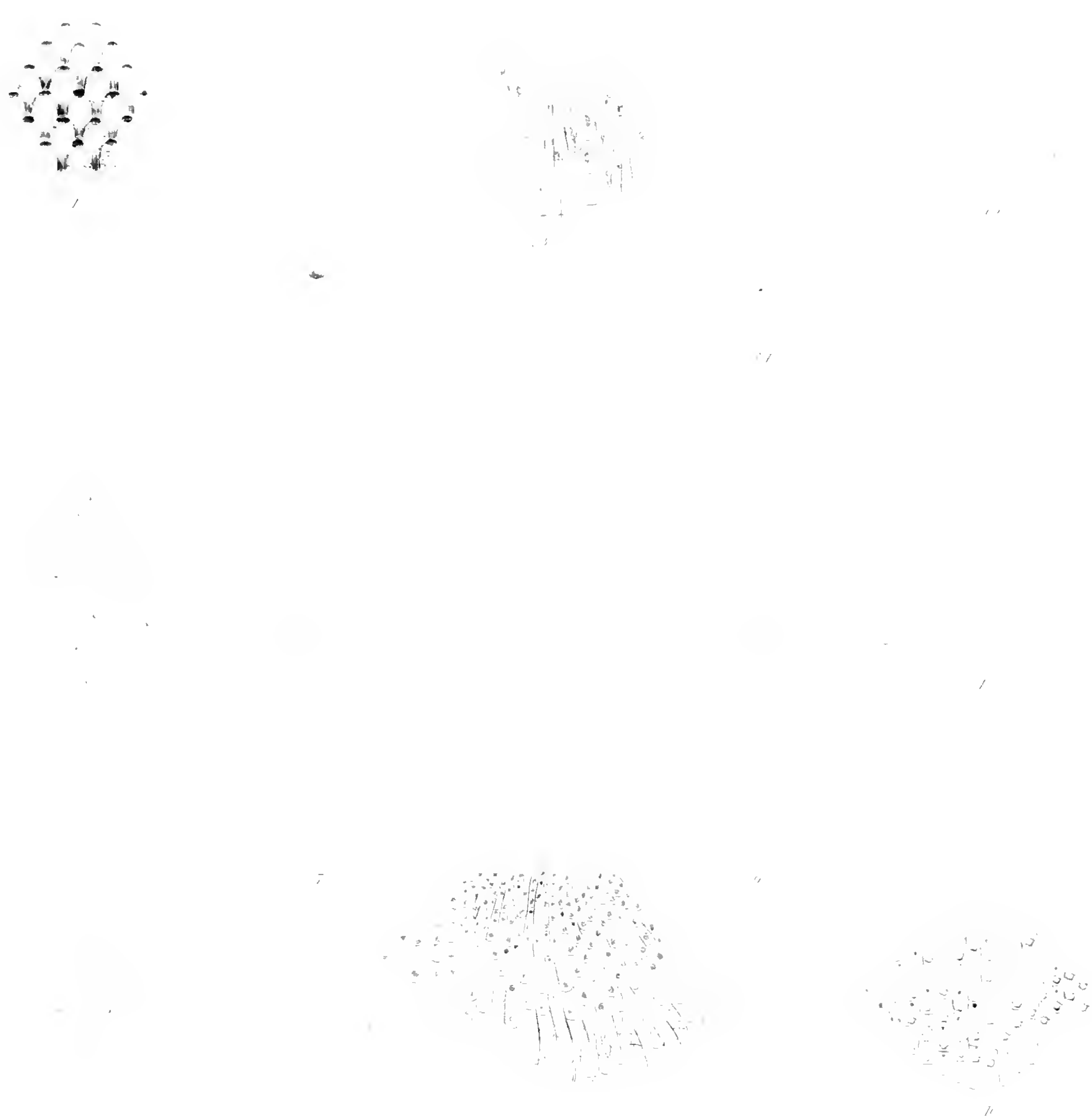
(1.) CELLEPORA CINGENS.—PLATE XXVI. FIGS. 3, 4.—The nature of this species is obscure. It always invests small and delicate substances. growing somewhat cylindrically around them, but thicker in the middle. which perhaps indicates more than a single stratum at the place. Thus it may be called a broad, greyish, circular belt, the surface wholly composed of cells, which tend to a ventricose form, being wider at the middle than the orifice.

The cell is occupied by a very minute light grey ascidian hydra, with about 14 ciliated tentacula, broadening slightly towards the extremities, but little recurved. The cilia are of difficult detection.

Only a small portion of the animal protrudes from the cell. It is extremely flexible, turning freely from side to side. and exhibiting the usual habits of its race.

Many of the animals are often displayed at once.

PLATE XXVI. FIG. 3. *Cellepora cingens.*
4. Portion of the surface with hydræ, enlarged.



(2.) Cellepora pumicosa.—Plate XXVI. Figs. 7, 8, 9.—The subject of this paragraph has always occurred to me, like the former, as a circular or cylindrical parasitic belt, surrounding other substances.

The outer surface of larger specimens exhibits various irregularities, as prominences and depressions, apparently corresponding with a similar formation of the inner surface.

Perhaps the thicker parts may consist of more than a single stratum.

The exterior is composed wholly of cells, with a circular orifice, inhabited by a lively, active, ascidian hydra, having about 14 ciliated tentacula.

One specimen, which was certainly very old, invested the tube of an *Amphitrite* ventilabrum, forming a hollow cylinder, two inches and a half in length, by an inch of internal diameter. The interior was very irregular; probably resulting from the presence of other substances on the surface of the tube invested. Both ends were thin, their increment being obviously advancing.—Plate XXVI. Fig. 7.

Another smaller specimen, with several obtuse prominences, is represented, fig. 8; and a portion of the surface, enlarged, with the hydræ, fig. 9.

On a third, a younger and augmenting specimen, an imperfect cylinder, with attenuated edges, pale grey ova, as I concluded them, were dispersed.

The colour of this product is generally dingy white, or yellowish.

Its largest dimensions seem to be attained in deep water.

The life of most hydræ is short; but those of fig. 8 apparently survived some months. Such facts are nevertheless difficult to be proved, for we cannot ascertain whether the old or the young are before us.

Plate XXVI. Fig. 7. *Cellepora pumicosa.*
8. Another specimen.
9. Surface of fig. 8. with hydræ, enlarged.

(3.) Cellepora ramulosa.—Plate XXVI. Figs. 10, 11, 12, 13.—The preceding species are generally very superficial, investing Cellepores, but the present zoophyte approaches more nearly than any other native calcareous marine productions to the formation of the white coral of warmer climates. It is particularly distinguished by consisting of a number of branches, as the name denotes.

Small specimens are of frequent occurrence; those of larger dimensions are rare; the finest specimens being perhaps recovered from deep water.

The branched Cellepore is usually of pure or dingy white, sometimes yellowish, or tending to orange colour. It rises from three to eighteen lines, or more in height, by a short stem, and then divides into a number of branches, which probably multiply in proportion to the age of the subject.

The whole surface is occupied by cells, containing lively, active, almost transparent, hydræ. These animals have about 15 tentacula, but this number is not uniform; and many of the hydræ are light grey.

A specimen tending to orange colour is represented, Plate XXVI. fig. 10:—Its hydræ enlarged, fig. 11. Another specimen is seen, fig. 12. The extremity of a branch of this subject, fig. 13, shewed a number of stout spines, interspersed with the hydræ,—possibly indicating a variety.

Many single red spherules occupied cells of fig. 10, which were vacant of hydræ.

The great irregularities of form and condition pervading the calcareous zoophytes, represses the reference of individual specimens to particular genera and species.

A specimen, extending scarcely three lines, of dingy white, and resembling a portion of the *ramulosa*, occurred in April. Ascidian hydræ, with about 12 tentacula, protruded from the prominent orifices of the cells. Single reddish-orange spherules occupied those which were empty.—Plate XXV. fig. 14.

PLATE XXVI. FIG. 10. *Cellepora ramulosa*.
11. Hydræ, enlarged.
12. *Cellepora ramulosa*.
13. Extremity of a branch of fig. 12, with hydræ enlarged.
14. Portion resembling a fragment of the *Cellepora ramulosa* with hydræ, enlarged.

(4.) Cellepora iris.—Plate XXVI. Figs. 5, 6.—Various Cellepores, as well as many other subjects, occur in the course of research, to which, without finding them in a living and perfect state, in different stages, and of different dimensions, the observer is unable to assign their proper place.

It must be also taken in view, that while the orifice of the cell is apparently circular to the naked eye, or under moderate enlargement, it will be found rugged and irregular under powerful magnifiers.

The same remarks apply to the aspect and the arrangement of the component parts of the whole surface of almost all the calcareous zoophytes.

The subject here represented is of solid compact substance, in form rudely resembling an Iris.

Plate XXVI. Fig. 5. *Cellepora iris.*
6. The same, enlarged.

Membranipora Pilosa.—Plate XVIII. Figs. 16, 17, 18, 19, 20, 21, 22.—Perhaps the true place of this zoophyte is between the Lepralia and the Cellepora.

Nature is so far from exhibiting uniformity and regularity in all her works, as many are prone to conclude, that this opinion proves applicable only to general resemblance. Though the naturalist may presume on the identical genus, or the identical species of two different subjects, it is often vain to attempt either uniting or separating them with confidence, unless through the medium of many intervening auxiliaries. He is confounded by some trivial or apparent discrepancies of structure. Specimens have undergone such extraordinary mutilations, that experience alone, nor always that, can determine or conjecture what may be their real formation. Thus, a series of perplexities, such as repeatedly alluded to, ensue, and never to greater extent, nor in greater frequency, than among the calcareous zoophytes.

Thus, whatever I shall continue to say, must be regarded as mere notes, liable to revisal and correction. At the same time, these remarks are not intended as impugning the unity of design.

The *Membranipora pilosa* is one of the more diminutive zoophytes, which should be perhaps deemed an investing *calcareous*, more than a *membranaceous* incrustation. In general, if not always, it is a parasite.

Its genuine colour is white, but it often partakes of the hue of the substance invested.

I cannot affirm what may be the most luxuriant state of this product. But, in earlier, and I apprehend also in later stages, it is composed entirely of a stratum of irregularly elliptical, dentate, superficial cells. A profusion of very long, slender, rigid bristles, covers the surface of the stratum.

If the stratum thicken with age, the colour of the substance invested may then have little effect on its appearance. It follows the form of the substances invested; which seem in preference to be the slender Algæ or Sertulariæ. Thus, specimens of the *Sertularia falcata* bear it in great abundance.

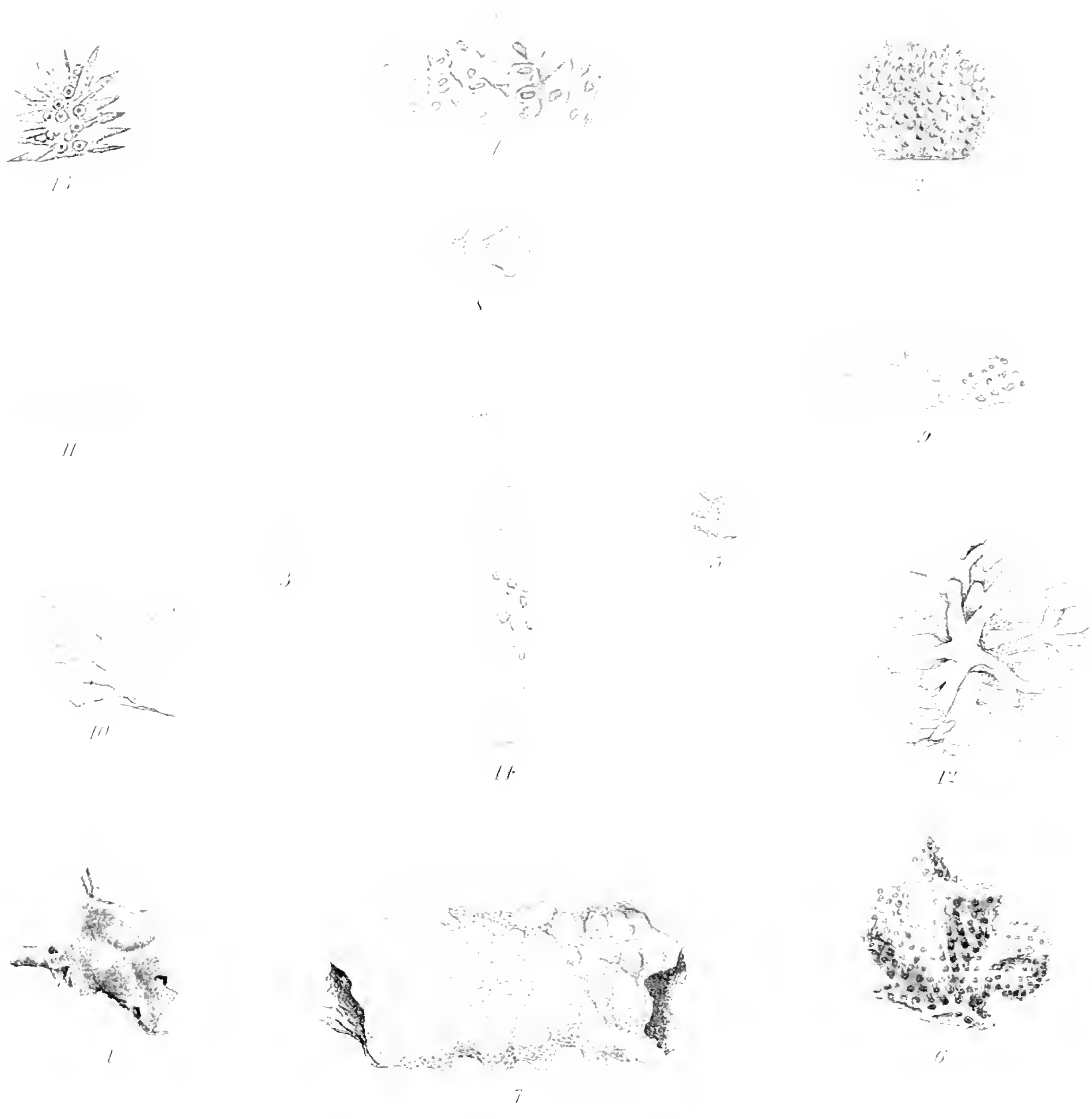
The elliptical orifice of the cells, studding the crust, wherein sunk, is guarded by eight marginal spines, about as long as equal to half the width of the cell. They are white, and incline slightly over the cavity. The long bristly processes, besides, are dispersed over the whole product. Dr Fleming remarks, in his distinct and accurate description, that "the spine or tooth, near the base, is prolonged into a long bristly hair."

I feel much disposed to conclude that there are either varieties of the *Membranipora pilosa*, or that some are totally divested of the bristles, which, indeed, seem little calculated for resistance.

A specimen, investing one of the delicate Algæ, is represented Plate XVIII. fig. 16; and a portion as viewed by the microscope, fig. 17.

The cell is inhabited by a very vivacious, light grey, ascidian hydra, with 12 tentacula; at least, these have been ascertained, in some individuals, fig. 18. As the one cell lies partly under another, the animal issues upwards, from below, to display itself.

There may be specimens, whether identical or kindred, wherein the



Lepralia 1, 2. Cellepora 3–14.

long bristly processes are entirely wanting, or wherein the marginal spines are developed with less regularity. The discrepancies apparent in such diminutive objects may be deceptive.

A specimen, investing the *Tubularia indivisa*, is represented, fig. 19. Portion enlarged, fig. 20. One investing the *Sertularia (Campanularia) dichotoma*, is seen, fig. 21. Portion of the surface, enlarged, fig. 22.

PLATE XVIII. FIG. 16. *Membranipora pilosa* investing a slender substance.
17. Portion enlarged, shewing the hydræ and bristles.
18. Hydra.
19. *Membranipora pilosa* investing a stem of the *Tubularia indivisa*.
20. Portion of the same, enlarged.
21. Specimen investing the *Sertularia (Campanularia) dichotoma*, enlarged.
22. Part of the surface of the same, more enlarged.
Of the preceding figures, 17, 18, 20, 21, 22. are enlarged.

TUBIPORA SERPENS.—PLATE XVIII. FIGS. 11, 12, 13, 14, 15.—This is a diminutive, calcareous, tubular zoophyte, of which the nature seems to be yet but indifferently understood.

When recent, it is of purplish colour, gradually refining into pure white, like many other zoophytes.

It appears under two different aspects, as a substance with tubular extremities, either adhering by a contracted basis to some foundation, or rising by ramifications from that foundation. The latter form is the more frequent.

These ramifications consist of transverse rows of tubuli, composing a common wall by their approximation, there being seldom any distinct separation of them. The number in a row seems indefinite, and apparently depending on the form, age, and dimensions of the specimen, Plate XVIII. fig. 11. The same enlarged, fig. 12. Another specimen, fig. 13: enlarged, 14. Another specimen natural size, fig. 15.

This product is always seen as a parasite. In earlier stages it rather assumes a fan shape, expanding into those divisions compared to ramifications, when more mature. But the form of the growth may be modified by position. When established on the slender parts of the Sertulariæ, it appears to most advantage, the subordinate organization then projecting free and uninterrupted. In the course of increment elsewhere, however, it often becomes so confused, as to produce more resemblance to an irregular investing scurf, which precludes comparison to any definite figure.

The tube is occupied by an ascidian hydra with twelve tentacula, as enumerated in two individuals. But some have certainly more.—Fig. 15, *a*.

Very minute corpuscula whose origin could not be ascertained, appeared in a vessel containing specimens of the Tubipora.

The whole substance of the polyparium is hard and shelly.

PLATE XVIII. FIG. 11. *Tubipora serpens*.
12. The same, enlarged.
13. Another specimen.
14. The same, enlarged.
15. Another specimen, natural size.
$\frac{15}{a}$. Hydræ in their tubes, enlarged.

CHAPTER VI.

LUNATE ASCIDIAN ZOOPHYTES.—CRISTATELLA, ALCYONELLA, PLUMATELLA

By the general dispositions of Nature, the form of the active organic portion of most zoophytes admits of comparison to a flexible funnel—one of variable dimensions and capacity, through the influence of a number of ribs—the tentacula. These important organs are endowed with many faculties—so many, indeed, that some of them cannot be confidently explained. They are enabled to attract, seize, and to transmit the matter necessary for sustenance of the hydra downwards to a central orifice constituting the mouth; and such currents are produced in the water as conduce to the renovation of the aërial fluids, essential for preserving its salubrity. The food is conveyed to the stomach, where, by elimination and assimilation, that portion which is required for subsistence and increment of the subject is withdrawn and incorporated with the system.

From the wonted arrangement of the external parts, there are some noted exceptions, of which, the first to come under review, is the form and position of what, in the more perfect animals, would be denominated the head. There the disposition of the prehensile or active organs securing the food, is not in circular order, though alike vigorous as the others in discharging their important functions. Instead of springing from a circular lip, they issue as an entire marginal border from *around* the edge of a fleshy horse-shoe or crescent.

Thus, the hydræ of the zoophytes to fall under consideration, are of a *lunate*, not of a circular or *funnel* form.

None of this precise description, however, in as far as I am aware, belong to Scotland, as existing in a simple state. All are compound. They are combined with a fistulous, arborescent, or gelatinous inorganic portion over the origin of which they do not evidently possess any secreting influence or mechanical controul.

The family is small, consisting of but a few genera or species; and all are inhabitants of the fresh-waters of this country.

We shall have a future opportunity of offering a few observations on a marine animal, indeed, of infinitely larger size, with the higher external organs of somewhat corresponding office and conformation. But there is a material difference between the two, for the latter, inhabiting the sea, fabricates an artificial dwelling for its own protection, by a most peculiar and interesting mechanical process, not to be equalled by human skill. It cannot be incorporated with the subject now under discussion, though many analogical features may be displayed by both.

The polypus of the fresh-waters or common hydra, and the Ascidia proper of the sea, occur as simple animals unconnected with any polyparium, sheath, or receptacle for their retreat. The same remark will apply to the Hydra or *Coryna squamata*, and, as we have seen, to the *Pedicellina*, besides some others; nor is there such shelter to be obtained for the *Coryna glandulosa*, whereof so very little seems to be known. But, in as far as I am aware, a polyparium is uniformly present in combination with the lunate ascidian zoophytes; and sometimes it is of large dimensions.

It should be observed, however, that although the polyparium of any of the zoophytes may enlarge to unwieldy bulk, this ensues without influencing that of the inhabitants. Their size seems to remain always the same. It seems always alike diminutive, at least no sensible alteration is discovered, though I will not venture to deny, that some enlargement of the present, or of a subsequent generation, may follow.

In certain respects a correspondence may be found between the polyparium of the lunate ascidian hydræ, to several of those already described, and especially to that of the *Flustra hispida*; notwithstanding, they are widely apart in points alike characteristic, if not more so.

The lunate hydræ of Scotland falling within the sphere of my observation, are of three distinct genera—each appearing under a very different aspect. All are marked by the strongest features, and are deeply interesting to the physiologist.

In general description these three stand as follows :—

I. The *Cristatella*, consisting of a multitude of independent hydræ, rising as a border from a gelatinous or fleshy sole or base, which is endowed with a slow locomotive faculty.

II. The *Alcyonella*, consisting of a multitude of hydræ, rising promiscuously from a gelatinous mass or stratum, serving as a polyparium, which invests some foreign substance in firm and permanent adhesion.

III. The *Plumatella*, consisting of a vegetation in arborescent form—stem and branches wholly tubular, and, for the most part, adhering laterally to indurated or vegetable substances, the hydræ issuing from the extremities.

All these products are perpetuated by capsules or ova.

§ 1. Cristatella vagans.—*The Erratic Cristatella.**—Plates XXVII., XXVIII.—Among the zoophytes of the fresh-waters of Scotland this is, perhaps, the most remarkable of all. The features, by which it is distinguished, belong to none of the rest, nor, it may be, to any other known animal of the universe.

The erratic Cristatella is of various, probably of indefinite dimensions: in highest luxuriance exceeding two inches in length, by three or four lines in breadth. It is of a flattened form, with straight sides and obtuse extremities; or the sides are sometimes slightly curved, the body elliptical, and, considering the convexity of the surface, it rises equal to a longitudinal section of the fourth of a cylinder. The middle of the back is bare, and bordered by a triple row of about 350 erect, single, ascidian

* Perhaps *Lunatella*, as indicating the form and arrangement of some of the external parts, might be a more suitable name than *Cristatella*.

While labouring under considerable embarrassment, as I do still, regarding the identity of the genera described in this chapter, with those of other observers, I submitted a few remarks on the subject to the British Association, when assembled in Edinburgh during the year 1834. This I did principally for the purpose of inviting the attention of Scottish naturalists to an interesting field for investigation, whereon I was not aware, that any of them had bestowed special notice.

hydræ, standing vertically around it. The margin of the body, spreading somewhat beyond their origin, is rather of vascular appearance. A smooth uninterrupted surface forms the under surface or sole. Fine translucent green colours the whole product.—Plate XXVII. fig. 1.

The numerous hydræ, constituting the border of this compound zoophyte in activity, are sunk amidst the common mass or polyparium while quiescent, in like manner as the hydræ of the *Flustra hispida*, the *Alcyonium*, or *Lobularia*. When induced to return, each rises separately, protruding its cylindrical body a line above the surface of the back, crowned by a head of crescent, or lunate shape, which is environed by about 100 tentacula, as a fringe or border. These organs, in themselves, curve frequently, and strike vehemently in all directions. Possibly they are hollow; but the entire hydra is of small dimensions, as this head, or higher extremity, might be circumscribed by a circle not exceeding a line in diameter.—Plate XXVIII. figs. 1, 2. The mouth, with a projecting lip, resembles a shallow cup in the surface of the crescent. It dilates for reception of the food, which is transmitted to the stomach; from whence the intestine descends below, then to return upwards, as in the ascidian race, and terminates by the extremity of the intestinal canal under the orifice of the mouth.—Fig. 2, *a*. The intestine is about a fifth of the diameter of the body, which, through its thin integument, seems replete with water. A peculiar motion, belonging either to the intestine, or to a neighbouring vessel, is occasionally visible.

Meantime that the parts are displayed, buoyant particles are attracted and repelled, or received by the mouth, from the influence, it may be concluded, of cilia; or, when rejected, they are tossed about among the tentacula, or from one to another, or amidst the multitude of hydræ. Nevertheless, whether owing to colour, tenuity, defective light, or position, I have been unable to detect the presence of cilia, though no ascidian hydra is, in as far as I know, without them.

Here the hydræ shew great vivacity; they are evidently endowed with acute sensation. The tentacula clasp across, like the fingers of both hands closing, while each of the whole also exercises a percussive faculty; and the entire creature sinks suddenly for shelter amidst the common border, whereof it forms a part.

The true figure of the Cristatella is partly dependent on its age and dimensions, that is, the sides are bounded by parallel lines if long, or the whole is oval if short; the extremities being always curved: according to the length of the specimen the linear shape is more evident. When oval, its general aspect bears much resemblance to the Doris, its sole being alike soft and smooth. A specimen, two inches long, is of unwieldy size, and of rare occurrence in this country: nor does the breadth augment in any proportion with the length. Some have much the figure of a longitudinal section of an ellipsoid, being convex above, flattened below, and with curved extremities.—Plate XXVIII. figs. 3, 4, 5. Some are beautifully symmetrical, as the adult, prolific subject, fig. 3, enlarged, as fig. 5, the nascent specimen, Plate XXVII. fig. 13, Others, less regular, especially in their earlier stages, cannot be referred to any definite form.*

When a specimen is withdrawn from its native waters the whole hydræ are generally replete with dark muddy matter, clearly exposing the shape of the stomach. Perhaps their sustenance may be thence eliminated; and it is to be observed, that whenever the element they inhabit becomes turbid, by the dispersion of mud among it, they are ready to avail themselves of its presence.

Nothing indicates that these creatures are carnivorous. I have not observed any animalcula absorbed by them; nor is it evident that any current which the Cristatella can produce is strong enough to overcome the resistance such living beings might offer against its influence.

Though having little reason to ascribe the voracity demonstrated by the hydra proper to ascidian hydræ, I endeavoured to feed those of the Cristatella with the soft whitish substance of certain larvæ dwelling in their own element. At first they seemed to avoid it, but on repeating the experiment afterwards it was surely absorbed. Yet it might not be

* The general appearance of this creature may be explained by a homely comparison. Suppose it represented in quiescence by a green satin pincushion, half the length of a lady's little finger, having a flattened sole, with a border of three rows of pins, on the surface, sunk over the heads. Now, the whole is smooth, but, when active, all the pins representing the hydræ, rise the twelfth of an inch. Each head, with 100 feelers, resembles a horse shoe; and the pincushion can move along on its flat sole.

by selection. However, whitish particles were discharged, and the whole specimen continued healthy.

My belief of a great error may be often repeated, to which I now ascribe many disappointments of a successful issue to important observations, in allowing the water with animal products to remain free of muddy matter, whether in accumulation or suspension. Nevertheless, it is impossible to discover the minutiæ of their configuration, as the exterior becomes obscured by the deposition of the invisible suspended particles. Thus, both pure and muddy water may be usefully employed alternately for the same subject.

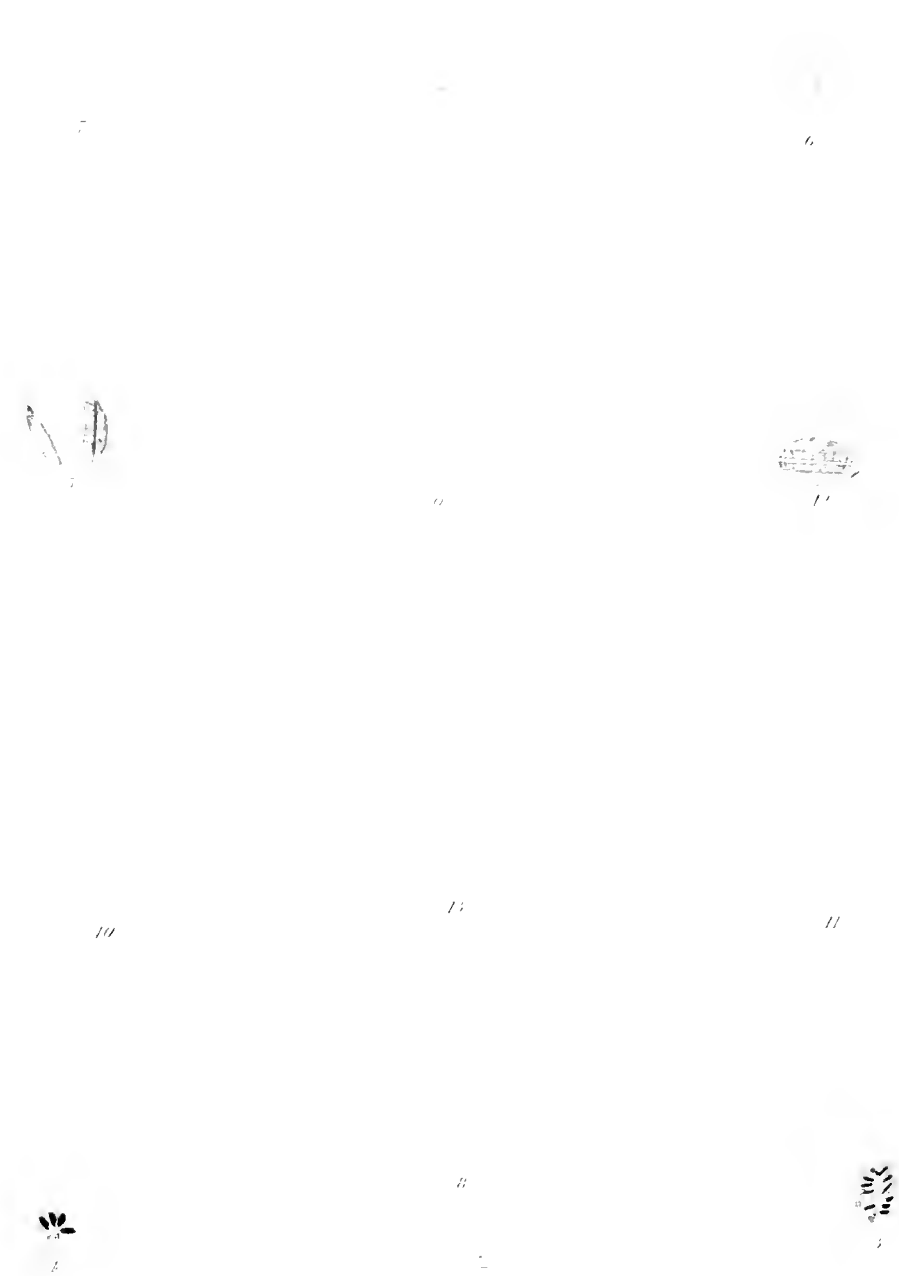
This extraordinary being, the Cristatella—a living mass compounded of at least 300 or 350 independent animals, is endowed with an undoubted locomotive faculty, though exercised imperceptibly to the eye. A property so extraordinary and inexplicable, is one of the most singular facts in the natural history of the animal tribes, and that which, were it not verified, we might be prone to call in question, on mere assertion.

The rate and extent of transition do not exceed an inch in twelve or in twenty-four hours. In the course of it, either extremity indifferently is in advance. The favourite resort of the Cristatella is to half decaying branches of shrubs or trees in still water. If any be deposited there, the animal will be found on them. Sometimes it appears twisted around a twig, so as to form a single long spiral or volute, much after the fashion of certain species of the Doris *(Eolis)*, when applying the long, bare, flexible sole in a similar manner. In default of branches, the Cristatella takes up a position on aquatic plants or on stones.

Each of the hydræ is independent; yet, as just observed, how minute the animalculum which may resist one exercise of its faculties. Its simple appearance is enough to deny it strength, though endowed with inclination.

We may almost presume that the locomotive faculty results from some kind of volition belonging to the common mass—not very intelligible indeed, and exacting the concession of its superiority over the separate or united influence of hundreds of distinct animals, enjoying an independent will, forming its great border, and carried along as a portion of the whole.

Pl. XXVII



All these are evidently endowed with their peculiar individual sensation and action; all originate, live, and die as separate beings. But there is no evidence to indicate that they are animated by a common will, or act in concert. Perhaps this would require a share of intelligence far surpassing what has been assigned to these creatures. Nothing shews that each is affected beyond the external cause affecting itself, or that it performs more than its own peculiar functions. But I have often observed, that external causes seem to operate on a whole colony with a similar effect; thus, while the functions of each are restricted according to its individual sensation, the operation of all may contribute to the common welfare, or to actuate the common basis sustaining the whole. This is not inconsistent with assuming the peculiarities of individual existence.

Yet it is undoubted that a principle of volition does reside in the mass, and that it does influence its motion. The two portions constituting the specimen, Plate XXVII. fig. 2, when it was artificially sundered, receded from each other as if by common consent. In twenty hours they were nearly an inch apart, and much farther on the following day. But in a week they had come reciprocally nearer together. The hydræ close to the line of division having displayed themselves immediately after the section, prohibits our presuming that such extraordinary violence had severely affected them.

Two entire specimens, of about equal size, were seated exactly parallel to each other on a vertical branch. By the descent of one of them, they had separated half an inch in forty-eight hours.

Their motion is inconceivably slow, and their adhesion is usually very slight.

No other mode of progression than crawling belongs to the Cristatella. The originating animal is buoyant; but the adult cannot swim. It is a solid, consistent mass, of considerable specific gravity.

Motion must therefore result most probably from successive rugosities or inequalities formed on the sole.

The hydræ are displayed more luxuriantly at night and during genial temperature. Then, their action is most vehement, and the progression of the subject more evident; whence the Cristatella must be classed with nocturnal animals.

It seems also to be of solitary habits.

All the compound zoophytes that is composed of hydræ along with the polyparium, such as specified in the preceding pages, manifestly decline on the permanent retreat of the animals. Though covered at first by thousands, leaving scarcely an atom of the surface vacant while in vigour, fewer and fewer at length appear spontaneously, and that in proportion to the time of preservation, nor is the renewal of their element effectual in eliciting them to the light.

Here, as the hydræ cease to unfold, the substance of a specimen becomes somewhat thicker, and is greatly contracted on the whole. Yet, even after the entire colony has continued in pertinacious and protracted retreat, the specimen shifts its site, thus demonstrating, as I apprehend, that progression does not result from volition of the numerous hydræ, whose activity seems concomitant only on the display of their own organs.

In as far as circumstances have enabled me to judge, the life of the Cristatella does not exceed a single year. This is a difficult point, indeed, whereon reserve is necessary. Perhaps, however, it is limited to six or seven months. One of the hydræ of an adult specimen survived during nine weeks. That specimen was much contracted; its skin had become very tough and elastic—yielding on pressure.

Perpetuation.—This important part of animal physiology offers some peculiarities, which it has not been my lot to witness in any other product of the creation. Though fulfilling the general rule devised by the Author of Nature, for the preservation of the race, and the continuance of life, its difference from the ordinary progress of evolution, merits our highest admiration. Singular it is, that those minute objects, passing unheeded by ignorant and thoughtless mankind, should manifest a power reserved for Omnipotence only. Ought we not to be humbled in all our pride of preeminence, on reflecting that the ablest among us, far from the faculty of forming an original atom, cannot even comprehend how that atom is formed: and, although beholding the evolution of animated matter advancing more and more towards perfection before our eyes, we can but offer conjectures of the process whereby it is accomplished.

Numerous ova, of various hue, according to their respective stages of maturity, appear irregularly dispersed amidst the smooth and translucent fleshy parts of the Cristatella—nor confined in any definite ovarium.—Plate XXVIII. fig. 6.

While retained within the zoophyte, perhaps each is invested by a certain gelatinous matter, sometimes, but not invariably, present when produced. Originally, or at an early period, the internal ovum appears of dingy white, then greenish. Next, in maturity, it is a beautiful and singular object, of lenticular form, with dark brown sides, smooth and convex, the edge environed by a vivid yellow circumferential margin, also begirt by a row of spines, which terminate in as many recurving hooks.—Figs. 7, 8, 9. The hooks are double, that is one recurves to either side of the extremity of the spine. This portion seems of later formation.

I cannot explain how the ova are produced by the zoophyte, whether in the earlier part of the season they escape by some appropriate channel, one or more, while the animal is fresh and vigorous. Neither do I know that there is any precise reciprocal relation, collectively or individually, between them and the hydræ.

The principal mode of liberation is undoubtedly from the decay and decomposition of the Cristatella, towards the close of autumn, for nothing has proved its permanence to exceed a single season. Some survive longer than others, as the extinction of life does not appear to be regulated specially by abstract portions of time in any animated being: apparently it is rather dependent on circumstances.

Towards the end of autumn, all Cristatellæ hasten to speedy decay. The specimen, Plate XXVII. fig. 1, a very fine one, of unusual dimensions, which was exhibited to the British Association, at Edinburgh, in September 1834, had shrunk to half its original length within nine days of its capture, many of the hydræ having withdrawn from view. In another week, not above a dozen, from 350 or more at first, composing the luxuriant border, were displayed; at which time the product had contracted to a fourth of its pristine dimensions. All the hydræ ceased to protrude, with the lapse of the following week ; yet the mass still shifted its place ; and in twenty-eight days from the date of manifesting the utmost vigour, now completing the fourth week, it was reduced to the shape and dimensions shewn by fig. 3. Entire decay of this interesting subject ensued in another fortnight.

Meantime, the ova, generally resting on edge, become greatly compressed by the shrinking flesh, and are brought more and more to this particular position, which probably facilitates their escape through the now attenuated substance of the Cristatella.

No hydræ were displayed by the preceding specimen after the 4th of October. The ova continued escaping, some singly, some in clusters of three or of six : the whole amounted to twenty-five ; some of them connected with, or invested by, gelatinous matter.

I know not whether the foregoing observations on this particular race of zoophytes, or on a few yet to follow, remount high enough to reach the formation of the embryo in the ovum. The earliest stages of the ovum itself are concealed from our view by its position. It may be questioned whether, at the moment of its escape from the parent, the development of the rudiments of the embryo has commenced. But this will not affect the fact that zoophytes do actually produce inert bodies, as the ova of birds and other animals, wherein the elements of the progeny are nurtured and come to maturity.

The ovum of the Cristatella has a hard shell, with yellowish fluid contents. The planula from the Sertularia, the gemmule of the Flustra and Alcyonium, and the spinula of the Botryllus, are all endowed with vigorous activity, when discharged from each of the parents, which themselves are immoveably rooted. But, the ova from the Cristatella, which itself is free, are void of the faculty of motion.

The shell of the ovum may be compared to two meniscus valves, that is, it much resembles two watch-glasses united by the edges.

In 202 days from its escape, the edges of the ovum begin to gape, like the separating shells of the bivalve *Testacea,* gradually widening to allow protrusion of the nascent Cristatella, as the halves shall sunder more.—Plate XXVII. fig. 5.

But now, by a wise provision of Nature, the ovum is brought to such a position in its buoyancy, that the head of the originating animal dips downwards in protrusion, as if to secure constant immersion amidst the liquid element. The two shells remain close, or nearly so, for a considerable time, though separating as the nascent hydra escapes, when they become much more transparent than previously; and both are thrown off at last.

The hydra, on quitting the ovum, is yellow, next converted to pale green, which deepens with age.

In common with the progeny of other zoophytes, the young of the Cristatella consists of a single hydra, but the base disproportionately large, and as if distended by internal contents, or tumid from approximated embryonic elements—as it were the vitellus of the ovum of the oviparous animals.—Plate XXVII. fig. 6. The form of the nascent creature is not circumscribed by any regular outline, to be explained in words; but, during a favourable season, and when subjects are vigorous, it soon approaches the shape of a spherical triangle, wherein the hydræ may be said to spring at the base.—Plate XXVII. fig. 7. In a few days the vertex becomes less acute. After being divested of the valves, or shells of the ovum, the young Cristatellæ frequently appear of irregular form, and very turgid, fig. 8, *a*, *b*, *c*; enlarged, figs. 9, 10, 11. Frequently, also, the base is definitely circular, while three or four hydræ have developed from it; and then the nascent product is a beautiful object. But I feel induced to conclude that the genuine original formation of the base or sole is triangular.

Some, in earlier stages, are of exactly the same specific gravity as the water, remaining suspended amidst it at any given point from the surface. Many reach the sides of the vessel containing them, where they are prone to affix themselves, or they adhere to other solid foundations. One had contrived to seat itself on the surface of an ovum, left empty by its own nascent inmate,—the first hard substance, perhaps, with which it came in contact, for the shells often close when freed of their contents, and remain long united.—Fig. 12. The Cristatella seems to float only in the earliest stages.

It is from nascent animals that the structure can be most satisfactorily ascertained. But while floating reversed, that is, with the hydra downwards, they have a horizontal rotation, probably from the action of the tentacula or cilia below; sometimes exceedingly inconvenient to the observer in shifting the objects from the focus, or from the field of the microscope.

A single hydra is developed in the ovum, but a companion to this original animal is generated from the same base, within thirty hours of its production; and a third then rises between the two. At this stage the product is light greenish-yellow. One basis having thus generated six nascent hydræ, had become circular; and here the evolution of three ensued in eight days. Such evolution is apparently successive.—Pl. XXVII. fig. 13. From the object represented, a figure, which appears in most works treating of the Lunate Zoophytes, may be understood, but which I could never previously comprehend. In that figure are shewn four animals which are originating Cristatellæ. It was given first by Rösel, who represents several of the young Cristatellæ soon after their liberation from the ovum, but he gives no figure of the parent.—Tom. iii. Plate xci.

Unfortunately it is impossible to preserve the animals thus bred from the ovum until acquiring their oval shape.

The great breeding season occupies April and May. It continued throughout the month of June in the year 1838.

The ova of the fine subject above described, first began to open for production of the young in 202 days after the hydræ ceased to protrude from the mass, and the latest period of opening was 230 days after the same cessation.

The specimen, Plate XXVIII. fig. 6, was procured on the 3d of October, when it seemed quite replete with ova, irregularly disposed, whereof about 24 could be enumerated. Their dark sides and yellow circumference, were agreeably contrasted with the translucent green of the Cristatella. As its flesh decayed, 33 had escaped on the 3d of December, that is, in sixty days, each now floating with the gelatinous matter investing it.

In some specimens, a number of dark opaque corpuscula, denoting immature ova, may be seen near the root of the hydræ, apparently between the intestinal organ and the integument of the body. These do not exceed a tenth part of the size of the prolific ovum; they are thicker in proportion, with an imperfect row of spines, but wanting the circumferential yellow ring.

No other mode of propagation has been witnessed than by the production of an ovum, the formation, protrusion, and liberation of a single hydra from it; together with the subsequent evolution of additional animals from the same basis that sustains the first.

Nothing like spontaneous division of the Cristatella has occurred: nor do I know that such division belongs to any product of ascidian nature: I have it not in recollection at the present moment. However, it is not unlikely that two or three specimens may be derived from the accidental transverse rupture of one single specimen having attained maturity. Nay, it is possible that portions may be detached from either extremity of long and unwieldy subjects, by the mere embarrassment of motion, position, or restraint. If so, the wounded parts may heal readily. But I am ignorant whether new hydræ will be generated to complete the border.

Two specimens in contact, occupying the same line, may be mistaken for one by the observer.

This product has never occurred to me except in tranquil waters. Indeed the soft consistence of its body, and its slight adhesion to any substance, seems little adapted for an abode in the current of flowing streams.

Numerous specimens have been obtained from Duddingston Loch, near Edinburgh, and Coldingham Loch, in the county of Berwick; and I am indebted to the sedulous care of an affectionate relative, the companion of all my excursions, the encourager of all my exertions, in so tedious, laborious, and difficult a work, for the finest of any,—that exhibited to the British Association, taken by herself from the garden pond at Binns House, in Linlithgowshire.

Combining the facts and illustrations afforded by the whole, this *wandering* Cristatella is one of the most wonderful productions of nature; and one with which no narrow parallel to any other living creature can be drawn, at least I am unacquainted with any to be compared to it. Entire, it is a single living animal, sustained through the medium of a multitude of subordinate, independent, living animals, forming an integral portion of itself.

The preceding observations lead to the following conclusions:—

I. The *Cristatella vagans* consists of from 200 to 350 individual hydræ, rising as a border from a fleshy mass, which serves as their common basis

II. The hydra is of ascidian nature, consisting of a body incorporated below with the basis, and terminated above by a head of lunate or horse-shoe form, environed by 100 tentacula.

III. Each of the hydræ is endowed with separate, distinct, and independent action, and discharges functions peculiar to itself.

IV. A locomotive faculty, confined to the fleshy basis only, belongs to the Cristatella, which is exercised although the hydræ be in retreat or decay.

V. Numerous internal ova are generated, and attain maturity in the basis, from whence, in the later season, they are liberated by its decay or decomposition, to float at the surface of the water.

VI. The contents of the ovum, originally fluid, require 200, 230 days, or longer, for consolidation and maturity of the embryo.

VII. The fœtus developes as a single hydra, with an ample basis, on quitting the ovum. It is subsequently joined by the successive evolution of others, whose ultimate numbers are proportioned to the survivance of the specimen.

It appears from the history of this animal, that it is suitably characterised by the name *Cristatella vagans*, said to have been given by Lamarck. The genus, believed to comprise only a single species, was instituted by Cuvier.

PLATE XXVII. FIG. 1. *Cristatella vagans* (*Mucedo mirabilis*), from the garden pond at Binns House.
2. Another specimen, entire. When bisected, the two halves first receded from each other, and afterwards approached reciprocally.

PLATE XXVII. FIG. 3. The specimen fig. 1, in decay, 28 days subsequent to its original delineation in vigour.

4. One of the halves of fig. 2 in decay. An ovum *a*. escaping through its substance.

5. Nascent Cristatella protruding from a sundered ovum.

6. Nascent Cristatella from an ovum of fig. 1, which sundered between 202 and 230 days after production.

7. Nascent Cristatellæ, wherein the genuine configuration of the sole appears at an early period: slightly enlarged.

8. Nascent Cristatellæ, *a*, *b*, *c*: natural size.

9. 10. 11. The same enlarged.

12. Nascent Cristatella seated on an empty ovum.

13. Nascent Cristatella, consisting of six hydræ, disposed around the common basis.

All the figures of this Plate, except figs. 1, 2, 3, 4, 8, are enlarged.

PLATE XXVIII. FIG. 1. Hydra.

2. Young specimen from the ovum, when consisting of two hydræ; shewing their relation and the arrangement of the parts.

3. Adult specimen.

4. The same seen in profile.

5. The same enlarged, viewed from above.

6. Prolific specimen.

7. Ova.

8. Ovum slightly enlarged.

9. Ovum more enlarged, showing the border of recurved spines.

All the figures of this Plate, except figs. 3, 4, 7, are enlarged.

§ 2. ALCYONELLA.—PLATES XXIX., XXX.—The subject of the last paragraph is sufficiently definite,—set apart by Nature herself so wide from all others, that it cannot be mistaken. But as to the subjects of the present paragraph, whether it may be owing to my more limited range, to an ungenial site, to premature investigation, or otherwise, I find much embarrassment: nor have I been able to free myself of it with all diligence; for I feel infinitely perplexed, first, in endeavouring to determine the identity of my specimens with any already described by skilful authors; secondly, in endeavouring to distinguish between species and varieties.

As I cannot affirm with confidence my success in either attempt, I shall solicit the reader's permission to lay a copious narrative before him, trusting, as on other occasions, to indemnity for failure, in the legal maxim, *quod superflua non nocent*.

The extraordinary modification of animal and vegetable form and aspect, from climate, position, and the profusion or deficiency of aliment, are always ready to disturb our conclusions: Nor does the great Creator seem to have decreed an absolute uniformity of condition to all his works, subsisting under a noted diversity of circumstances.

The Alcyonella is fixed, while the Cristatella is free.

(1.) Alcyonella stagnorum.—Plate XXIX.—About the middle of summer, the under surface of the Water Plantain growing in lakes and ponds, is frequently invested by a gelatinous stratum, studded with very numerous white specks, as beheld with the naked eye.

In earlier stages this peculiar stratum, especially when of smaller extent, manifests a tendency to a stellate figure, not wholly obliterated by diffusion over the entire surface capable of receiving it, but then less decided than when confined to patches of subordinate size. It somewhat resembles the formation of the *Flustra membranacea* in its earlier stages, as investing the *Laminaria digitata* previously adverted to, where the stellate figure is lost also with age.—Plate XXIX. fig. 1.

I conclude that fig. 2, on the edge of a leaf belongs to the same species, but farther advanced.

This product occurs of all dimensions, from minute gelatinous spots to patches equalling an area of two or three square inches. It overspreads one surface of the leaf of the growing water plantain, and frequently both sides of the fallen leaves, or those still pendent, sunk among the mud from their weight. There is considerable resemblance in this and in some other features between the Alcyonella and the *Flustra hispida*, likewise bearing down among the mud of the sea-shore the leaf of the *Fucus serratus* invested by it.

Incredible multitudes of hydræ, resembling the general aspect of those of the Cristatella, whiten the surface of the gelatinous stratum of the Alcyonella. Their numbers are such, as in some zoophytes already described, to preclude the free exercise of their external organs individually. They offer a confused assemblage to the observer.

The hydra is very minute, perfectly white, its lunate head provided with from 42 to 44 tentacula, ciliated, as may be discovered with a powerful magnifier. The body consists of a sac or integument, surrounding the intestinal organs, in the lower part of which a pulsatory or peristaltic motion is seen, and internal particles, evidently tossed up and down, probably indicating fluid circulation.—Plate XXIX. figs. 3, 4.

After protrusion from the stratum, the hydra sinks amidst it in precipitate retreat, leaving a conical projection above the surface, which exhibits some motion. When rising to display itself, and completely unfolded, and in vigorous activity, the cilia of one row bordering the tentacula strike upwards, and those of the opposite row on the other side downwards, so that the influence of the whole tends to the same purpose. But high microscopic powers are necessary to shew it.—Figs. 5, 6. However feebly this is done by each, the agitation of such a number as composes the whole, produces the attraction and repulsion of neighbouring particles, many of them falling among the tentacula themselves, from whence they must be extricated and carried towards the mouth. A sufficient quantity being at length collected in the cavity, the œsophagus dilates, and the mass is swallowed by evident muscular exertion. Its transmission to the stomach is distinctly visible. It is only on the accumulation of a quantity of matter in the cavity of the mouth, which opens horizontally amidst the tentacula, that deglutition follows. The animal's selection is demonstrated by rejection of particular substances. Should a microscopic eel be involved among the tentacula, the hydra endeavours to free itself of the intruder, instead of attempting to swallow it.

It is difficult to obtain a distinct view of an individual hydra amidst the multitude peopling a specimen, unless when projecting from the sides, or perhaps when adhering to a glass vessel, which is an incident of rare occurrence.

Sometimes a profusion of oblong greenish particles, discharged by the hydræ, strew the bottom of their vessel soon after receiving specimens. Their nutritive aliment seems to be eliminated from the grosser matter absorbed by them.

The duration of the individual hydra's life, as well as the permanence of the stratum, seem to be limited. Two hydræ of fig. 3, survived delineation 22 days; and one of fig. 4, survived 24 days. The physical condition under which the product exists, probably prohibits the reverse. In saying so, however, I wish it to be understood, as speaking of that precise state wherein I have beheld it. Circumstances may be so different elsewhere, as to affect the duration of the specimen, though not of the hydra.

As above observed, the *Alcyonella* is permanently affixed in firm adhesion to the substance invested, while the Cristatella is free. In this sense, therefore, it is a parasite, which cannot be the character of the other wandering at large. The general nature and conformation of the hydræ seem to correspond, but there are other prominent features in the detail of the history of each, banishing all conjectures of their being kindred species.

The hydræ have never amounted to 400 in any specimen of the Cristatella that I have seen. Their number is indefinite both here and in the Alcyonella; but as the specimens of the latter seem constantly enlarging during summer, so does this diffusion always give birth to more. Perhaps when once founded, it never ceases to grow during its existence; and some specimens bear thousands.

Perpetuation.—After vigorous advances throughout the finer part of the season, the whole product manifests approaching decay towards the close of autumn. Few of the hydræ are displayed in the third or fourth week of October, and often in a languid state. But innumerable ova, now dispersed amidst the substance of the Alcyonella, convert its natural greyish aspect to a brownish shade. Though subsisting much earlier in the season, it is only thus late that the ova apparently attain maturity.

They are sometimes seen while the hydra is active, vigorous, and symmetrical, fig. 7. When escaping towards the end of June, I could not refer them to any but perfect specimens,—nevertheless, a great modification ensues as autumn advances near to its termination. The body of the hydra within the integumentary covering, wastes away, and the integument itself enlarges proportionally to receive the ova from below, where they are in all appearance generated. At this juncture they rise upwards into it, as into a vascular receptacle. Here they become at length evidently suspended, and tossed about amidst the fluid contents of the now turgid integument. Ligaments, as in other ascidian hydræ, probably secure the body of the animal originally, but as these changes succeed, its extremity seems to be free; and as the turgidity augments, the body is observed completely attenuated among the ova.

When several ova are together within this integument, as I design it, their motion is neither rotatory nor progressive, but rather a confused tumbling over each other. This movement continues where the hydra has totally decayed, and only the hollow prominence covering the included ova remains. But the ovum itself is entirely devoid of spontaneous motion; it has no such faculty, corresponding in this respect with that of the Cristatella; and differing entirely from the nature of the active ciliated gemmule of the Actinia and the Flustra. It resembles a real ovum with a hard shell, or it may be membranaceous, for, in such minute bodies, it is difficult to determine the quality and proportion of resistance on pressure.

For the purpose of ascertaining whether the motions which I beheld were voluntary or accidental, I selected a hydra advancing to decay, with four ova in the vascular distension. Two were in irregular motion, sometimes tumbling over, and a third was moving also. But on slitting the integument with small sharp-pointed scissors, whereby all four were liberated, they remained perfectly quiescent and stationary, floating like others on the surface of the water.

The motion of the ova being therefore involuntary while confined within the hydra, it must ensue from some external influence,—and probably from an invisible absorption and discharge of water by the product. But it is very singular, that after the hydra has quite wasted away and disappeared, four included ova should be tossed about in the distended integumentary prominence remaining.

Possibly the ovum ripens as the hydra decays. I have conjectured, that some peculiar aperture about the root of the tentacula, allows the previous escape of the earliest, which are matured during summer; but later in the season, I cannot find that they are liberated otherwise than by decay of the body.

As autumn advances, and particularly during September or afterwards, the number of hydræ protruding from the stratum decreases, while the number of ova escaping increases. Thousands are at length freed by supervening decomposition, and rise above in groups on the water, or form a complete internal belt around their vessel at the surface.

The ovum of the Alcyonella is lenticular, like that of the Cristatella. but not a fifth part of the size. Its surface is smooth and shining, and the arrangement of the colours inverted, compared with those of the latter, the middle being yellow, and a broader zone brown. There is no circumferential row of hooked spines or other processes present. As the ovum rises to float after liberation, the observer must then beware of deception from its apparent elliptical, instead of its true, circular formation.—Fig. 9. This delusion is often very strong, insomuch that it is difficult to reject its impression. The dimensions of the ovum will not admit an investigation, whether the obliquity of its position results from some internal aërial reservoir appropriated for the use of the embryo, until enabled to subsist on liberation by maturity.

A long time elapses, not less than 167 days, in perfecting the contents of the ovum, when those of the preceding season are hatched during the subsequent April, May, or June. Each ovum then sunders like the former—that of the Cristatella—to allow the protrusion of a shapeless substance, which is gradually moulded as a symmetrical hydra.—Fig. 10.

The hydra has attained considerable size against the time the halves have completely separated, and it is then that its structure is best exposed. But the number, proportions, and arrangement of the tentacula, now scarcely exceeding 20, are of future evolution and modification. Let us recollect that the complement of the adult amounts to 42 or 44. Only those of the exterior row are distinct in early stages, the rest are less definite.—Fig. 11.

The nascent hydræ either occupy the sides of their vessel, fig. 12, or remain free in floating groups. But microscopical observation on the latter is somewhat inconvenient, for the heads of all the animals being downwards in their immersion, and a similar rotatory motion advancing as before, perhaps also from the action of the ciliary apparatus, the object is withdrawn from the field of vision.—Fig. 13. The varied forms and curvatures, the contrasting brown and yellow of the ova, interspersed with the white of the hydræ in their different stages among them, impart a great degree of elegance, beauty, and interest to the clusters thus borne by the limpid element.

I have not observed that, in our climate, any ova from the Alcyonella of the preceding year, were hatched after the 3d of June. But the period assigned above for attainment of maturity by the embryo, may be accelerated or retarded according to the temperature of the season. This will occasion discrepancies in all calculations and conclusions. In truth, no absolute uniformity prevails. As ova seem to escape during summer, it remains to be ascertained whether the term is ever so much abbreviated that their contents are brought to maturity before winter.

Whether the ova float or adhere they are alike prolific, though many prove abortive on the whole. Each gives birth to only a single hydra; nor do any others originate from the basis of this nascent animal as with the Cristatella. Therefore, it is by no means obvious how the gelatinous stratum is formed. But the offspring of a number of prolific ova in immediate approximation, are connected by some kind of diffusion, which may account for its origin.

If decay of the parent be almost cotemporary with the maturity of the ovum, and if that be its principal source of liberation, we should conclude, that, by the regular course of nature, the duration of the product is limited to a single season. Whether this conjecture would be supported by the transience of the substance invested, would exact further investigation. But the waste of the hydra, and the distension of the integument for reception of the numberless ova, visibly imbedded below, seem preparatory to their liberation, by dissolution of the product wherein they have originated.

This Alcyonella occurred in sufficient profusion during several years in a small pond, one scarcely ten or twelve yards in diameter, between Queen Street and Heriot Row, in the centre of the city of Edinburgh. Here also is the abode of the *Vorticella rotatoria*, which might be seen affixed to the hydra, with its ciliated apparatus to each side in apparent revolution.

I have never observed the Alcyonella otherwise than as a single stratum, investing the surface of leaves, or surrounding their pedicles. During summer, however, I once found in the same place as above, a detached rudely cylindrical dark spongy mass, exceeding eighteen lines in length, and half as thick, of cellular structure. The numberless cells were all empty, with a few white hydræ interspersed among them. But no more continuing to appear, I rent the mass asunder a short time afterwards, for examination of the interior. On pouring water over it a multitude of ova escaped, exactly resembling the ova of the superficial grey patches forming the Alcyonella from the same pond. They produced many hydræ before the last day of June.

Probably the white hydræ within were from some of the ova of previous seasons there. As nothing could sanction the supposition of this uncommon mass being generated in a single season, if belonging to years preceding it may have been different from the subject of the present paragraph. Its general appearance was not unlike the polyparium of the *Alcyonella fluviatilis* of *Raspail*. Possibly the *Alcyonella stagnorum* grows in much greater luxuriance than I have ever seen it. If the preceding mass was of this species, it must have been the accumulation of many years.

Much has to be understood regarding this subject, and especially whether important modifications may not be concomitant on the peculiarity of its site, and the period during which it has subsisted.

There is so little correspondence between the Alcyonium and the Alcyonella, that a preferable name might have been bestowed on the latter, than what is so obviously derived from the former. But when

names become familiar by general recognition, we have already seen that etymologies are of less avail: One correct representation is worth an hundred etymologies.

PLATE XXIX. FIG. 1. *Alcyonella stagnorum* in an early stage, showing its stellate form.
2. Specimen older, and of more compact figure, on the edge of a leaf of the Water Plantain.
3. Portion with five hydræ, enlarged.
4. Portion with three hydræ, wherein their crescent form is exposed.
5, 6. Ciliated tentacula.
7. A vigorous active hydra containing ova.
8. Decaying hydræ, distended by an internal fluid, wherein the ova are tossed.
9. Ova floating obliquely.
10. Ova floating. The sides are opening, and the halves sundering, *a*, *b*, *c*, according to the maturity of the nascent hydra *d*.
11. Nascent hydra farther advanced, sustained on buoyant particles.
12. Ova with their hydræ far advanced, as adhering to the side of a vessel.
13. Floating cluster of ova with their hydræ.
All the figures, unless the first and second of this Plate, are enlarged.

(2.) ALCYONELLA GELATINOSA.—PLATE XXX.—As neither colour nor dimensions, nor even the number of external organs, are absolute guides to the identity of animal productions, where all these qualities are liable to be affected by age and position, the precise place of the present subject must be considered provisional, until future observation may correct and embellish its history. But I do not hesitate on its insertion here, from having led to some interesting facts of another kind.

On visiting a pond at Foulden House, in Berwickshire, during September 1831, I found various specimens of this Alcyonella. Some spread in greyish patches of gelatinous aspect, like the spawn of frogs, as an irregular superficial stratum, equal to two or three square inches, often tending to diffuse in angular prolongations; others resembled the specimen, Plate XXX. fig. 1. All invested the branches lopped off birch, beech, and different neighbouring trees, falling accidentally into the pond, which, according to my information, had been drained completely three or four years previously. None were found on leaves.

The specimen, fig. 1, invested an old birchen branch as a single stratum, with three prominences, *a*, *b*, *c*, rising from it, here bearing much resemblance to the form and consistence of the *Alcyonium digitatum* or *lobularia* of later authors. Numerous ascidian hydræ issued from the surface, of the same general conformation as others of this kind, but considerably larger, for the whole protruded between two and three lines, and the head expanding nearly a line in a lunate form, was provided with about 70 tentacula. Towards 40 of these composed the exterior row; and towards 30 the inner row of the crescent. They were active, long, and transparent, frequently exercising their percussive faculties. Though eluding observation from various causes, especially the want of optical instruments, at the time, active cilia were undoubtedly present, for along with the same motions and habits, together with the attraction and repulsion of buoyant particles, were their tossing about among the tentacula, as witnessed in the rest of the race. Part of one of the prominences is represented, fig. 2, whence the figure and proportions of the hydræ are seen.

This animal is extremely vivacious, and displays both its form and its habits in greatest perfection on the approach of night. Then, when undisturbed, and all the organs in fullest expansion, the hydra, on the slightest shock or alarm, collapses and sinks down in a twinkling, and the skin closes as an obtuse conic frustum over it. Now the included animal is of cream colour or primrose-yellow, as seen through the skin; and while in this state, the prominence of the cell above is capable of some motion. Next, the creature rises slowly and cautiously to unfold as the inverted finger of a glove, then exhibiting the stomach as dark-grey and ovoidal, if replete with food. Thus the integumentary skin connecting the hydra with the specimen or common mass, is modified by the position of the hydra, whether without or within, converted to a covering on retreat, and relaxed as a cylinder on the greatest extension from the polyparium.

When originally collected, the hydræ of all the specimens were replete with dark matter, the substance or residue of the mud suspended among the water of the pond, which was soon discharged so profusely in pellets, as to cover the bottom of the vessels containing the subjects.

While the hydræ of the specimen above described remained quite vigorous, ova were liberated in the beginning of October, but the hydræ having ceased to protrude about the 14th, progressive decay of the common mass favoured the escape of hundreds to float at the surface of the water, fig. 3. Their numbers continued augmenting to a great multitude until the 7th of November, when nearly the whole investing substance had disappeared: and the branch, of which very little was originally exposed, remained totally bare on the 30th.

Now, many of the ova were discovered to be imbedded in its surface, in rows of eight, ten, or twelve together, fig. 4. Thus it is quite evident that the ova were generated below.

Most unfortunately supervening incidents interrupted the course of observation, preventing also the preservation of the numerous ova, from which I had anticipated much interesting information ; so that the history of the subject remained altogether incomplete.

The naturalist must submit to many disappointments and contrarieties, as will be but too plainly proved by the sequel.

I had left much undone ; but desirous of resuming investigation of a subject still promising satisfaction, I resorted to the same spot in the county of Berwick, between fifty and sixty miles from my usual residence, during the proper season in 1833.

Not a single specimen could be found; nor was I more fortunate on repeating my visit during the succeeding year.

I know very well that natural products previously in the greatest vigour and profusion, sometimes suddenly disappear; that others before unnoticed, originate unexpectedly, as if substituted in their place. Likewise, it so happens, that subjects thus disappearing, sometimes return to resume the former position, as it were, which their genera or species ocpied. No doubt reasons may be given,—we can readily conjecture the absence, or the suspension, of those conditions essential for the evolution of animated beings, and the support of animal life for a season, and their renovated energies when similar obstructions cease.

As the pond, the precincts, and a large portion of the neighbouring territory belong to some of my nearest and dearest relatives, every thing was placed at my disposal to promote such investigations as I had in view.

In confident expectation of the return of the zoophyte, whose disappearance I was induced to ascribe to some unknown temporary obstruction, posts were fixed in different parts of the pond during September 1834, so that the ova might have a secure harbour, and that the young issuing from them should be preserved always under water.

On drawing the posts in autumn 1835, this proved to have been an abortive expedient; neither were any Alcyonellæ to be discovered on others which had stood there ever from the time of obtaining the specimens in 1831.

Therefore it was not unreasonable to conclude, that this species, the only one of its genus inhabiting the place, had been utterly extirpated.

There is no pursuit whatever among all that engage the attention of mankind, requiring more protracted time, or more anxious care for satisfactory investigation, than the natural history of living animals. It is not an hour, a day, or a season that suffices, for hardly is any indefinite series of years enough, computing merely by time. Neither is it the transient inspection of a single, nay, of a number of specimens, that will elucidate the subject, unless many concurring circumstances favour the observer, for he may be left in doubt after all.

Renewing my search for the preceding object in the year 1837, I acknowledge that it was not without surprise that I now discovered a profusion of the Alcyonella, and of that kind, which, if not to be identified with it, might be noted as a variety: Not denying, however, that some may judge this product a different species.

The pond had been reduced very low during 1836, in which year it was not visited by me; but in 1837, it was full even to overflowing.

Various specimens, under great variety of aspect, were collected in the end of August, the diversity of appearance resulting, it might be, at least in part, from the diversity of the substances invested. Among these was chiefly wood as before, apparently the peculiar and favourite site of the Alcyonella. But it also covered the slender stalks of the grass growing at the edge of the water, and there completely immerged. The radicles of those trees bordering the pond, which, penetrating the soil, reached the water, together with almost every ligneous fragment which had lain amidst the element any considerable period, bore the same product advancing vigorously.

A long branch of the larch, even one of its cones, was invested, and the fallen leaves of other trees, accidentally in contact, were firmly united by the overspreading vegetation of the zoophyte. Twigs, such as that represented, Plate XXX. fig. 5, were completely invested by it.

With exception of the grass, it rather seemed to me that those substances serving as the site of the Alcyonella had been matured by age, and adapted for it by approaching decay; and that they were thus rendered more favourable for its reception.

Sometimes an hundred spots appeared on a large surface, or one occupying smaller space was totally overspread. Cylindrical portions, of more limited dimensions, were wholly encircled, probably by the edges from each side meeting in their diffusion. While this is advancing, the Alcyonella diffuses at both ends, upwards and downwards, as may be concluded, supposing the position of the investing cylinder to be perpendicular. Thence results the encircling stratum. Something analogous, but on a larger scale, is evident in the snowy white *Alcyonium digitatum* or *Lobularia,* when investing the dingy tube of the Amphitrite. In like manner, and under corresponding resemblance to the same product, some parts of the Alcyonella thicken much more than belongs to a single stratum, but likewise rising in hemispherical or conical protuberances. How this ensues is far from obvious. If by superposition, the destruction of the hydræ composing the lower, earlier, or original strata, is the necessary consequence. We might ask, does it abridge the life of these animals, of which observation seems to sanction the longer promise?—Figs. 6, 7.

Perhaps a favourable season, conjoined with abundant aliment, may promote the rapid growth of the species.

The *Alcyonella stagnorum* is always grey or blackish; masses of the present subject are yellowish.

Here the profusion of the hydræ is very great, insomuch, that I found on computation, that about sixty individuals might occupy a superficial square inch.

In as far as can be discerned by our grosser senses, these creatures are similar to those of the preceding paragraph. But many minutiæ, inappreciable by us, may constitute real distinctions. Every augmentation of microscopical powers discloses some novelty; whence such varieties of form may exist among the animals as would sanction the multiplication of genera or species of the Alcyonella.

The form and proportions seem to correspond narrowly with the aspect of the others; but the tentacula of two which were enumerated, being only 50 or 60 respectively, the question of their augmenting during the season, or during life, must be weighed. So many leading and subordinate points always remain to be fixed, that the most acute observer can never affirm that his work is complete.—Fig. 8.

The hydra in full extent stretches between two and three lines from the surface of the stratum, and the head may be circumscribed by a circle towards a line in diameter. The slenderness of the body increases in proportion to its extension.

Like the others, this animal is extremely quick and lively. If an hundred be in full display at once, all collapse and sink amidst the stratum in a moment. As in others also, this collapse seems the effect of what may be called or compared to muscular action, through the operation of a number of ligaments connecting different parts of the body with the substance below. But until incipient decay diminishes the opacity of the intermediate organization, they are concealed from the eye of the observer by their transparence. During vigorous animation, the extremity of the body is too deeply seated amidst the polyparium to admit distinct inspection, but it is discovered to be free when decay has commenced, from the ligaments being either ruptured, or having lost their hold, by dissolution of the substance to which they were affixed.

Trembley, I think, represents descending spiral organs in his *Polypes à pannaches*, which are certainly *Alcyonellæ*. I have never had any specimens exposing a similar structure. Whether there be not besides the receptacle of aliment, organs in all, separately imparting the benefit of nutrition received by the hydra to the polyparium or common mass below, deserves investigation. The descending organs of the Lobularia are very conspicuous.

The hydra of this paragraph is very sensitive of the presence of light, and the influence of the atmosphere. Under genial temperature the body is protruded far, and the head is so much expanded, as almost to appear flattened. But the animal contracts in the dark; and during cold weather it becomes languid and inactive.

These are general characteristics of the hydræ of this section. Also the whole *Lunatellæ* constitute a nocturnal race. It is then that they are most amply unfolded, to enjoy the renovated medium wherein they dwell.

Limpid water, as already said, does not seem adapted for the support of any zoophytes, though its freshness is always important. Their food is undoubtedly eliminated from the muddy matter so often suspended, whereof the hydræ collect a surprising quantity. In the species which has just come before us, a dark internal mass occupies the whole intestinal canal of the hydra, descending farther than the eye can reach it amidst the mass below. Amidst this also, the point of divergence of the excretory duct is lost before it ascends to terminate under the lunate head. When thus replete with food, a specimen of the Alcyonella, which forms the encircling stratum of a twig, with the hydræ stretching from the surface, seems entirely beset with thorns.

I must anticipate future opportunities of acquiring sufficient acquaintance with the actual structure of the different Alcyonellæ; much is to be still explained.

Where investing a twig, the general aspect of its cellular conformation seems to resemble that of the Lobularia, investing the dark tube of the Amphitrite. It appeared to me that when the animals were in retreat, the surface exhibited a congeries of compartments, somewhat angular and irregularly confused together. The compartments or cellular receptacles were indistinct. A portion of fig. 5 is represented by fig. 9; and the extremity of another specimen investing a dark branch with a very thin stratum, exposed the cells, as in fig. 10. When the under surface of the product can be detached, its structure appears irregularly tubular, fig. 11.

Propagation.—The latter species, with which we are now engaged, perpetuates its race like its kindred, by numerous ova from each of the specimens.

Several prominences rose above the surface of a specimen which invested six inches of a branch in the pond. One of these, nine lines high, and as many in diameter, having been cut across, exposed a number of short flexuous channels occupied by ova.

In various other specimens, the ova could be recognized towards the first of September; and about the 20th, some had escaped by supervening maturity.

From subsequent observations, ova were observed in the body of the hydra; but this remarkable fact seemed to be ascertained, namely, that the ovum does not properly belong to it, that is to the body,—probably a general feature of the lunate zoophytes.

Should such a hypothesis be well founded, the number and the period of subsistence of ova in any individual hydra, may be variable and transient.

I cannot affirm that so great an apparent anomaly may not be dependent on the peculiar state of the product at a certain season of the year, or that it would be hopeless to search for the rudiments of ova connected with the hydra at some time of its life. But, that infinite variety of circumstances does prevail about the period above specified, can be assumed from discovering the ova occupying the bodies of hydræ yet vigorous, while they are also contained in the conical projection remaining on decay.—Fig. 12. *a, b, c.*

Ova are seen between the common integumentary covering of the body and the internal parts. Their number is not only indefinite, comprehending from one to seven, but the numbers actually contained are subject to alter, and here presenting a very singular process. While a hydra, containing three ova, was under the microscope, one of them visibly passed into the body of the hydra next to it. As I beheld the ovum in the course of transit, there could be no mistake.

It is difficult to account for the influence whereby the transference ensues, and especially if occurring in the prominence which may remain from decayed hydræ. As the ovum traverses an irregular circumscribed orbit while revolving on its centre, or on some axis shorter than the central line, a certain force, such as an impinging current, may fall on the circumference.

Among the frequent alterations of the relative or reciprocal position of the ova, one, the lowest of four, rose above all the rest, while the hydra was under microscopical observation.

If the ova pertain to the common mass, and occupy the body of the hydræ, and shift their site, the whole cavities are obviously replete with a fluid wherein they are suspended,—and herein is much correspondence with the nature of the *Alcyonella stagnorum.*

Likewise the circumference of the ovum is smooth, being destitute of hooks or spines, that noted characteristic of the Cristatella.

The most favourable circumstances are indispensable for the observations whereon all these facts are to be established. Many of them are slowly and progressively disclosed.

Like the others, whereof the lunate hydra constitutes the distinguishing feature, this product decays and breaks up at the end of the season, when multitudes of ova are liberated with the close of autumn. Few hydræ were displayed on the 29th of October, though some still survived on the 19th of November.

Many ova were now set apart in phials, also portions of twigs and branches, wherein they were imbedded, awaiting the issue on arrival of the ensuing season.

There is great interest in experiments involving a *tractus futuri temporis.* Our vigilance must never sleep; we must banish all precipitation, otherwise our cares and expectations may end in disappointment.

On the 26th of April, the ova of this Alcyonella began to sunder, for giving exit to the embryo; but it was ascertained from those protruding on the 13th of May, that they required at least 189 days for coming to maturity.

Few precautions but those which may not readily occur, will aid the means of solving the problem. The gravity of the Alcyonella retains it at the bottom of the water wherein it is immersed. But the ova, as liberated by decay, generally rising to the surface, are attracted to the side of the vessel by the peculiar curve formed there by the water, as previously alluded to, and would remain dry on its evaporation. But should the phials or vessels containing ova be inverted at first for a short time, some will adhere below, that is, about the sides which were near the original surface. On being reversed to restore their natural and wonted position, the same ova are now under the surface. Moderate replenishment at intervals of time to counteract the progress of evaporation, will preserve them in a sufficiently humid state to prevent sterility.

The naturalist must await very patiently the lapse of a long time, not to defeat his own purpose.

The native site of the Alcyonella thus occurring in the pond during 1837, was evidently wood. No specimens were found on the leaves of trees, unless on those accidentally in contact with the wood became overspread by the advancing stratum. But almost every portion of wood, which had lain there apparently for a considerable time, was invested less or more: and after all that could be observed were collected, still other portions came in view, being dislodged most probably by the diving of swans kept in the pond.

In further prosecuting the history of this subject, I detached a large portion of bark on September 9. 1837, which was previously loosened from a fir post standing in the pond. Its superficial area equalling 30 or 40 square inches, was almost completely invested by the Alcyonella, which in some places had an indefinite ramified appearance, but too faint to be recognised as a distinct character. I sunk it again, secured by a cord, in the pond, so as to be kept fresh and accessible until I should quit the country, designing to carry it along with me. Such conveyance is always safely and readily effected in tin cases, to be easily made in many towns, and filled with water.

In twelve days, when withdrawn from the water, the cord where encircling the bark, proved to be entirely overgrown by the Alcyonella, whereby the thickness of the stratum was there augmented. The same succeeded with other specimens secured in like manner. Growth had been rapid, which might be probably ascribed to the profusion of mud continually rising from the bottom of the pond, frequently disturbed by the swans, and thence affording the hydræ copious nutrition.

This large portion of bark was finally raised, and removed on the 21st of September.

Still later in autumn, myriads of ova escaped from the Alcyonella investing it. But after the lapse of seven months, multitudes remained imbedded in numerous channels of the bark, much resembling worm-holes, such as we see in wood. Here they were arranged in straight or slightly curving lines, in a single row, composed of an indefinite number.

Though apparently oval, from the nature of their position, the ova were circular, of lenticular form, the middle yellow, environed by a brown circumferential ring. When removed, a number of depressions in the bark, whereby the ova lay rather below the surface, indicated the excavation of the places they had occupied by some peculiar corrosion, if not the previous work of insects, figs. 13, 14; ova *in situ*, fig. 15, enlarged.

Some of the young brood were hatched from such ova on May 9. 1838. They became very numerous in June, and perhaps more were hatched in July, if not in the earlier part of August. Thus they had required a long time to attain maturity, fig. 16.

The hydræ of the young brood being pure white, their interspersion with the ova yet entire amidst the dark coloured bark, offered a singular contrast. Those examined in August had about 32 tentacula, whereon, but only in a certain position, a double row of cilia could be discerned, whose action by the one striking upwards, and on crossing the summit striking downwards, corresponded with those of the hydræ belonging to the *Alcyonella stagnorum*, fig. 17.

This generation of 1838 having perished at the end of the same season, still a third generation occupied the bark in June 1839. Being now between fifty and sixty miles from its original abode, I could entertain no doubt that the hydræ composing it sprung from those of the preceding year. They amounted to hundreds in the first week, all perfectly white; none had above 36 tentacula at most, nor were they yet divested of their shells.

This third generation proved to be the identical resemblance of the progeny of the original parent of the stock; no essential change of structure had taken place, for the evolution of additional tentacula seems incidental to age and permanence, probably in proportion to both.

Even a fourth brood was hatched from the same piece of bark in the first week of June 1840, all the hydræ being white as previously. They did not subsist long; neither did any appear in the beginning of August, when a few ova, presumed to be recent, were observed.

In the course of the history of the Sertulariæ in the preceding volume, numerous illustrations of their mode of propagation by means of ova, or of embryos contained in vesicles, have been given. Nothing of this kind is ascribed to fresh-water zoophytes. Nor ought the observer to yield to delusive appearances, to prejudice, or hypothesis, without the strictest scrutiny. Minute vascular bodies were observed on the surface of the bark above described during the month of May 1838, that is, the year subsequent to its removal from the pond. In various places six or eight were closely approximated, even in contact, others solitary; and they were distributed more numerously on the outer than the inner surface of the bark. They stood always irregularly, some of them contained also in vacuities, covered by loose portions of its substance.

These vesicles are affixed by the smaller extremity; they are hollow, with a dentate orifice, of dingy white colour, superficially speckled black. Fig. 18.

It would be vain to speculate on the peculiar nature, or to assign any special province to bodies so minute in such a situation, and subject to scarcely more than general inspection. They might not be animal products.

In as far as sensibly exposed all seemed empty. Their numbers certainly augmented; but in two or three months they underwent no evident change; indeed, had they done so, it would have been of difficult detection. Though here denominated vesicles, in conformity with their resemblance to similar objects on the Sertulariæ, I cannot venture to pronounce any decisive opinion regarding them, or their real nature, without farther opportunities. Possibly they are known to others.

Returning once more to Foulden Pond, which had previously afforded such an exuberant harvest, not only of zoophytes, but of other natural products, I resumed my search for the Alcyonella in the middle of September 1839, being two years from my last visit; but now, I may affirm, unsuccessful in what I had expected to find.

The pond had been completely drained in spring, enlarged considerably at that time, and, at the present juncture, very full and muddy from recent rain.

Few fragments of wood were obtained from it, nor were any of them invested by animal substances.

A very handsome canoe, the workmanship of an ingenious amateur mechanic, Captain Murray Garthshore, whose regiment was quartered in Berwick, now lay in the middle of the pond. It had been newly painted in May, nor had ever since been out of the water, and at the present time was half full of it.

To leave nothing undone, the canoe being hauled on the margin and turned upside down, I was much astonished, after my previous unsuccessful search, to find a zoophyte overspreading the bottom in the most luxuriant profusion.

At least forty specimens were presented to view, which soon convinced me, by their dimensions and rich vegetation, of how little I had previously witnessed in such an interesting product.

As before, these specimens much resembled the spawn of frogs. They diffused in tendency to circumscription by a circle, radiating from a centre, to terminate in angular extremities confined within that boundary. Very fine specimens were four inches or more in diameter; one spread eight inches in length by six in breadth in an uninterrupted stratum, tending to an oval form. Nevertheless it is not to be assumed that such extraordinary dimensions belong unequivocally to a single specimen, for the margin of two might meet in the course of their mutual diffusion. However, many of inferior extent were undoubtedly single and entire. Several short tubular projections were crowded together near the centre of some fine specimens. The angular extremities terminated in several hydræ, which appeared dingy white when retracted; then the surface seemed to be composed of ill-defined pentangular cells.

This Alcyonella diffused in a superficial stratum over the white painted wood, dark streaks denoting the hydræ replete with mud, which gave great variety and interest to the objects. Some of the strata near the keel of the boat were thicker, possibly being better sheltered, and were there four lines deep.

The hydræ were very numerous. Besides a notch at the summit of the body, I thought, that under the microscope, an orifice might be discovered in each side of the integument near the summit. Were there no illusion here, it would help to explain how the ova may escape while the animals are yet entire. A few were visible. Eight ligaments appeared to be the number connecting the body with the stratum below.

Though averse to precipitate conclusions, while stating at large the impressions received, I am induced on the whole to conclude, that the products described in the present paragraph nearly correspond with the nature of the Alcyonella recovered from the pond in 1831.

Yet there are certain discrepancies to be reconciled, which deserve more profound investigation than I have had an opportunity of devoting to them.

Should these three Alcyonellæ be truly three different species, they may be distinguished by three different names. Should the whole merge in one, as future opportunities, better skill, and observation of other naturalists shall determine, the *Alcyonella stagnorum* must be alone retained.

Meantime various interesting physiological facts will remain immutable.

PLATE XXX. FIG 1. *Alcyonella gelatinosa* investing an old branch. Fleshy protuberances *a*, *b*, *c*.

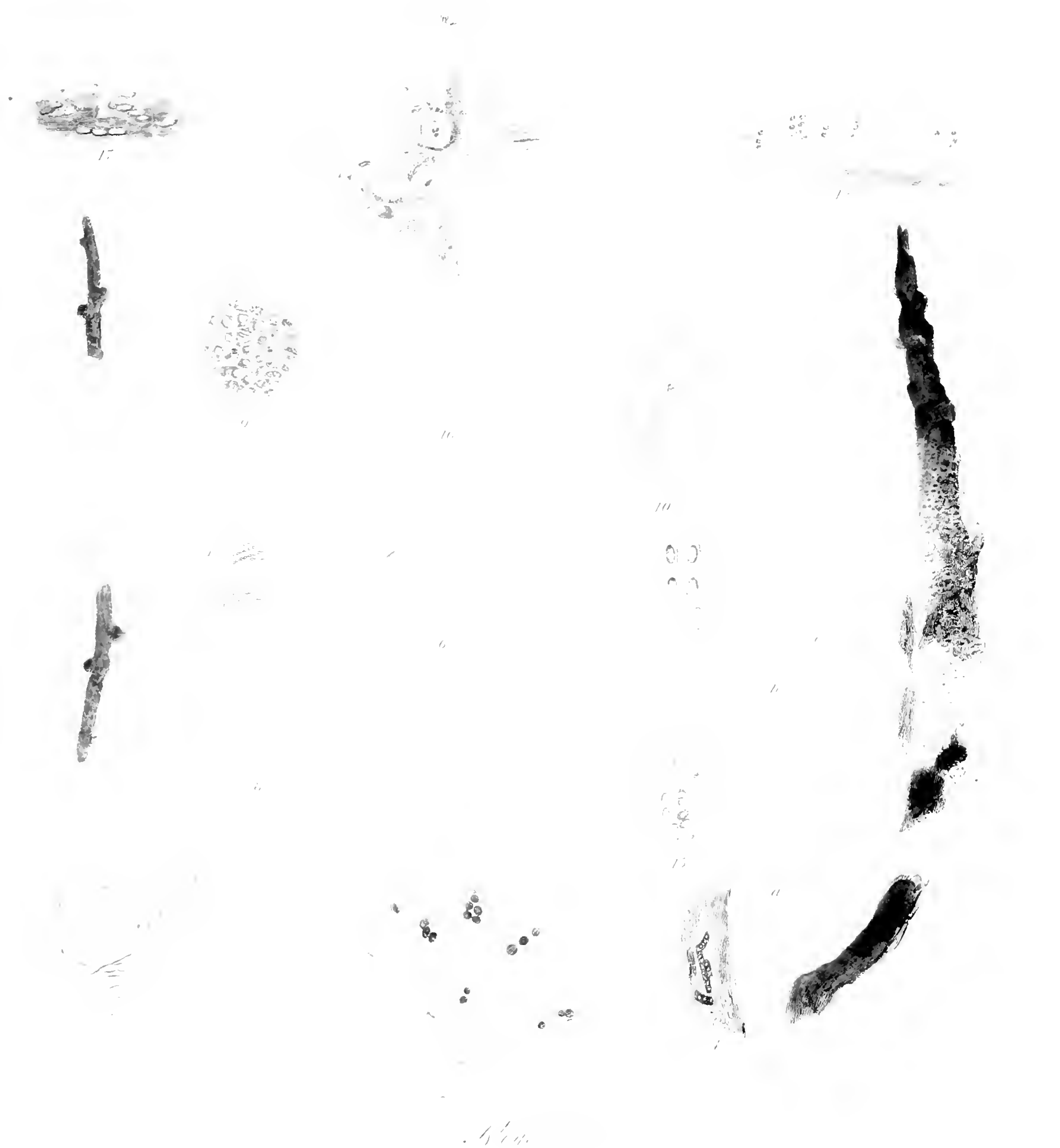


PLATE XXX. FIG. 2. Summit of one of the protuberances of fig. 1, shewing the form of the hydræ.

3. Ova floating.
4. Ova remaining *in situ* after decomposition of the Alcyonella, fig. 1.
5. *Alcyonella* (*anceps*), specimen investing a larch twig.
6. Fleshy prominence of fig. 5 with hydræ.
7. Fleshy prominence of another specimen with hydræ.
8. Hydra.
9. Cellular formation of part of the surface of fig. 5.
10. Cellular formation of another specimen diffusing a very thin stratum.
11. Under surface of a specimen where applied to the substance invested.
12. Entire hydræ, together with the conical prominences *a*, *b*, *c*, of decayed hydræ, containing ova.
13. Ova *in situ* depressed in a portion of fir bark, the Alcyonella having decayed.
14. Other ova also *in situ*.
15. Ova on the same bark.
16. Young hydra from an ovum of fig. 15.
17. Nascent hydræ developed from ova on the same bark, interspersed with ova still entire.
18. Vesicles of uncertain nature dispersed on the bark.

All the figures of this Plate, except figs. 1, 4, 5, 13, 14, are enlarged.

§ 3. PLUMATELLA.—PLATES XXXI., XXXII., XXXIII.—None of the Lunate tribe of Zoophytes exceed the luxuriance or the beauty of the Plumatella, nor do any of them so narrowly resemble a plant. The delicacy of its parts, their extraordinary number, the richness and vivacity of the efflorescence, are all the best adapted to excite our interest, and attract our admiration.

Nevertheless, the diversity of aspect which is almost universally incident to zoophytes, does not diminish the wonted perplexities assailing the naturalist in his attempts to assign to each its proper place, should it appear that there are more than a single species. But in truth, the most prominent disparities are either too slight, or the subjects too indefinite, or too intricate, to admit that ready determination, finding such powerful auxiliaries in other departments.

Amidst a competent number of specimens of all different quality, occurring also in very different places, I acknowledge myself unable to pronounce whether the whole concentrate in one species, whether they constitute more, or whether they consist of varieties. The distinctions among them are not sufficiently prominent: neither have I discovered a single specimen hitherto, which I can thoroughly identify with the Plumatellæ of authors.

Thus, I can only conclude, that the reciprocal resemblance of specimens to each other, is not so striking as at once to prove identity, though enough to establish kindred.

I believe that, on the strictest scrutiny, we should find the same want of similitude, long since alluded to, as pervading both the animal and the vegetable world.

Authors affirm that there are two distinct species of the Plumatella, the *repens* and the *reptans*.

I can speak only of the former; for if there be actually two, it has not been my fortune to see both. Much is certainly due to age and position.

In general, the *Plumatella repens* occurs of small dimensions, for the most part formed like a branch, and always as adhering to some more solid substance.

But a perfect specimen, of great luxuriance, and of ample dimensions, seems to diffuse originally rather from a central point, and finally adopting such a superficial figure, as the proportional vigour of the parts shall have regulated.

If this be true, considerable difference of form will ensue from the vegetative power being stronger at certain points than at others.

The finest of all specimens are seen on stones. Of these an admirable example occurred near a ruinous mansion called Fenton Tower, in the county of Haddington, about twenty-one miles east of Edinburgh, for which I was indebted to that same affectionate companion of my excur-

Pl. XXXV

sions already noted, who takes the liveliest interest in all my pursuits, and who values the beauties of Nature as demonstrations of the Divine essence vouchsafed to the gaze of admiring mankind.

This fine specimen spread in adhesion over a stone bare of all other vegetation. Its diffusion was such that it might have been bounded by a quadrangle of four inches above, besides descending so much over one end of the stone, that the whole area it occupied would have equalled twelve or fourteen square inches. Nothing could surpass its luxuriance. At least 1200 vivacious hydræ decorated the extremities of this wonderful product.—Plate XXXI.

No description can adequately convey the appearance which so beautiful an object presents to the view of the spectator.

In the immediate vicinity of Fenton Tower, are some old quarry holes of limited extent, full of water, with a quantity of loose materials broke out of the rock. The under surface of some of them bore the *Plumatella*.

The specimen having occurred unexpectedly, when I was unprovided with a vessel of suitable capacity for its conveyance, it was carefully wrapped in a wet cloth, whereon water was poured occasionally afterwards, and thus reached the place of destination in perfect safety, on the 23d July, the same day when found.

The *Plumatella repens* is wholly tubular. It consists of very irregularly formed boughs and branches, with tubular twigs, all alike irregular, crowned by a retractile lunate ascidian hydra. This animal is provided with numerous ciliated tentacula; those of the specimen from Fenton Tower, I computed as between 70 and 80. Another withdrawn from a neighbouring pool, invested the bark of a portion of some decaying shrub, whereon the hydræ were in extraordinary profusion. They had at least 66 tentacula as enumerated. The dimensions of this latter specimen were much inferior to those of that on the stone which had occurred during the preceding year.

Although much variety and irregularity may prevail in the fashion of the growth of zoophytes, it is probable, that where vegetation is invigorated, and its extension unchecked, corresponding forms will ensue. But such facts can be established only by multiplied observations.

Towards the middle of August, a specimen taken in the same garden pond which had afforded the Cristatella exhibited to the British Association, diffused in ramifications with tolerable regularity, as if originating from a common centre, on a leaf of the Water Plantain. It might have been covered by half-a-crown or little more.—Plate XXXII. fig. 1.

Here all the boughs and branches, evidently tubular, adhered laterally to the leaf. They were scantily clothed with short cylinders, somewhat as the denticles of the Sertulariæ, projecting from their upper surface, inhabited by hydræ issuing from the orifice, and retreating completely within. Besides the animals in vigour, many were decaying; and many tubular projections, which had been of earlier formation, were tenantless.—Fig. 2, enlarged.

A faint green hydra, displaying its lunate head, above a line in diameter, provided with about 60 tentacula, and extending above a line from the orifice, belonged to this latter specimen. Buoyant particles in their vicinity were powerfully attracted or repelled, and received by the mouth projecting with a thin lip, susceptible of dilatation as a very shallow funnel amidst the tentacula.—Fig. 3.

Large green ovoidal pellets were discharged by the hydræ. The upper part of the integumentary covering of the body dilates as a circumferential edge, from which the closed tentacula issue, to expand the head as a crescent.—Fig. 3.

Another specimen, or which I rather considered only a portion of one, adhering to the back of a decaying *Iris*, was taken from the same pond, on September 20, of the preceding year; together with some more luxuriant than fig. 1. Its hue was much darker than any of the former, contrasting deeply with the pale green hydræ: and here the skeleton and tubular receptacles were strongly defined. But, various fragments being dispersed on the leaf, I cannot affirm what was the general character of its formation, presuming that it might not be entire, fig. 5; enlarged, fig. 6; hydra, fig. 7.

The character of the first two described, though not of equal size, this not being essential, seemed to correspond in other points.

The greater portion of the large specimen, found at Fenton Tower, diffused in adhesion to the stone, which is perhaps peculiar to the growth of the species; but in some parts branches arose an inch or more, quite free, bearing eight or ten hydræ. This is probably indicative of high luxuriance, requiring both time and a favourable situation.

Lateral adhesion, however, is the nature of the zoophyte. A small portion, deposited in a watch-glass, began to adhere in time.

We have seen that the Alcyonella testifies a preference for wood, or, if accidentally obtaining a position there, it vegetated luxuriantly. I cannot affirm that there is a similar preference, or that similar benefit of the Plumatella succeeds on its adhesion to stones, but certainly this is alike favourable as any other position.

About two miles west of the city of Edinburgh, is a pool of considerable depth, at the hamlet of Blackhall, part of the possessions of the Trinity Hospital, a charitable institution for the reception of aged persons.

This pool appears to have been originally a spacious stone quarry, and is always full of water, to which there is no visible outlet. Numerous stones, reminding me much of the quality of those near Fenton Tower, and of various dimensions, lie near the edge of the northern part.

Having resorted thither many years ago, I found the under surface of some of the stones invested by beautiful specimens of the Plumatella. The best were brought from the south-west, which place was inaccessible by myself personally.

All the specimens were in lateral adhesion; but I did not remark that they appeared to spring from a central point. They consisted of a stem with boughs and branches, diffusing more profusely from one side than the other, and terminating in tubular orifices, about an eighth of an inch above them, when most luxuriant. By this, I mean it to be understood, the projection was vertical, or at right angles to the product, which must be considered as spreading horizontally. It is difficult to render such descriptions intelligible. Hydræ issued from the orifices. The general tendency of vegetation may be considered as represented in Plate XXXIII. figs. 1, 2.

Specimens, of all different dimensions, but without any strict uniformity in the arrangement of the parts, spread upon the stones. Some extended four inches in length by three in breadth, which were the largest I have observed. They are usually smaller, and there being frequently much greater proportion of branches from one side of the stem, their formation must be deemed irregular.—Figs. 1, 2. If a branch bears several twigs, the twig is very short, and often forks into two receptacles, with hydræ.

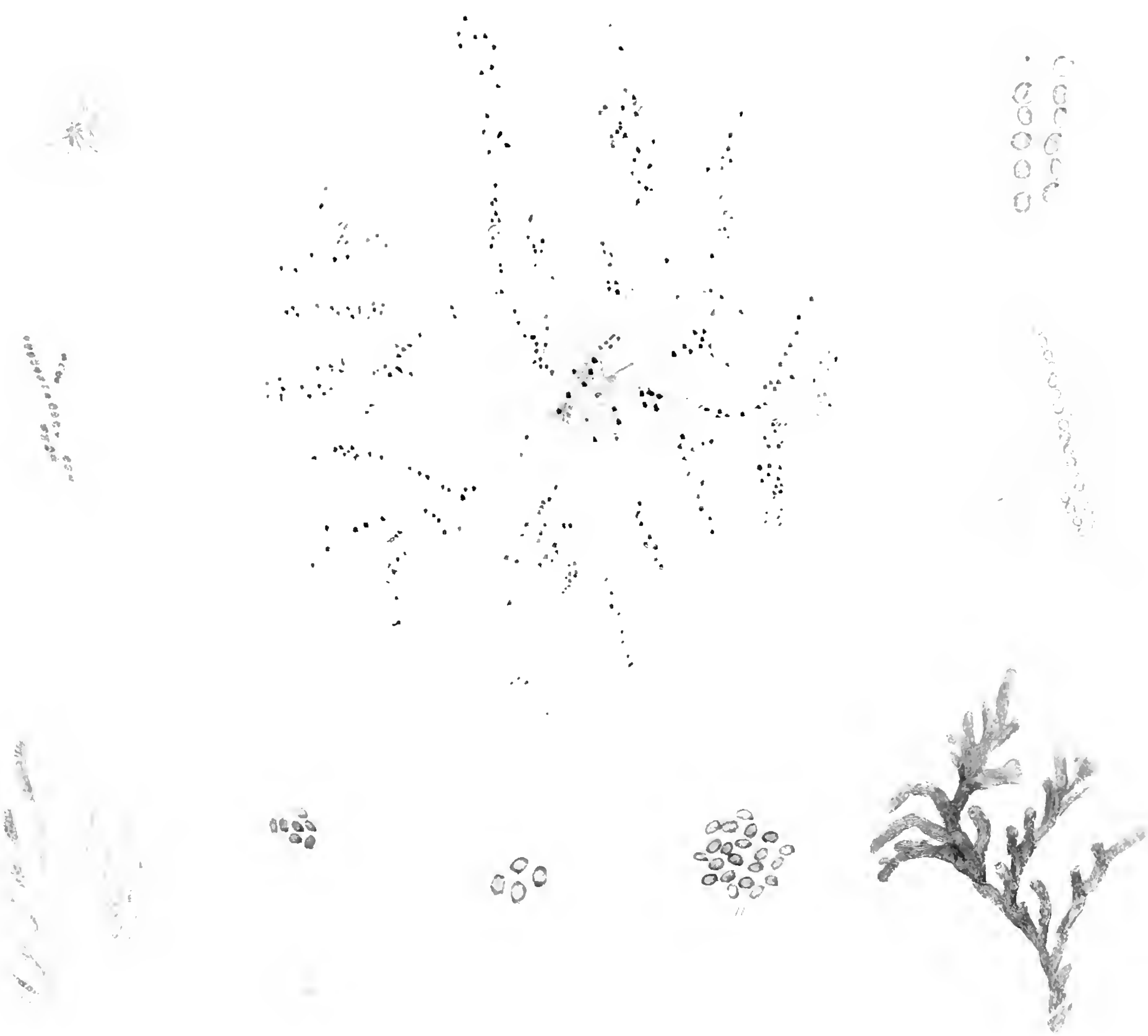
Here the hydra is of a greenish colour, and, as may be concluded, completetely retractile within the tubular extremity. Its lunate head is bordered with an outer and inner row of tentacula, in their circuit. I conjectured that the respective number in each might be possibly somewhat enlarged or diminished, if the animal can alter the shape of its crescent. The tentacula are clothed with very short active cilia, extremely difficult to be detected, and only by interposing shades, in different positions, between the light and the object.

As the number of tentacula certainly augments with age, it is impossible to determine the true complement; because it is impossible to discover which animals are of the longest survivance, and whether they have grown under favourable conditions. In one of the hydræ from Blackhall, I enumerated 60 tentacula—in another 52. Those of the latter were so disposed that 28 were in the exterior, and 24 in the interior row. In the former, the inner row comprehended 22. I thought a large orifice visible in the neck, under the head.

The pulsation of a vessel below could be discovered, alternately dilating and contracting about twelve times in a minute, when the thermometer stood at 60° in the open air. By this alternate action, dark particles were carried downwards and then returned.

It is seldom that the cilia of such minute hydræ are visible, and in these zoophytes they appeared more difficult to be found than usual. But, by dropping a little muddy matter over the animals, they are roused to great activity. Such an effect, produced by an extraneous substance on the cilia, narrowly resembling the like, under similar circumstances, on the *Amphitrite ventilabrum*, may render it doubtful whether the office of these organs is restricted to those functions usually ascribed to them.

Though many animalcula were entangled among the tentacula of the



Plumatella, I have never observed that any of them were seized, retained, or swallowed.

Numbers of the *Vorticella rotatoria* infest the Plumatella in Blackhall pond. Many seat themselves on the extremity of the tubes, the spot where they harbour in particular, and there twelve or twenty may be seen at once.

In as far as I could determine, no vegetable substance bore this zoophyte in that pond, during the period of my investigations; nor, with the following exception, any other substance than stone, and then chiefly the under surface.

But, I was surprised to find at least four or five specimens vegetating luxuriantly, inside an old tin pan, which had been thrown into the water. These run over the surface of the metal in lateral adhesion, the tubular receptacles of the hydræ projecting about two lines from the branch, independent of the hydræ themselves. Whether the twigs were in adhesion or free, they originated from only one side of the member sustaining them. The best of the specimens extended two inches, or two and a half in length, diverging about as much across.

Besides all the preceding, I shall name but one other specimen investing a leaf of the common yellow Iris in Foulden pond after the middle of September. It consisted of irregular tubular ramifications, extending in adhesion about two inches. The hydræ were in such vast profusion, that the formation of the specimen became more obscure with the diffusion of the parts.—Plate XXXII. fig. 8.

I could not ascertain that any of these animals had above 50 tentacula in the arrangement of a crescent, like those of the rest. They were of pale green colour, and presented the wonted peculiarities of structure and habits, fig. 9. But owing to their particular position, and the multitude crowded together on the edge of the leaf, where most accessible to the microscope, it proved, nevertheless, impossible to free any one from the rest for distinct and satisfactory inspection. The whole product had a yellowish tinge.

Perpetuation.—Some of the most remarkable facts continue to be afforded by the Plumatella, on this interesting department of the arrangements guiding the universe.

The organic parts, by which our remarks must be confined to the hydra, are not dissimilar in the tribe of lunate fresh-water zoophytes. I speak only of general appearances, for perhaps, considerable distinctions exist in reality.

The inorganic parts of the Plumatella, however, are very different from those of the two preceding genera, the Cristatella and the Alcyonella. I would not be understood to affirm, however, that the sole of the former, or the subordinate stratum of the latter, is absolutely of that description. But all the skeleton of the Plumatella is tubular, nor does this tubular portion decay with the animated portion.

The present zoophyte propagates by ova like the others. It is difficult to say where they are generated, for here there is no substantial mass amidst which their elements may be reposited, as in the Cristatella and Alcyonella. They are most conspicuous when occupying the tubular parts of the Plumatella.

The specimen, Plate XXXII. fig. 8, recently quoted as occupying the leaf of a yellow Iris, was removed from its native site on the 21st of September, while the hydræ were in great vigour. Numerous ova occupied the tubular parts, but in the hydræ none were observed. Many lay below them in the hollow ramifications. There they were arranged in lines or curves according to the form of the parts, which are no wider than the diameter of the ovum. Twenty or thirty were in contact, their position nearly horizontal.—Fig. 10.

This ovum much resembled that of the *Alcyonella stagnorum*, though larger. It was of lenticular form, the disc or centre yellow with a dark circumferential ring and a smooth edge, fig. 11. It appears to me that the ovum of the Plumatella is originally white. As the leaf of the Iris decayed, the parts of the skeleton of the specimen became admirably exposed.

The first ova had escaped to float on the surface of the water about the 16th of October; a few hydræ still survived next day; but on the 22d none.

After careful preservation during winter, the shells of the ova began to sunder, and give birth to the young hydra of the Plumatella on the 10th of May. Numbers continued hatching for two weeks successively. —Figs. 12, 13, 14, 15.

On computing the period requisite for bringing the embryo to perfection, from October 22d until May 10th, it appears to extend to at least 198 days.

But many ova having remained entire considerably later, the interval must be rated longer in proportion. Thus, the period elapsing between the delineation of the ova in fig. 10, and the young hydra hatched from one of them, fig. 15, amounted to seven months. The whole hydræ represented, figs. 12, 13, 14, 15, represent the young brood from other ova of fig. 10, there being additional ova or shells in their vicinity.

The horizontal position of the ova in the branches was still preserved by those remaining there in June. None hatched after the 24th of that month.

Similar general principles, perhaps, predominate over the propagation of other specimens, without perfect uniformity in the detail, which is scarcely surprising, seeing that we cannot declare the identity of species. There may be varieties, or a great difference may be concomitant on age, and something may depend on season.

A specimen investing a leaf of the Water Plantain, the hydra of which had 60 tentacula, is above referred to (p. 126), Plate XXXII. figs. 1, 2. The hydræ of that last quoted diffusing on the leaf of the Iris, had only 50 tentacula.—Fig. 8.

Numerous ova occupied the tubular parts of the former on the Water Plantain, in the middle of August; and some had escaped on the 20th of that month, of lenticular form like the others, with a smooth edge, dark circumferential ring, and yellow disc or centre.—Fig. 4.

But, besides the ova in the tubes, some were contained in the body of the hydræ, between the integumentary skin and the interior organs, wherein they rose high. One of the hydræ had at least six. Ova also occupied the cavities of those tubular ramifications, which, at this time, were vacant of hydræ.

The specimen was still vegetating, and had advanced so far that the hydræ had reached the edge of the leaf, and the branches turning over it were beginning to adhere on the opposite side.

All the hydræ had perished on September 24. Many ova had then escaped; and many still occupied the skeleton, which was nearly free of the whole in the close of October.

Thus the ova are connected with the body of the hydra; and I remarked of specimens from Blackhall pond, that the ovum seemed to be attached to the body from its rising and falling in the tube, according as the hydra rose and fell. The tubular cavities likewise were obviously full of water, from the ova being tossed about within. After decay of the animals, they here remained behind, fig. 16; but they were not arranged regularly in the skeleton more than in the rest. There was room for only one laying across. I could bring these ova into no position, wherein they did not appear elliptical, though I incline to think this form illusive.—Fig. 17.

The beautiful specimen, Plate XXXI. was taken, it will be recollected, on July 23. Numerous dark ova were contained in the higher parts of the ramifications, towards the hydræ: and in other places, were numerous white ova, being immature. On the 4th of September the hydræ ceased to display themselves. A month earlier the ova had been discharged; some were then seen in the body of the animals, and at the date last specified, they were still escaping from the specimen. After thousands were floating, the water became vitiated, thus disappointing me of their progeny.—Plate XXXIII. figs. 8, 9.

A specimen, whereof the hydræ had 66 tentacula, has been above referred to as investing the bark of a piece of a shrub found at Fenton tower in the month of July.

Some portions were separated, and deposited in a crystal jar, where they lay undisturbed for three or four months. In December a specimen was vegetating on the side of the jar, which I conjectured to have originated from a prolific ovum. In the end of this month it bore about twelve white hydræ. None survived in the end of January, and the parts were then decaying. But here was an example of hydræ flourishing in the middle of winter. Probably this is common in the native abode of many zoophytes; and it may be witnessed from experiment. If the stems of a group of the *Tubularia indivisa* be cut asunder, new hydræ will be developed from the higher extremity, and after the fall of the first or second their successors will appear, all during the winter season.

All the observations hitherto made certainly apply to the *Plumatella repens*. Understanding that the *Plumatella reptans* dwelt along with it in a pond called Lochmill, in the county of Fife, I proposed visiting the place. Fulfilment of my design, however, was anticipated by the friendly attention of Dr Fleming, from whom some specimens, carefully packed in wet moss, reached me, then 30 or 40 miles distant.

But their preservation proved difficult, owing to an interval of a few days elapsing before they could be treated suitably. The chief precaution, necessary on such occasions, is to preserve the zoophyte humid and cool.

I am not entirely satisfied that I was now in possession of the *Plumatella reptans*, providing that species has been sufficiently defined. Here the specimens spread on a stony surface, or rose above it. The hydra protruded its lunate head, with about 45 tentacula, from the extremity of the tubular ramifications, with much vivacious action. When retracted completely within, a slight influence remained by sensible inflexion of the summit. Particles were attracted and repelled by the tentacula, and dark matter filled the stomach. A notch seemed to indent some of the tubular extremities.—Plate XXXII. Fig. 18.

The specimens survived about three weeks, during which time they were enlarged by new accessions. Older portions being of chestnut colour, or yellowish brown, the young animals with their tubular extremities were perfectly white.

I dread that the preceding long detail will be considered prolix and unsatisfactory; that some parts of it may appear equivocal to the reader. I should have gladly solved the doubts entertained by myself, but of later years specimens have disappeared from their wonted abode. I know not how many seasons I have visited Blackhall pond, as one of the most accessible, but unsuccessfully.

My chief anxiety has been to establish an absolute distinction among the various species, if actually susceptible of being distinguished. Perhaps they are not, and for all that has been said of the variety of the number of parts, the tentacula may go no farther than the great variety of colour among certain quadrupeds and birds constituting a genus, or even a single species.

Nevertheless, certain facts, about which there can be no controversy, are derived from preceding observations, combined with the following conclusions.

Zoophytes, wherein the hydra is crowned by a head of a horse-shoe or lunate form, with ciliated tentacula, are of three distinct genera, void of any reciprocal kindred; the *Cristatella*, the *Alcyonella*, and the *Plumatella*, to be thus described:

I. *Cristatella vagans* [*Mucedo*], a fleshy basis, two inches long, and above three lines broad, endowed with the slowest motion, sustaining a border of 300 or 350 hydræ in a triple row, each provided with 100 tentacula.

1. Propagation ensues by lenticular formed ova, begirt by a circle of double recurved spines, generated in the fleshy basis, whence they are liberated by its decay.
2. An interval of 200 or 230 days is required for maturity of the embryo, after liberation of the ovum.
3. The embryo, developed as a single white hydra, quits the ovum; after which other hydræ are developed from the same basis, their numbers augmenting with time.
4. In maturity the Cristatella is of a fine translucent green colour.

II. *Alcyonella*.—A gelatinous, adhesive, immovable stratum, from which the hydræ issue in extraordinary numbers.

A. *Alcyonella stagnorum*.

1. Invests leaves or stems of aquatic plants, in a grey stratum.
2. The hydræ, numerous in proportion to the surface overspread, are provided with from 42 to 44 ciliated tentacula.

3. It propagates by ova of lenticular form, with a smooth circumferential edge, which are liberated chiefly by decay in the season of autumn.
4. The ovum contains a single embryo hydra, which reaches maturity 167 days after being liberated from the Alcyonella.

B. *Alcyonella gelatinosa.*

1. Invests wood, sometimes by a thick, yellowish, or grey, stratum, from which prominences arise, as in the *Lobularia* or *Alcyonium digitatum.*
2. The hydra, yellowish-grey, larger than that of the former, is provided with 70 tentacula.
3. It propagates by ova of a lenticular form, with a smooth edge, which are generated amidst the stratum.
4. They ascend into the body of the hydra, and many pass from the body of one into that of another.
5. They are liberated in autumn, chiefly by decay of the hydræ, and of the stratum; but some may remain in channels of the wood during winter.
6. The embryo attains maturity in 189 days from the date of liberation.
7. The young of the Alcyonella, of the third or fourth generation, identically resemble the parents of the first.

III. *Plumatella.*—A zoophyte, with tubular stem, boughs, and branches, adhering laterally to subjacent substances.

1. A greenish hydra, with from 50 to 70 ciliated tentacula, protrudes from the extremities of the parts, and is retracted within.
2. It propagates by ova, which are sometimes contained in the living hydra, but are seen in numerous rows in the tubular branches, whence they are liberated in autumn, or earlier.
3. An embryo hydra is contained in each ovum, which attains maturity in 198 days.

Among the general analogies of the three different products, the following are evident.

I. The common conformation of the hydra in some of the essential organs.

II. In the decay of all with the lapse of a single season.

III. All propagate by ova, which are principally liberated by decay of the prolific product.

IV. The embryo requires a long period for the attainment of maturity.

V. Maturity is gained by all towards the commencement of the summer season.

VI. No sensible metamorphosis is undergone by any of the race, farther than evolution of additional hydræ from the sole bearing the first from the ovum of the Cristatella; and of additional tentacula, with advancing age in all.

The principal discrepancies consist:—

I. In the different formation of the three products.

II. In the Cristatella being endowed with a locomotive faculty.

III. In the larger size, and different form of its ovum.

IV. In the diffusion and adhesion of the stratum of the Alcyonella.

V. In the arborescent form, and tubular structure of the Plumatella.

VI. In the position of its ova within the cavities of the arborescent parts.

VII. The ovum of the Cristatella is the largest, that of the Plumatella the next, and the ovum of the Alcyonella the smallest.

Plate XXXI.—*Plumatella repens.*—Adult specimen affixed to a stone from Fenton tower.

Plate XXXII. Fig. 1. *Plumatella repens*, specimen on the leaf of the Water Plantain.
2. The same, shewing the peculiar formation of the skeleton.
3. Hydra of the same.
4. Ova of the same.
5. *Plumatella repens*, another specimen.
6. The same, shewing the tubular receptacles of the hydræ.
7. Hydra of the same.
8. *Plumatella repens* on a leaf of the yellow Iris.
9. Hydra of the same.
10. Ramifications of the lower portion of the same, containing ova, as on October 17.

PLATE XXXII. FIG. 11. Group of the ova floating.

12. Nascent hydræ from the ova; the shells seen to the right still adhering.
13. Nascent hydra from the ovum, among other ova still entire.
14. Portion of fig. 10, as on May 17 of the following year, or seven months later than the date of that drawing, shewing the hydræ now nascent, with ova still entire interspersed.
15. Nascent hydra of the young brood.
16. Branches of a specimen of the Plumatella from Blackhall pond, containing ova.
17. Group of the ova, from the same, floating.
18. Hydra of a specimen of Plumatella from Lochmill.

All the figures of this Plate, except the first and the eighth, are enlarged.

PLATE XXXIII. FIG. 1. *Plumatella repens* on a stone from Blackhall pond.

2. Another specimen.
3. Single hydra subsisting after the decay of others.
4. Hydra and an ovum affected by its rise and fall.
5. Branch with the whole hydræ from one side.
6. Skeleton of a young specimen, which bore twelve white hydræ in winter.
7. Branch of the specimen, Plate XXXI., with hydræ and ova.

8, 9. Ova of the same floating.

All the figures, except fig. 6, are enlarged.

CHAPTER VII.

ASCIDIA.

As an introduction to one great section of the race of Zoophytes, a few words have been already said of the genus Ascidia, an animal very common in our seas, though the nature of none is less known in its details. We have seen an animated being bearing some analogy to it in several important features, combined as well with other organic as inorganic parts. But what shall now be briefly said, applies to the Ascidia as simple in itself, and void of all foreign combinations.

Naturalists are very little acquainted with the history of this creature in its living state; nor can I add any illustrative observations of material consequence; yet, with sufficient care, the Ascidia may be easily preserved a considerable time in captivity. Neither does it belong to a tribe of transient existence; on the contrary, it seems to be a long-lived animal. If observers find the safety of such creatures precarious, it is from their having previously suffered some unseen injury. Thus pressure is always pernicious, and without frequent change of its native element, mould is readily generated on the surface of the skin. Inveterate enemies are found, besides, in more than one species of the smaller bivalve shells, which, penetrating the flesh, render it their permanent abode, or abandon it at will.

Most of the Ascidiæ are coarse, unsightly, deformed looking animals, utterly void of that external symmetry and beauty rendering many of the tenants of the waters so interesting. Nor is it in this only, that they should fail to attract the spectator's notice. They testify neither instinct, action, nor motion, nor even the symptoms of life, farther than slight enlargement and reduction of size, together with contraction and expansion of the two tubular orifices of the body. No sensible alteration follows abstinence or repletion; the external form undergoes scarcely any modification from health or disease; even the lapse of time, that universal consumer, seems hardly to make any impression on the shapeless mass, which is rooted immoveably from the first moment on the same spot to vegetate, live, or die.

Such is the case, with but few exceptions, during any ordinary or reasonable period, that may be occupied in observation.

Yet, let us recall what is disclosed when this rude object is stripped of its external integuments, from which some of the genus may be withdrawn almost as from a bag. How complex the structure then displayed; what a wonderful arrangement of muscular, respiratory, circulating, secretive and digestive organs, adapted for discharging the vital functions, all proving the handiwork of the Great Architect, as directed towards a common end.

To external view, some species of the Ascidia consist of an outer and an inner portion, quite distinct in colour and general appearance; in others the aspect is wholly homogeneous. Sometimes, in event of a wide rent, or great rupture of the outer coating, the red internal substance escaping, leaves the rest as clear as crystal behind.

The Ascidia, I should repeat, does not properly belong to that extensive tribe with which we have been engaged—the zoophytes; for those brought under review only participate of its nature. But, by assuming a discretionary latitude, it receives a few illustrations here, principally as another introduction to certain natural products of compound formation, wherein its properties hold an important place.

Besides these, their nature distinguishes many of the testaceous genera, of which I shall say nothing at present, unless that it may be seen how extensively the genus is distributed, and under how great a variety of aspect and combination.

Almost the whole Ascidiæ with which I am acquainted, are permanently affixed to some foreign substance. I have not seen above two exceptions; and the whole Ascidiæ proper are inhabitants of the sea.

The external aspect of this animal is much diversified. Some, dark and opaque, clumsy, or inactive, resemble the root of a vegetable; some are not unlike small or large red currants. Many may be compared to a diminutive sackfull of grain or other commodities, and a few are of a beautiful green, glassy, translucent colour. I speak only of those of more common occurrence, such as are not difficult to be procured.

If any of those in adhesion be detached they seldom fix again. Though undergoing no sensible alteration, and adhering firmly to the substance whereon it is implanted, the two orifices of the body of the Ascidia are often contracted and dilated alternately, the higher being appropriated for the absorption of nutritious matter, and the lower, the termination of the intestinal canal.

The food of the animal seems to consist in what may be eliminated from muddy solutions. Quantities of mud suspended in water are evidently absorbed and long retained; they visibly fill the intestinal cavities of those species whose transparence exposes the interior. If the clearest sea-water be rendered turbid, it is speedily purified by the secerning operation of internal organs, serving to select the nutrition, while the residue is rejected, to be discharged in rolls or cylinders.

Most Ascidiæ are sufficiently hardy to survive long in captivity with due precaution for frequent renewal of their element, and to preserve them from pressure. Though numerous colonies may be crowded together, and certainly suffer pressure among themselves with impunity in their natural abodes, all artificial pressure, even where slight, seems always fatal.

Probably this creature attains very great age. Specimens bear undoubted evidence of the fact. The surface serves as a fertile soil for the germinating fuci, or the implantation of zoophytes. Several of the cirripedes and testacea find a permanent habitation there; and may be occasionally found entirely overgrown and incorporated with the flesh.

Naturalists have hitherto paid very little attention to the living Ascidia. Indeed, we must own, that an animal displaying such indefinite habits, those scarcely to be distinguished, is not likely to attract notice. A copious and excellent treatise, chiefly anatomical, was published above thirty years ago, on the simple and compound Ascidiæ, by M. Savigny, a learned French physician, illustrated by numerous interesting plates. A treatise by M. Milne Edwards on the subject in detail, was published in

1841, wherein that author refers to his previous observations in 1828. Not having seen the latter, I am precluded from availing myself of them. A few other more brief and incidental observations have appeared from very intelligent authors.

Here I propose merely to enumerate a few of our native species of simple Ascidiæ, and that, as before said, as a prelude to further comment on some singular points in the history of others, and especially of those consisting of a multitude of individuals united indissolubly in compound masses.

§ 1. Ascidia villosa.—*The Woolly Ascidia.*—Plate XXXIV. Fig. 1.—Unlike the common nature of all the Scotish Ascidiæ, excepting one, with which I am acquainted, this species is not affixed by the base to any substance; it is free. Its dwelling is in deep water, among sand, at the bottom of the sea; and it is usually recovered by means of the fishermen's lines, but not, as I understand, from touching or seizing the bait.

Though classing the animal here with the Ascidia, I apprehend that it may be found only in immediate approximation to the genus, instead of being incorporated along with the other species. At the same time, I am ignorant of any of those to which it is allied. Let its name and position be therefore accepted meantime as provisional, if no other naturalist has already assigned it a place.

The *Ascidia villosa* extends from four inches to four and a half in length, by about nine lines in its greatest diameter, towards the lower extremity. The anterior extremity consists of two brief abrupt prolongations, or rather prominences, in lieu of the tubular parts of the Ascidia proper; each with its peculiar orifice, which, in a vigorous specimen, is about half an inch beyond the forking of both from the body. The posterior extremity of the body may be compared to the transverse half of an ovoid; it is somewhat villous, and frequently invested with fine sand.

This animal is round, wholly of reddish-brown colour; the interior of the orifices scarlet.

Whether the posterior extremity is sunk amidst the sand in its natural state, and the opposite extremity disengaged above, is not to be ascertained. In captivity it always lays horizontally, without any effort, that I have seen, to penetrate downwards, or even to shift its position.

This animal is very rare.

PLATE XXXIV. FIG. 1. *Ascidia villosa.*
2. Orifices *a*, *b*, enlarged.
3. Young specimen.

§ 2. ASCIDIA INTESTINALIS.—PLATE XXXIV. FIGS. 4, 5.—This animal bears some resemblance to a Florence oil-flask, with two necks of nearly equal dimensions, having a larger and a smaller orifice. It extends between three and four inches in length, and, where thickest towards the lower extremity, it is about nine lines in diameter. The whole skin is smooth, and of a fine grass-green colour, with a vivid yellow margin bordering each orifice. The larger orifice is octagonal, the smaller hexagonal.

There seems to be a variety wherein the larger orifice is subdivided into sixteen, instead of consisting of the usual number of eight convexities, with eight equidistant orange spots on the exterior of each orifice. Several specimens have been seen thus distinguished.

This animal is of translucent, soft, and delicate appearance.—Plate XXXIV. fig. 4.

It is easily injured by pressure.

The ordinary habitation of this species is in the double, and often the single cavity of old oyster shells, wherein a group of five or six may be occasionally discovered in contact, closely packed together. But by rending such double shells asunder the Ascidiæ are generally much injured, for they are in firm adhesion by a large portion of the side and to both valves, instead of adhering by the base as some others. Laceration or abrasion is almost always fatal.

These creatures occupy double shells from an early age; the orifices protrude through the valves for the purpose of nutrition, though a very inconsiderable part of the upper portion of the specimens is free. If any occur entirely loose, it should be ascribed to accident.

The young are nearly transparent. A month or two after a small one of this description came into my possession, it was removed from its position where the adhesion was not strong. Being about half an inch long, it remained free another month, when fleshy prongs generated from the lower part of the side now affixed it to a new substance. Its size increased considerably during survivance for eight or ten months, however the slightness of the adhesion allowed it to be detached.—Fig. 5.

Shelter seems indispenable for the security of this species. The skin grows dark in time, and peels off if distempered. External changes are more conspicuous here than in those originally of darker hue. The transparency of the animal adapts it well for observation. Almost the whole line of the intestine is frequently visible, as occupied by the muddy mass from which sustenance is eliminated.

The *Ascidia intestinalis* is common in our seas.

Plate XXXIV. Fig. 4. *Ascidia intestinalis*. Orifices *a. b.*
5. Young.

§ 3. Ascidia rustica.—Plate XXXIV. Fig. 6.—Of all the Scotish Ascidiæ this is of the most frequent occurrence; and it dwells in situations the most different, as well as occupying the greatest variety of substances. To each of these it is affixed by the base alone, and rises about an inch and a half, or somewhat more, in height. It is rather of ovoidal form, with two low serrate orifices; and it is totally invested with a thick coriaceous integument. Larger specimens are reddish, or mottled red and grey, or white. Smaller subjects are distinguished by these latter colours.

In early stages the animal is comparatively transparent. If then detached from some softish substance whereon it is sometimes found, which may be easily done, and freed of impurities, it proves an interesting object for microscopical observation.

One of this description, a line in length, small and white to the naked eye, now exhibited six vivid red specks around each of the low serrated orifices. An internal blood-vessel below collapsed about sixty times in a minute, and dark particles, intermixed with its fluid contents, were evidently conveyed by other channels to different parts of the body; while in some portions of the transit, they were carried along with accelerated velocity. Circulation continued visible during a fortnight. As the animal darkens with age, nor has any means of relieving its skin from the extraneous matter always deposited from sea-water, the lower portion of the body, wherein the blood-vessel is the best exposed, gradually becomes obscured. Here the marginal specks remained visible also, until similar obscuration rendered them imperceptible.

Such minute specimens grow rapidly, but they can be seldom preserved long.

The *Ascidia rustica* is occasionally found in numerous societies, but for the most part it is solitary, or only a few are together. Above twenty were seated on one of the valves of the razor shell (*Solen siliqua*); about eighty invested another shell, crowded within an area not exceeding twenty-one lines square, where no space seemed remaining for further increment. A colony sometimes forms a kind of belt around the circumference of a shell, whereon the Ascidiæ have originated, or a group is concentrated in the middle only.—Fig. 6.

The brood is seen in remarkable profusion, and absolutely compressed within such limits as might be concluded pernicious to the individuals. Of this there is an example of the young of the *Ascidia rustica*, as I conceive, which is represented by Plate XXXV. Here two slender portions of a marine vegetable production, one of the *Floridiæ*, were each invested by about 100 small Ascidiæ. The whole subject resembled two strings, three inches long, entirely beset with animals like currants on their twig. From its appearance, it might have been almost compared to some of the *Botryllus* among the compound Ascidiæ.

Individually the animals were grey. Many had a white cross on the skin, which appeared to be composed of minute pure white specks under the microscope.

This specimen having been suspended by a silk thread, in a capacious jar of sea-water, to avoid the peril of pressure, the Ascidiæ survived three weeks. Nevertheless, they began to mould on the lapse of that period, having probably sustained some injury before reaching me.

The full-grown Ascidia is generally a very rude and coarse production in external appearance.

PLATE XXXIV. FIG. 6. *Ascidia rustica*, colony.
PLATE XXXV. *Ascidia rustica*, young brood.
PLATE XXXVI. FIG. 7. *Ascidia rustica*, young?

§ 4. ASCIDIA SCABRA.—PLATE XXXVI. FIG. 2.—The aspect of this species is very different from that of the preceding; it resembles a fine smooth plum, 18 lines long by 12 broad, with a very thick transparent integument, enclosing a red kernel.

The general figure of the species is a rude, somewhat flattened ovoid. Commonly the integument is about two lines, or the sixth part of an inch in thickness, like very solid diaphanous ice or jelly; but a little thinner above at the orifices, of smooth and even surface, unless for some inequalities on the upper part, and where affixed by the base. The coat of the kernel, which contains the internal organs, is finely reticulated, as distinctly seen when interposed between the naked eye and a penetrating light. The intestinal tube curves from the bottom upwards to the lower orifice, just within the red portion, wherein the principal organization is lodged.—Plate XXXVI. fig. 2.

Smaller Ascidiæ frequently occur, which, without farther preservation, cannot be identified with any of the larger, familiar to us, they are so different in form and colour. Such is one not a quarter of an inch long, always white, found adhering to the corallines. Another, having still to undergo much alteration, I was induced to conjecture the young of the *Ascidia scabra*. The external integument was thick and clear: the internal surface of the second tunic yellow and reticulated.—Fig. 3. The same, enlarged, fig. 4.

A small Ascidia, deposited in a vessel during autumn, began to adhere in two days, promising to become useful and convenient for observation. This subject was pale grey, speckled red, and of such colour as to expose the interanea obscurely. On the whole, I concluded that it might be a young *Ascidia rustica*. The skin continued spreading more than usual, on the glass vessel containing it. After the animal had survived four months in vigour, nothing remained on subsequent inspection but an empty sac.

When the *Ascidia scabra* decays, an empty transparent bag, the exterior coating, is left, being voided of its contents.

It is thus that the ascidian race is constituted a distinct class, denominated *tunicata*, because the integument is, in fact, a bag, besides which another envelope includes the vital organs.

Plate XXXVI. Fig. 2. *Ascidia scabra.*
3. *Ascidia scabra*, young?
4. The same, enlarged.

§ 5. Ascidia mentula.—Plate XXXVI. Figs. 5, 6.—Compared with the preceding, and all others that I have seen, this species attains gigantic size. It is the largest of its tribe. Specimens obtained in the Orkney islands, are no less than eight inches in height, and three in their widest diameter. There is more inequality in the relative position and proportion of the parts here, than in most of the rest in the Scotish seas; the higher orifice terminating that portion of the body which is five inches above the lower orifice. The whole exterior is very hard and coriaceous, of irregular conformation: much resembling an old root, or part of the stunted, decaying branch of a tree. Those of large dimensions are covered completely with fuci and other parasite substances, finding an appropriate foundation in the rugosities of the surface.

But specimens of this description are seldom found. They seem to belong only to what are esteemed the more remote parts of Scotland: Nor are they common there. I have seen but few.

I was indebted for a fine specimen to the favour of Dr Duguid, a learned physician in Kirkwall, Orkney, always ready to promote the researches of the naturalist. This animal, perfectly clean and vigorous, extended three inches in length, by an inch thick where of greatest diameter. The distance between the orifices, though great, did not appear quite so disproportionate as in those of unwieldy growth.—Plate XXXVI. Fig. 5.

On the upper portion of this animal, a younger specimen was seated in slight adhesion. The orifices were proportionally somewhat more approximated than in fig. 5; which shews that the disproportion is in the ratio of the age.—Fig. 6.

These specimens did not survive above a month.

The adhesion of such Ascidiæ as the *mentula* and *rustica*, sustained on the base, is rather an intimate application, like that of the *Lobularia*, than by union or incorporation of the parts. Yet it is difficult to detach these specimens without laceration. The reverse is seldom practicable, which renders all very liable to perish.

Though I have preserved a multitude of some of the preceding species, with all possible care throughout, very little of their nature has been disclosed: Nor has any success attended my anxious endeavours to discover their formation in the earliest stages. This will, no doubt, seem very singular. It is one example of the disappointment in a search after interesting points of zoology, even where subjects are abundant.

When first obtained, all specimens, if intended for permanent observation, should undergo careful inspection, that it may be seen they are free of external injury. None, unless perfect, need to be retained. Doing so would be superfluous trouble.

Plate XXXVI. Fig. 5. *Ascidia mentula*.
6. *Ascidia mentula*, young.

§ 6. Ascidia papilla.—Plate XXXVII. Figs. 1–11.—Farther than ascertaining the external formation and a few—very few of the habits of the Scottish Ascidiæ, I cannot affirm that the care and attention bestowed by me on them, have been rewarded by much success. Perhaps an animal permanently rooted to the same spot, whose senses are so obtuse, that possession of one only is definitely evinced, whose shape never changes, and which appears to have little more than a mere passive existence, may be said to be scarcely susceptible of displaying any thing else.

The internal organization of the various species, as shewn by the skilful anatomist above named, is full of interest; nor, however desirous, could I pretend to offer any additional illustrations, of that which I do not consider a department which I am entitled to embrace.

Nevertheless, there are some other branches curious and useful to be known, in the nature of the living subject, essential also in illustrating its history, for our whole acquaintance with animal physiology is not confined to that which can be chiefly discovered only when life has fled.

The frequency of disappointment obstructing the pursuits of mankind, whatever they may be, ought to teach them more than ordinary satisfaction, when their purpose proves successful.

I had long and earnestly endeavoured to discover the precise nature of the young of the Ascidia, and the form wherein it appeared at its earliest stages. I could find no definite and satisfactory account of either recorded in the annals of science, which, to say the truth, I ascribed to my very limited acquaintance with the published works of naturalists. Therefore, I kept numberless specimens of various kinds, in hopes of verifying such desiderata by actual observation. But herein I was uniformly frustrated. I might have reflected, indeed, on the peculiarities just specified —so uncommon among the animated tribes,—and I might have there found so many impediments to the fulfilment of my expectations,—for how could animal propensities be demonstrated where there was hardly the semblance of life?

Yet here, as in some other subjects, obscurely denoting it, animation did certainly exist, and if the vital functions of other creatures might be discharged in confinement, it certainly was not impossible that a stationary position, under suitable treatment, should be rather favourable for their preservation and exhibition than otherwise.

An animal, however, which is rooted to the same spot, void of active external organs, whose food is unknown, which scarcely betrays symptoms of life, it must be admitted, seems the least likely to gratify the curiosity of naturalists in any respect. It appears, indeed, as if Nature, willing to conceal her hidden mysteries, exacted more than ordinary care to discover them.

Nothing can prove more decisively than the subject of these reflections how scanty is our knowledge of the objects of Creation, how fruitless our conjectures, how fallacious all our reasoning from analogy.

But this, at the same time, offers the strongest inducement to search for the truth, by steady perseverance in observation and experiment.

The *Ascidia papilla* is the most common of any of the tribes inhabiting our Scotish seas. Almost every substance is readily, and many of them most profusely, invested by it. Vegetables, zoophytes, wood, shells, rocks, and stones, serve alike for its abode: Nor does any of these seem to be chosen in preference. Here it is affixed, solitary, associated in groups, or conglomerated in masses.

The single animal is of an irregular hemispherical form, somewhat elongated upwards, with two tubular projections and orifices above, like the rest. Under this aspect, it is of all different dimensions, *within* nine lines in diameter and nine in height,—though seldom reaching that size—and it is of all different shades, from dingy white and carmine to tile-red, or somewhat brighter. However, it is commonly seen as a low spherical segment, with two nipples, and adhering by the base. Larger specimens are usually inclined, not upright; and in these, both orifices are found to be quadrangular. Infinite discrepancies occur, both in size and colour.—Plate XXXVII. figs. 1, 2.

Where dwelling in society, this Ascidia is dispersed over the surface of shells: if in groups, five or six are incorporated together as a common mass, or there may be a congeries of thirty, intimately united.

One particular group consisted of at least fifty Ascidiæ, adhering to each other, and covering an area equal to fifteen lines square. This group was three lines in thickness, in some parts comprehending two Ascidiæ, that is, some individuals over some others. The congeries was profusely overspread by the *Pedicellina*, and the whole surface darkened by muddy matter. The vicinity of mud seems congenial to all the species.

On vitiation of the water, the Ascidia merely swells and stretches upward, as if to escape the deleterious influence; thus evincing its inability to detach itself—though some animals contract closely, as the *Actinia*, *Solen*, and others, while enjoying the faculty of quitting their place: Thereby manifesting a very low degree of instinct.

This species requires as frequent renovation of its element as the rest. With due precaution it may be easily preserved.

Having obtained a quantity of heterogeneous collections from the sea, about the middle of summer, I discovered, for the first time, a minute reddish animal, towards a line in length, resembling a common pin, such as used in apparel, which was endowed with considerable activity. It disappeared suddenly, without exciting much surprise, for many creatures, of extraordinary conformation and habits, are continually occurring in the course of deviation, into various paths, amidst the boundless field of Nature. For the purpose of recognition, a rude sketch had been made of it, and it was denominated *spinula*, from its peculiar shape.

Exactly five years afterwards, the same animal appeared again: and it was with some surprise that I found this to be precisely on the same day of the year, the 19th of July; also, as before, among collections whereof the *Flustra carbasea* constituted a principal portion. The coincidence being remarkable, demanded more sedulous attention. I acknowledge that I felt rather disposed to consider the object an earlier stage of some fistulous, foliaceous, or carnose zoophyte, than pertaining to anything else, provided it were not itself a perfect animal. I had seen nothing at the time written on the subject; nor have I since.

The Spinula bears the strongest resemblance to the shape of the common tadpole, so familiar to every one, as well as in motion. A large head, almost opaque, with a black internal speck, declines into an attenuated flattened tail, with indistinct indications of segments and fins, or cilia. It wriggles through the water chiefly by aid of its tail, like the tadpole. The motion of animals depends on the power, formation, or position of their organs; but none, either principal or subordinate, could be distinctly recognised as external here.—Plate XXXVII. figs. 3, 4, 5.

On both occasions, the past and present, there was a whole colony of *Spinulæ*: but of the second, many were preserved, and correct drawings now made of several, as also on subsequent opportunities.

All the animals disappeared as they had done previously. Here, however, various minute circular spots, not unlike those which had formerly indicated originating zoophytes, remained on the internal surface of the vessels. The same followed every future observation: No other discrepancy being sensible than in the earlier or later interval of their appearance.

The Spinulæ having continued healthy, active, and vigorous, for a certain time, some of them are seen with the head applied to the bottom of their vessel, and the tail upright, stationary, and as if enjoying a state of perfect repose, in this inverted erect position. Meantime, the front is enlarging: it seems hollow, the margin is dividing into angular projections, and incipient adhesion, by one or more of them, to the glass, ensues. Now, the animal is no longer tranquil: its violent struggles testify that it is unwittingly or unwillingly arrested: its exertions are vehement to be free. At this juncture, the vibrations of the tail become so rapid, that, like those of a cord in tension, its figure is hardly discernible by the eye.

At length quiescence follows; some diffusing matter escapes from the margin of the flattened head, and the spinula is rooted irreversibly to the spot.—Fig. 6.

Some analogy will be doubtless recognized here between the circumstances now related, and those concomitant on originating zoophytes, so largely described above. I leave further prosecution of the parallel, and its explanation, to more skilful physiologists.

But in respect to the subject before us, an evident alteration succeeds in a few days. A dark, solid nucleus, is substituted for the adhering head of the Spinula; the tail has vanished; a transparent marginal diffusion surrounds the front where applied to the glass, towards the circumference of which are distributed 26 or 28 flattened radicles, diverging from the nucleus as a centre.—Fig. 7.

As the nucleus consolidates, two nipples, with quadrangular orifices, rise from the surface, while the radicles below, gradually attenuating, disappear from view; and the transparent diffusing matter forms a skinny environing ring of the basis,—a complete metamorphosis has been accomplished;—the Spinula is transformed to an Ascidia,—such as the *Ascidia papilla* above described.

It may be credited, however, that this process is not as rapid as the description; on the contrary, its advance is slow and gradual. Sometimes the spot denoting the elements of a nascent animal has formed within twenty-four hours of the first appearance of the Spinula. In that time it has affixed, become motionless, and the tail has wasted away. But this portion is also seen to continue vibrating for three days after the head has been arrested. Likewise, Spinulæ have continued active nine, or ten, or even during sixteen days. I remember to have been surprised at finding some of them no larger in nine days than at first.

After the nucleus has formed, certain interanea are indistinctly perceptible above and below, figs. 8, 9. The subject is not diaphanous. In three months the animal is mature; the oral and fæcal orifices have opened: and it has begun to colour.—Figs. 10, 11.

Stillness is not less essential to ensure success of the regular and perfect metamorphosis, than for that of the zoophytes strictly so denominated. Should the Spinulæ be disturbed, the front does not affix, and the head becomes strangely distorted. Yet all the alterations are rudely exhibited within an enlarging integument.

The Spinulæ are produced chiefly in June and July; also occasionally at other seasons. They are generally of a red colour, sometimes fine vermilion. Many Spinulæ and Ascidiæ are besides very pale.

I cannot entertain any doubt of their being living animals.

Plate XXXVII. Fig. 1. *Ascidia papilla.*
2. Another specimen.
3. Spinulæ enlarged.
4. Spinula.
5. Another more enlarged.
6. Spinula affixed by the front; the tail vertical. Circular margin diffusing preparatory to metamorphosis.
7. Diffusing basis, the tail having disappeared, leaving the front environed by radicles.
8. Nascent Ascidia *a*, viewed from below; another *b*, viewed from above.
9. Nascent Ascidia nearly mature, the oral and fæcal orifices having opened.
10. Young Ascidia three months old, where the interior is obscurely visible, viewed from above.
11. The same seen from below.

All the preceding figures, except the first and second, are enlarged.

Ascidia

CHAPTER VIII.

THE COMPOUND ASCIDIA.

Plates XXXVII. Figs. 12–24; XXXVIII., XXXIX., XL., XLI.—The preceding observations on the Simple Ascidia, will facilitate the explanations proposed to be given in the present chapter. Though such observations be meagre in themselves, from the most singular parts of the history of the subjects brought under review having never been disclosed in confinement, with one exception, we there discover a connecting link to the following more remarkable race of beings.

It must appear an astounding fact to our feeble understanding, that the final perfection of the marvellous works of the Creator should be attained through means so different from those we behold disposed around our own place in the universe. Yet, as our knowledge is permitted to extend, and we turn to profitable account the competent analysis of observation, penetrating as deeply as may be into the mysteries of animated nature, perhaps corresponding forms may be found in the elementary stages of living creatures, and similar principles governing the progress of their development. The design is so grand its basis may be simple.

Probably distinctions may arise in many important points, from the circumstances under which animated beings exist as single, or solitary, and compound products, inasmuch as the former live only for themselves. Their vital functions are there carried on for the benefit of each individual; thence its organization, being adapted for that purpose, is perfect in respect to itself. Animals dwelling in society are not removed from similar conditions. But the incorporation of compound animals with a common mass, seems to demand a twofold effort from the operation of their organic functions, the one tending to the preservation of the individual animal, and the other bearing some relation to the mass or bond of union. Something is contributed for each separate portion, and something for the whole.

Farther, when the mass is composed of animals combined in groups, the functions to be discharged become still more complex, as pertaining to the common mass, to the group, and to the individuals whereof the group is constituted.

It is with certain products of this description that we are to be now briefly engaged, and those in particular denominated the *Compound Ascidiæ.*

The history of the whole is yet involved in much obscurity. Great difficulty is experienced in determining the different species, arising, perhaps, from the irregular form, and varied aspect, under which the same species is often presented—owing, no doubt, in cases innumerable, to vigour, to age, and position. Thus I can do little more than offer a few very general observations on what has fallen within my notice regarding such a wonderful example of organic combination.

Botryllus verrucosus.—The Warty Sea-Fig.—I am compelled to assign a provisional name to this product, from inability to recognise its identity with any of the species enumerated by authors. But from the description and peculiarities here given, others can easily restore it to its proper place, should I be mistaken.

The *Botryllus verrucosus*, or Warty Sea-Fig, which, by an oversight, I had on a former occasion specified as an Aplidium, occurs occasionally in our Scotish seas, but under such different forms, that I hesitate on including those that follow within the same section.

It may be described generally as a subgelatinous product, composed of an indefinite number of ascidian animals, arranged in systems or groups, with a common central cavity to each system. These groups invest inorganic substances, either as a superficial stratum, or they constitute fleshy or subgelatinous masses, generally pendent from the marine Algæ.

All are of a semi-transparent appearance, of greenish, greyish-brown, or yellow colour.

When diffused superficially, the systems are more level than when consolidated in a mass.

But there is no uniformity either in the number of the individual animals composing a system, nor in the figure of the different systems composing an entire specimen of the Botryllus, as will be seen from the detail.

We are continually reminded of the unaccountable irregularities predominant among the productions of Nature, even when pertaining to the same species, animal or vegetable.

§ 1. Three old oyster shells, invested by the *Botryllus verrucosus*, were found near the eastern side of Cramond, an islet in the estuary of the Forth. One of them, about three inches in diameter, was completely covered by this product, in numerous and varied systems.—Pl. XXXVIII. fig. 1. Besides those of definite formation, there were other gelatinous portions, containing a multitude of yellow granules, dispersed throughout their substance.—Fig. 2. When viewed in profile, the systems appeared rising slightly above the level of the surface of the shell.—Fig. 3, enlarged.

Here the systems might have been inscribed in circles, ellipses, or surrounded by less regular outlines. They were composed of a row of from four to ten or twelve ascidiæ, environing a common central orifice; or they formed a superficial mass of several indistinct and more irregular rows.

The circular systems approaching symmetry, or presenting a stellate appearance, were about four lines in diameter, as in figs. 6, 7. The length of the longest oval system was about six.

The character of the different systems, and the number of ascidiæ composing them, will be sufficiently explicit on inspecting the various figures which are selected from all three specimens.

Each of the individual ascidiæ is about the sixteenth of an inch in length; the body swelling above is penetrated by two orifices, a larger and a smaller. The larger above, seems to be formed by four concave circular arcs; the smaller, nearer the centre, is not conspicuous in all. Both are horizontal.

Although the Botryllus, fig. 1, was superficial, as represented elsewhere, it formed thicker masses.

Another specimen invested the valves of a shell united by their hinge. Some parts of both surfaces were covered, and the specimen thickened considerably where the shells gaped in front.

Fine arborescent crystallizations, different from those afforded by sea-salt, occupied the intervals between some slices of the Botryllus laid on glass slips, appearing after the humidity evaporated; thus indicating the presence of other elements.

The rapid decomposition of the preceding specimens, for this product is of difficult preservation, obstructed that continued course of investigation which should chiefly interest the naturalist. The water wherein they lay was tinged greenish; and when the investing substance had disappeared, it proved to have covered so many oyster shells now left bare.

Frequently the higher orifice only is conspicuous, not the lower communicating with the central cavity. But there are various obscurities in the structure of this compound Ascidia, which I cannot pretend to explain.

§ 2. In the month of January a small specimen, composed of no more than four whitish specks, occurred on a leaf of one of the *Florideæ*, with which I had supplied a young Aplysia for food.

About two months later, this specimen had undergone much alteration; and on April 11th, I found it had extended to a quarter of an inch: that no distinct system being formed, it consisted of eleven pair of parallel. vigorous Ascidiæ, discharging dark pellets.

Some days previously, the extension of the under surface over the edge of the leaf, attaching it to the vessel where it lay, shewed how fit a subject it might be for observation, if a suitable position could be obtaintained. Therefore detaching it very carefully from the spot, I committed it to a pure and transparent watch-glass, in the expectation that consequent adhesion and diffusion would afford a favourable exposure of its structure.

I was not disappointed. The specimen began to adhere in forty-

Sandia Capilla var. Cirinellus Vermicosus × 24

eight hours, when an orifice was visible nearly about the middle; and the whole appeared as in Plate XXXIX. fig. 1, which is slightly enlarged.

At this time the subject was disposed as a parallelogram.

A week later it had become very irregular, as will be understood by inspecting fig. 2, enlarged.

My expectation of adhesion to the glass, and diffusion on its surface. were completely realized.

A great alteration of the upper surface had ensued on May 23. The whole colony of animals had now subdivided into three portions, or distinct systems; one consisting of five individuals, the other two systems of nine each, being twenty-three ascidiæ in all.—Fig. 3.

This subdivision into systems seemed very singular. Now the lowest was the most regular of the three, fig. 4. The orifice above of each ascidia was quite conspicuous, but I could not discover the other; it had been too low. When the central orifice is most perfect, it seems to present the edge of an elevated hollow cone.

Systems are seated on a kind of fleshy portion, susceptible of expansion and contraction, to which it may be owing that sometimes the central orifice or cavity is not seen distinctly. Thus, also, the different systems were at times almost in contact, and at times separated by intervals.

On June 6, the central orifice of the smallest system, fig. 3, next the narrow end of the leaf, was much elevated, as were likewise that of the others.

The specimen subsequently declined. Many of the individuals had disappeared in a fortnight; and, on June 24, only ten of the whole remained, two being in the lowest system, which was originally the most perfect. when consisting of nine animals, and four in each of the other systems.

A partial glimpse of the internal circulation of the blood may be occasionally obtained, when the larger, or the central orifice is much distended, as frequent in such products.

This organic function is discharged in a remarkable manner, and through the medium of vessels which would be deeply interesting to skilful anatomists. To them likewise, would be due the suitable explanation of the process.

My expedient for diffusion of the growing *Botryllus* on the watch-glass having succeeded, a thin transparent portion spread, unintercepted, from the larger extremity.

Herein were distributed a number of vessels resembling long grapes, terminating channels from behind. A cluster of five terminated as many channels, apparently connected with a common channel, originating in one of the ascidiæ on the leaf.—Fig. 5.

Many other similar vessels, with their peculiar channels, were dispersed throughout the transparent diffusion. Had the specimen been old and full grown, I conclude that it would have presented an arrangement of the sanguiferous sytem, corresponding to a section from one of large dimensions, as represented Plate XXXVII. fig. 15.

Numerous yellow particles, of equal size, and evidently suspended in a transparent fluid, pass along the channels into the long grapes, and return after a brief interval. Their course is extremely irregular; sometimes many pass from the vessel slowly along the channels, or rush down like the sand through the neck of a sand-glass. Then the current downwards is interrupted for a minute or two, when a new current, flowing upwards, carries the yellow globules along with it.

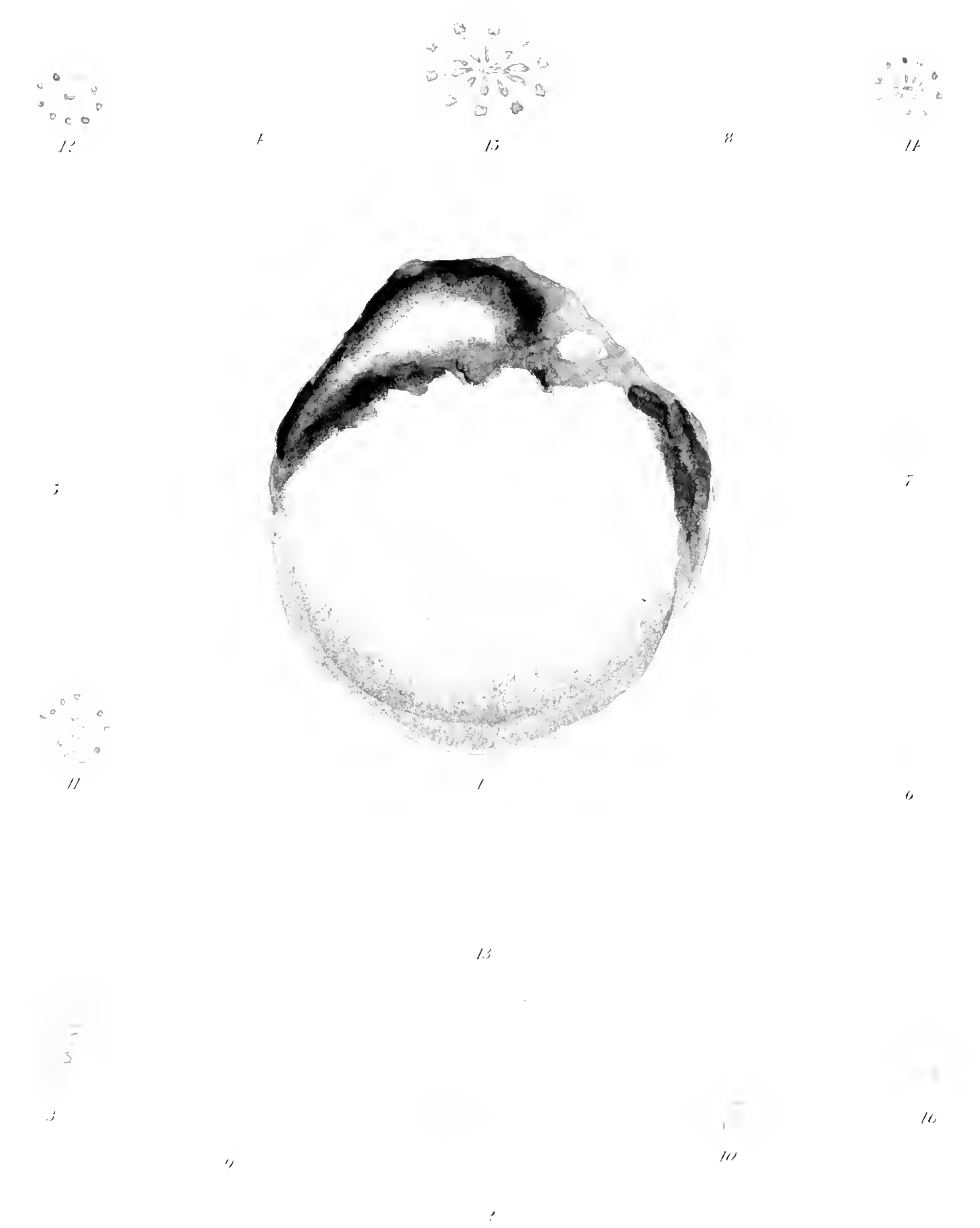
This goes on at the same moment in many vessels and channels, while, in some others, all is stationary and quiescent.

Meantime a similar current is discovered within the body of the Ascidia, through the larger orifice at the summit.

But both here and throughout the diffusion, the sides of the channels were imperceptible. Nevertheless, that the currents were confined in channels, is ascertained from the transit of the globules being invariably continued within the same boundaries. Certain marks denoted the precise course followed by them.

The visible discharge of these secret functions, so far withdrawn from the gaze of mortals, is a most interesting spectacle. It shews the application of those great and comprehensive general laws devised for the conservation of animal life.

The flux and reflux of what must be deemed equivalent to the circulation of the blood in the larger works of the creation, though quite evident


12
4
15
8
14
5
7
11
1
6
13
3
9
10
16
2

while the diffusive matter remains transparent, is obscured by the successive multiplication, thickening, and intervention of parts.

The whole ascidiæ of this specimen were yellowish and finely speckled white. In their latest stage they were quite yellow. None survived the fourth of July.

It may be said they have yellow blood.

§ 3. A specimen of larger dimensions than any of the preceding, afforded many valuable results in confirmation of the real nature of the Botryllus.

This subject, which occurred at the distance of twelve or fifteen miles or less from the site of the three shells, and, I believe, in shallower water, resembled a mass, of solid, consistent, semi-transparent, gelatinous, olive-green matter, tending to brownish-yellow. Its form was extremely irregular, scarcely admitting comparison with any given figure; but it might have been bounded by the sides of a parallelopiped, 42 lines in length, 18 in breadth, and 12 deep. The whole of warty appearance, was covered by prominences very low, almost even with the surface.

The specimen had been founded originally on some of the more delicate of the marine *Algæ*, overspreading them in its growth, from which it had hung in its native site, as they now passed through the centre.—Plate XXXVII. fig. 12.

From the mere external aspect, it was impossible to conjecture what this substance might be, more than a lump of inanimate matter. Nothing could be farther than the whole from indicating any thing like vitality.

But the imprudence of indulging precipitate opinions would have soon betrayed the naturalist, for after I had supended the shapeless mass, in a suitable position amidst the water of a capacious glass vessel, symptoms of animation were speedily evinced, by relaxation of the superficial warts into so many cellular prominences, apparently with a smooth even edge, when viewed in profile, fig. 13. As the product became familiarised with its new abode in a short time, numerous orifices opening in these prominences expanded as from united hollow circular arcs, forming an internal margin, like those of the preceding Botryllus.

Such prominences result from contraction of the parts then becoming conical, as the summit of the cone opens in the form of the four circular arcs, which is the larger orifice, of an individual Ascidia, in itself a low projection; it is scarcely elevated above the level of the neighbouring surface.

Along with the numerous orifices now opened, were interspersed numerous circular or elliptical deeper depressions.

Such was the general aspect of this gelatinous, consistent, suspended mass.

But inspected more narrowly, the whole surface was composed of systems composed of ascidiæ, as above described, yet less definite than in the preceding special examples. Equal regularity in the arrangement of those more distinct could be rarely detected. The deeper depressions proved to be the central orifice, around which the systems were disposed, either circularly or elliptically. The figure of each seems reciprocally dependent on that of the others, but which is the primary regulator, seems uncertain.—Fig. 12.

Only a single orifice of the two peculiar to ascidiæ being exposed in these component ascidiæ, the others must have communicated with the central cavity of the system.

Though I describe the orifice as consisting of the union of four hollow circular arcs, it is probable that an entire, uninterrupted circle forms by their extreme distension. As the orifices open, a strong current carries the neighbouring particles of muddy matter towards them, when absorption follows. In its previous abode it had not been idle, for now a quantity of large ovoidal pellets, quickly covering the bottom of the new vessel, proved both the absorption of the mud, and identified this large and shapeless mass as of kindred nature to the ascidian tribe.

The vast aggregate of animals composing such a mass, all at once in activity, completely depurated the turbid element.

Several discrepancies distinguished this specimen from the substance overspreading the three shells. They were in correspondence as compound ascidiæ.

The single Ascidia itself, though thus diffusing to an indefinite extent in systems composed of indefinite numbers, does not exceed a line and a half in length. These living animals are confined to the surface of the mass, which, distended by the vigour derived from a salubrious condition, is partly translucent.

The mass is solid. Its interior consists of a clear, consistent, transparent, greenish, gelatinous substance, interspersed with a peculiar organization, fig. 15. Observations on the preceding subject gradually increasing, shews this, which is deep-seated, to be the sanguiferous system.

Perpetuation.—The most profound physiologists maintain that the true analogy of animal kindred, must be sought from reciprocal corespondence of their earliest formation.

An admirable demonstration was presented here.

Some days posterior to the acquisition of the large specimen just described, dull orange corpuscula were perceptible amidst its flesh, which afterwards rising nearer the surface, became more conspicuous.

A smaller vessel was next introduced under the specimen, wherein twelve or fifteen yellow ova or capsules were soon after discovered amidst the muddy pellets falling below.

Subjected to the microscope these were found of ovoidal form; the first inspected exhibiting a solid nucleus, invested by a transparent integument, and others had nearly the same character.—Fig. 16.

But some being examined which were farther advanced, exposed a spinula confined within a diaphanous membrane, the head forming the darker nucleus, surrounded by the curving tail. It forcibly reminded me of the appearance of the embryo skate on slitting up the capsule, which may be seen in all stages of imperfection early in spring, and during the summer season. By gradual progress the tail of the spinula, here unfolding in curvature, fig. 16 *b*, extends straight to complete the animal's shape, and the head is shewn as equal to about a fourth of the whole length.

In eight or nine hours after introduction of the small vessel, not fewer than an hundred yellow corpuscula had been discharged into it. A number distinguished as of roundish or long oval form lay motionless below; and many having attained complete evolution of the parts as spinulæ, were swimming actively six inches above the bottom of the large vessel containing the small one.—Fig. 17.

But I could not discover how the yellow corpuscula, thus developing as spinulæ, had escaped from this specimen; the same remark in regard to the corpuscula or gemmules of the Alcyonium, may be recollected. They certainly rose higher from the interior of the mass, until apparently ready to burst the skin. Another important point seems very obscure, namely, whether they are generated by the common mass, whether by the systems, or whether they are the offspring of the individual ascidiæ. Here may be also recollected, perhaps, a question somewhat corresponding, relative to the history of the Cristatella.

Numerous ova, or probably speaking more correctly, embryonic capsules and spinulæ at large, were secured by the different expedients adopted. But the latter in far greater proportion. All the former exposed the embryo, inclosed as in an amnion, quiescent, the extremity of the tail so completely encircling the head as to meet its own root or origin. An internal black speck, perhaps denoting a large vessel, was likewise visible towards one side of the head.

The spinula is of a fine yellow colour as the other is red, and somewhat resembles a tadpole, nor are its motions in any respect dissimilar.

But these descriptions are only the preliminaries for illustrating a metamorphosis, equally interesting, nor less remarkable than any which have hitherto come under our notice.

The evolution of the spinula from the *Botryllus* is slower than that of the spinulæ from the *Ascidia papilla*, and the transformation quicker.

This wonderful change commences perhaps within a few hours of its escape from its integuments. The front of the head begins to fork, and its cleaving denotes the formation of incipient roots, which adhere to a solid surface.

In one instance adhesion had followed, accompanying the formation of radicles, within sixteen hours of the production of the spinula.

Now, also, as before, the animal struggles vehemently to be free. But its fixture, though commencing by only one projection, becomes rivetted amidst the surrounding diffusing matter, or by eight radicles, securing the head to the foundation, leaving the tail to vibrate above, fig. 18. By gradual attenuation the tail disappears, the radicles remaining below, figs. 19, 20, while a nucleus, enlarging proportionably as these diminish, is in the next place penetrated by two orifices in the upper surface, fig. 21. The yellow spinula so active on bursting its integument, has been now converted to a stationary ascidia, adhering ever after by the front of the head metamorphosed to a circular base.

All these transitions are rapid. While still in full activity, the head of the spinula seems enlarging; when motionless, its clefts are extending as roots amidst a thin diffusing grey substance, which soon disappears. Meantime the extending roots remain connected by a very slender communication with the central nucleus. Two orifices with sensible contraction and dilatation open above; the diffusing matter below continues scarcely perceptible; and some interanea may be obscurely discerned through the integument of the under surface. Within ninety hours of the bursting of the prolific capsule from the large and shapeless specimen of the Botryllus, the metamorphosis of the spinula was perfected.

The observations detailed at length in the preceding chapter, will aid the explanations given here. I had got the specimen on October 3; the first ova and spinulæ appeared on the 9th. Some of the latter, at this time escaping from the integument, were perfected as ascidiæ on the 17th. Each of these animals formed a spherical segment with two wide orifices, whither buoyant particles were attracted and absorbed, obviously passing to the intestinal canal. Thence they were ejected as dark pellets or cylindrical excretions, like those discharged by the numerous creatures in maturity composing the parent mass. The pulsation of a large vessel or heart below was distinctly seen through the fæcal orifice; and the distribution of the sanguiferous fluid by many channels.

Herein is again to be witnessed a fact of peculiar interest to the physiologist, a branch of that important system in the animal economy which was lately described. This pulsation still continues perceptible when the young ascidia is three weeks old; dark particles are visibly carried along with considerable force by fluid currents, and transmitted to the place of their destination within the body. The extremities of the radicles have enlarged, while the intermediate portion or neck nearer the ascidia has diminished. But the dark particles are sensibly conveyed through channels traversing the neck.

Neither the pulsation, nor the distribution of the sanguiferous fluid, is quite regular, being occasionally and partially retarded or accelerated. as in many of the lower animals.

During my earlier observations on such singular productions, when first beholding the eight radicles environing the nucleus, the fluid transmitted through the channel of the attenuating neck, and the subsequent alteration of their shape, I indulged some conjectures of their ultimate conversion to perfect animals, forming a system of young ascidiæ around the centre. Numerous dark specks were seen in the extremity beyond the channel. Then the communication or neck connecting the parts disappeared, but no orifices opened. Thus my conjectures proved fallacious.

Increment.—A single animal is the origin of an entire colony of the *Botryllus*, as a single animal is the origin of the Zoophytes proper. But how shall we explain the formation of such an unwieldy mass as the specimen now under discussion?

The increment of this compound product seems to advance by a second young ascidia pullulating from the side of the first, which consequently ensues without the intervention of a spinula.—Fig. 22.

Here the naturalist cannot fail to discover a remarkable coincidence with the growth of the various genera of zoophytes, and that so strong, that, were this the only feature of resemblance required, the two might be almost identified. In the hydraoids, a second hydra developes beside the first without the intervention of a planula; in the ascidian genera, and in the Alcyonium, a second hydra is evolved beside the original gemmule. without a second elementary gemmule to form it.

The Botryllus is next enlarged by a third ascidia pullulating from the side of the second.—Fig. 23.

Meantime the number of radicles augments, though I have not been able to determine by what law. A nascent Botryllus, about eighty-one days old, of gelatinous aspect, very prominent and distinct, resembled the longitudinal half of an ovoid to the eye. It consisted of four ascidiæ, surrounded by a common diffusion, wherein a number of radicles, perhaps as many as corresponding to the complement of the whole form, were seated. Dark particles were incorporated with the substance of the radicles, but no connecting channels visible. While an additional ascidia is thus generated in these early stages of the Botryllus, it appears that the duplication or triplication of the radicles is also concomitant.—Fig. 24.

Quiescence is a condition alike essential to the metamorphosis of the spinula here, as we have seen of the *Ascidia papilla*, and of the zoophytes. The front of the head dilates on its application to the solid surface, where the change is to ensue. Radicles rivet this, which is to be the under surface of the nascent ascidia, to its site, while the vertical tail, vibrating above, wastes away. A diffusing matter around contributes to secure the whole. But disturbance of the spinula prevents adhesion; the head is distorted, and the radicles, dispersed within the transparent growing integument, project in front, as the animal lies in a horizontal position. Some disorderly influence has impaired their regularity.

The orifices of the nascent ascidia are very short tubular projections, with a circular even edge, as I have ascertained by protracted observation. It is not of simple, soft bodied animals, ready every hour to assume a different appearance, that the true form can be at once discovered. In a week from its embryonic state, confined within the amnion, the young animal is matured, and it feeds. Buoyant particles dispersed among the water disappear quickly by attraction and absorption of the oral orifice, and sometime afterwards a small excretory heap is found under each

Several of the young Botrylli thus bred in my possession, survived about eight months, though I could not find that any of them consisted of above five individuals. The diameter of the base or under surface of the group in this stage did not exceed five lines. Meanwhile the whole acquired an olive-green colour.

The yellow internal corpuscula, whence the spinulæ are produced, have appeared in June and in October. Thence the Botryllus breeds in summer.

The large specimen cut as a piece of solid jelly under the knife; then the systems proved almost superficial, and below them was displayed the organization of the sanguiferous vessels.

In eight days from the first this specimen was in decay, tinging the water green.

§ 4. *Specimens.*—PLATES XL., XLI.—The following descriptive notices are given as a sequel to the preceding observations. They must be taken in a general sense, as requiring verification and further study, together with the proofs of identity, and various other matters.

I know not whether all the subjects are actually distinct from those represented and described. But they seem to correspond with the *Botryllus* or *Botrylloides* of M. Milne Edwards, whose work did not come into my possession, as already observed, until August 1846, though I cannot presume to identify them with the species named by him. Thus I shall merely allude briefly and generally to such as occurred to myself, which will serve to explain the varieties and the form of the product.

(1.) It is the nature of the Botryllus, while in the simple ascidian stage, to adhere to some foreign product, which it gradually invests by its increase, and almost, or entirely, conceals by the greatest progress of growth.

All the subsequent specimens have been originally pendent from marine plants, passing their utmost limits by the course of increment, and then hanging free during adhesion. But part of such plants remaining untouched, and the vegetation of other parts still advancing, shews what they are, notwithstanding their obscuration by the zoophyte.

A specimen of fine yellow colour, approaching a triangular form, had grown from its original foundation on a leaf of one of the Algæ, to the extent of an inch and a quarter in length, by an inch in extreme breadth.

The systems of both this and of other species consisted of from four to eleven ascidiæ, ranged around a common centre. Here the larger orifice was distinct, the smaller much less so; a red speck was interposed between them. From the resemblance of the individual ascidiæ composing this product to a plum, if not previously named, it might receive an appellative significant of the similitude.—Plate XL. fig. 1.; system, fig. 2., the same enlarged, fig. 3.

(2.) Another fine specimen invested an *Ascidia rustica*, which had adhered originally to one of the Algæ, and although the orifices of that ascidia yet remained free, the Botryllus was rapidly overspreading it. The whole product would have occupied three-fourths of an irregular hollow sphere fifteen lines in diameter. This Botryllus was entirely covered by

indefinite systems, but so closely huddled together, that their form and arrangement could be scarcely, if at all, recognised. Many of the ascidiæ projected as cones, each with an orifice of four concave circular arcs.

The specimen was very beautiful; its colour between buff-orange and Dutch-orange; and the surface seemed to be granulated with white specks. It decayed in four days.—Plate XL. fig. 6.

(3.) The tendency to decay is a great embarrassment to continued observation. As substances which are still affixed or rooted so as to be incapable of spontaneous action, become very liable to mould, nature appears to have allotted them such a position that they may be freely washed by the tide.

Besides other inconveniences, the observer is perplexed by appearances, for which he is alike unable to account at the time and to remove, if disturbing his inspection of the object. On one occasion two specimens became so completely studded by yellow dots, as to obscure the arrangement of the systems.

Sometimes the subject decays with the lapse of a single day. A fine yellow Botryllus, with dark orange systems, was decaying in thirty or forty hours.—Plate XLI. fig. 1.

(4.) It is fortunate, that notwithstanding frequent imperfections and accidents, enough remains to promote our acquaintance with at least the external appearance of this product.

A beautiful specimen, Plate XLI. fig. 2, much resembling a fig, pendent from the substances to which it was attached, extended two inches and a half in length, by an inch in extreme breadth, and was towards three quarters of an inch thick; the whole surface of pale umber colour, and rather opaque.

The systems, like so many stars, were composed of from four or five up to eleven ascidiæ, environing a large oblong common orifice, which exposed some other circular orifices obscurely seen within it at the bottom. —Plate XL. fig. 7. Each ascidia had a swelling shoulder, and the inner side next the central orifice was white, which produced a strong contrast of colour. That the upper orifice was circular, several specimens demonstrated.

(5.) Many specimens are of very irregular shape, some temporarily, others permanently; and the aspect of some depends so much on their condition, as readily to mislead the spectator.

The leaves of marine vegetables are invested by specimens appearing merely as superficial irregular patches. Thus some such patches, not exceeding an inch in diameter, consisted of a number of grey systems rising above the leaf, with the ascidiæ marked on the side by a bright red speck.—Plate XL. fig. 4, superficial patch. System enlarged, fig. 5.

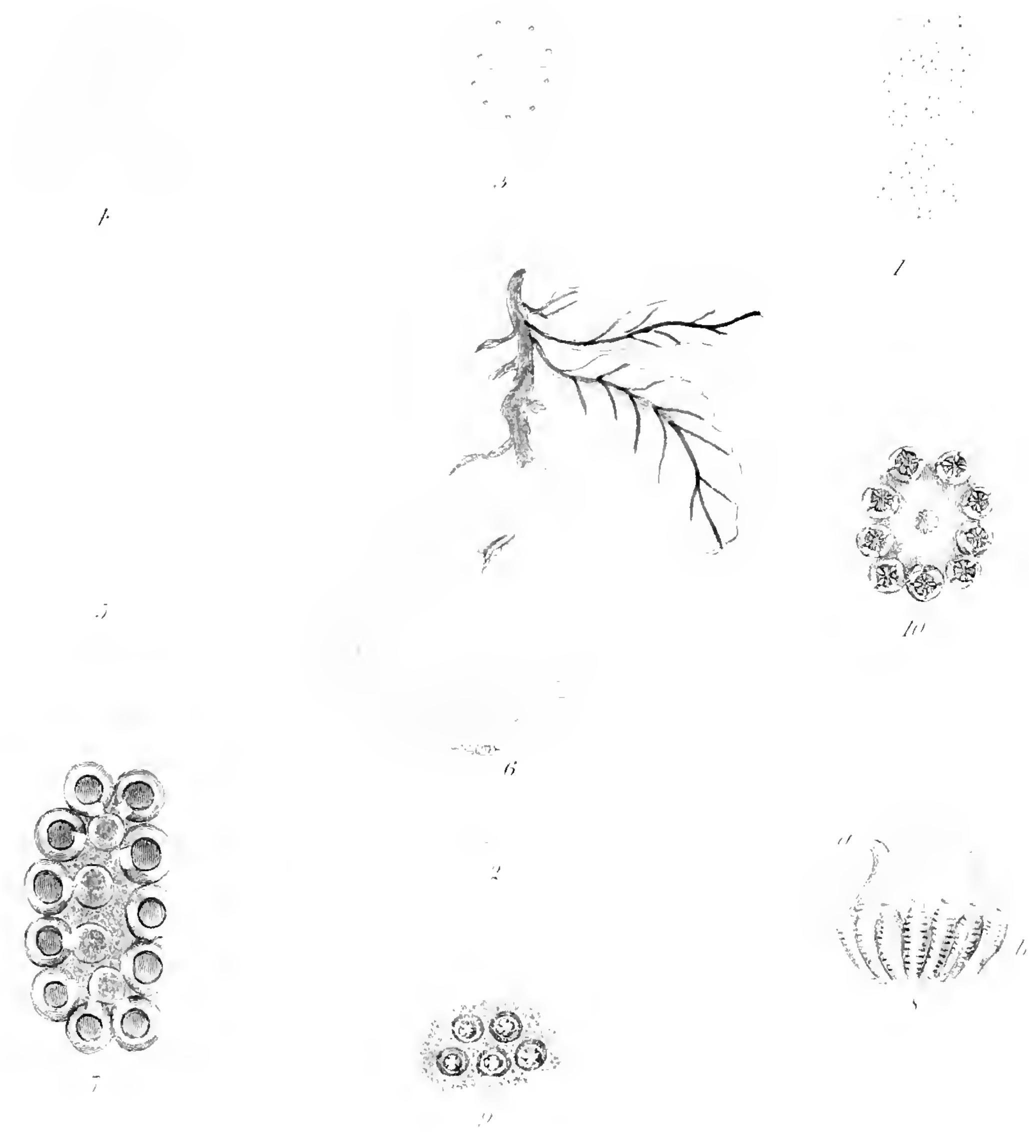
A specimen was entirely covered by *oscula*, wherein no determinate arrangement of systems could be discovered on June 11.—Plate XLI. fig. 3. It was then of a brownish shade, and semi-transparent in the thinner parts. The dimensions are distinctly represented by the figure. Its thickness varied irregularly from seven lines to fourteen. This specimen had been established originally on one of the Algæ, becoming free in its progress, and now resembling the aspect of a dried fig, but not withered. It was literally a dense, firm, gelatinous cake.

No definite formations could be discovered on the side exposed when first inspected. But in a few days its appearance had so changed, from the expansion concomitant on absorption, and acquiring a purplish colour, that the systems became very evident.

The ascidiæ were generally disposed in long lines or in irregular clusters. They seemed individually of a flask shape, the body ovoidal, with a cylindrical neck, and an orifice, apparently as four hollow circular arcs. No obvious central cavity was environed, nor was the lower orifice of the ascidiæ visible.

Two parts of the specimen, however, exhibited a peculiar form, perhaps indicating its real structure.—Plate XLI. fig. 4, *a*, *b*, representing the opposite side of fig. 3. At these points a number of ascidiæ surrounded a large central cavity with an elevated waving margin, shewing much flexibility. The contrast between these two component parts of what must be certainly judged the system was remarkable.—Plate XL. fig. 8, *a*, central cavity, *b*, ascidiæ.

The aspect was here so singular, as at first prompted me to suppose the large central orifice environed by the flasks, some parasite animal im-



Compound Ascidiae

planted on the surface of the specimen. The orifices of many of the other ascidiæ were rather indistinct.—Fig. 9.

The whole product might have been compared to an irregularly flattened cake.

(6.) A yellowish-brown specimen was covered by about sixty systems, arranged in whitish irregular ellipses, distributed over the whole surface. Each system consisted of a large central dilateable cone, environed by flask-shaped ascidiæ, of which only the shoulder and larger orifice were visible. This orifice exhibited four large spinous projections directed inwards, perhaps denoting four concave circular arcs, which might expand as a circle like others. The central cavity was turgid, being evidently full of water, as white specks were floating there during its distension.

This specimen might have been circumscribed by an irregular quadrangle of two inches and a half; the whole like a very flexible, flattened fig, under half an inch thick.—Plate XLI., fig. 5, Botryllus.—Plate XL. fig. 10, system of nine ascidiæ, and the central cone.

The whole subject remained sufficiently vigorous for a day or two, and then perished, from being invested by a thin transparent coating of mould.

These brief notices, together with the figures, may prove of some assistance to those who have opportunities of obtaining specimens of the Botryllus, and of extending the subject.

But many additional illustrations are requisite to constitute species from what has been said, as appearances were not sufficiently uniform to enable me to do so. The rarity of the product has obstructed the progress of that investigation of form and properties, which profitably elucidate the nature of such interesting works of the creation.

The following general conclusions may be nevertheless deduced from the preceding narrative, irregular and defective as it is, regarding the *Ascidia papilla*, the *Botryllus verrucosus*, and kindred; recollecting that all these names are provisional, that they may not interfere with the priority of observation.

I. The *Ascidia papilla* is a single perfect animal.

II. It is commonly solitary in the adult; but also dwells in numerous societies or groups of individuals, which are intimately approximated to each other.

III. Under both these conditions it is always rivetted by the base to a foreign substance.

IV. It propagates though the medium of a fœtus, which, on evolution from the integuments, resembles a minute tadpole.

V. This tadpole, denominated *Spinula*, being like an ordinary *pin*, is at first endowed with great activity, next becomes quiescent, to undergo complete transformation to the state of an ascidia, wherein it remains permanently.

I. The *Botryllus verrucosus* is a compound animal product, of fleshy or subgelatinous consistence, permanently affixed by the base to some solid substance.

II. It consists of aggregated ascidiæ united together, which are ultimately distributed over the substance invested.

III. The individual ascidiæ are arranged in distinct groups or systems, around a common central cavity; a number of these systems constituting a specimen of the Botryllus.

IV. Each of the ascidiæ subsists under an independent existence, wherein distinct functions are carried on, as, first, the circulation of a sanguiferous fluid; secondly, the nutrition derived from absorption of muddy matter suspended in the surrounding element.

V. The Botryllus subsists under compound conditions, such as the benefit derived from a common circulation, besides the sanguiferous system peculiar to the ascidiæ, and from nutrition benefiting the whole.

VI. It is propagated through the medium of a fœtus resembling a tadpole, like that of the *Ascidia papilla*, also denominated *Spinula*, which, quitting the integuments, enjoys life, activity, and motion for an indefinite period, then becomes rooted immoveably, loses the external organization, and is metamorphosed to an ascidia.

VII. The young ascidia is a perfect animal, wherein the vital functions are carried on and discharged, as in the ascidiæ composing each system of the Botryllus.

VIII. Without the presence of other spinulæ, or any sensible external or internal elements, other young ascidiæ are generated from the first, and in union with it, whereby systems are formed, and at length the Botryllus is a common mass.

PLATE XXXVII. FIG. 12. *Botryllus verrucosus.*

13. Ascidiæ, a portion of the surface of fig. 12 in profile.
14. Portion of the surface comprehending a system.
15. Sanguiferous system in the interior of the substance of the Botryllus.
16. Capsules with embryos in their integuments.
17. Spinulæ free, having quitted the integument.
18. Spinula, with the front of the head rooted, the tail erect.
19. Central nucleus, with diffusing radicles after disappearance of the tail.
20. Central nucleus, with the radicles farther advanced.
21. Perfect ascidia generated from a Spinula, being the elementary animal of the Botryllus.
22. Duplication of the elementary animal; a second ascidia having been generated, without intervention of a spinula, beside the first.
23. The same farther advanced, by the development of a third ascidia.
24. Nascent Botryllus farther advanced, as consisting of four ascidiæ.

All the preceding figures, except fig. 12, are enlarged.

PLATE XXXVIII. FIG. 1. *Botryllus verrucosus* investing a shell.

2. A portion of the specimen containing corpuscula.
3. System viewed in profile.
4. System composed of four ascidiæ.
5. System consisting of five ascidiæ in irregular arrangement.

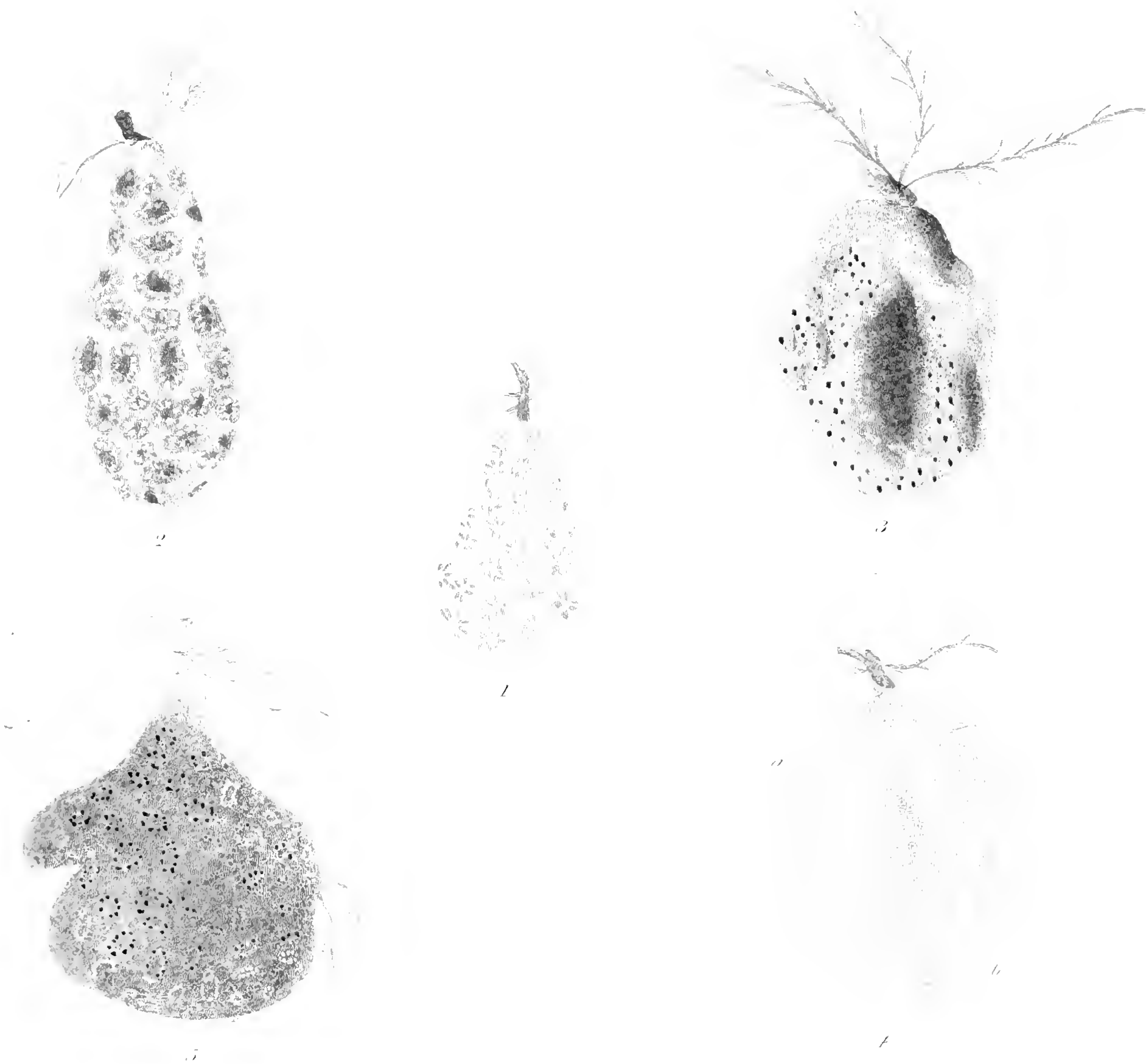
PLATE XXXVIII. FIG. 6. System consisting of five ascidiæ in regular arrangement.
7. System of six ascidiæ.
8. System of six ascidiæ.
9. System composed of a number of ascidiæ in irregular arrangement.
10. System composed of a number of ascidiæ in irregular arrangement.
11. System composed of a number of ascidiæ in irregular arrangement.
12. System composed of nine ascidiæ in elliptical arrangement.
13. System composed of ten ascidiæ in elliptical arrangement.
14. System composed of ten ascidiæ nearly in circular arrangement.
15. System of ten ascidiæ in elliptical arrangement.
16. System consisting of a double row, exterior and interior, each row with a number of ascidiæ in elliptical arrangement.

All the figures of this Plate, except the first, are enlarged.

PLATE XXXIX. FIG 1. Botryllus in an early stage, spreading on a leaf, April 11.
2. The same April 18. Diffusing margin *a*, *b*.
3. The same May 24. The ascidiæ now arranged in definite systems. Lowest system of nine ascidiæ *c*.
4. The lowest system *c*, of fig. 3, magnified.
5. Portion of the diffusing extremity *a*, *b*, of fig. 2, as on April 18, shewing part of the sanguiferous system.
6, 7, 8, 9. Different systems of ascidiæ of the Botryllus.

All the figures of this Plate, except fig. 1, are enlarged.

PLATE XL. FIG. 1. Botryllus of triangular form, and yellow colour.
2. System of the same.
3. The same system enlarged.
4. Botryllus consisting of a superficial patch of irregular systems.
5. System of fig 4, enlarged.



Compound Ascidiae

Plate XL. Fig. 6. Botryllus of yellow colour investing an *Ascidia rustica*.

7. System of the specimen, Plate XLI. fig. 2.

8. Portion of the specimen, Plate XLI. figs. 3, 4, consisting of a system formed by ampullate ascidiæ, *b*, around a central orifice, *a*, enlarged.

9. Ascidiæ of the specimen, Plate XLI. figs. 3, 4, with indistinct orifices.

10. System of the specimen, Plate XLI. fig. 5.

All the figures of this Plate, except figs. 1, 2, 4, 6, are enlarged.

Plate XLI. Fig. 1. Botryllus with dark orange systems.

2. Botryllus of umber colour, with systems of from four to eleven ascidiæ, one of which is represented in Plate XL. fig. 7.

3. Botryllus with indefinite systems on one side.

4. Opposite side of fig. 3, with definite systems.

5. Botryllus covered by between sixty and seventy systems.

CHAPTER IX.

ASTEROIDAL ZOOPHYTES.

Numerous modifications of the form and habits of the hydra or polypus have appeared from the description and discussion in the preceding pages. The like has been explained of several ascidian zoophytes, together with the Ascidia itself and the Botryllus. I have ventured to depart from systematic arrangement, and with the view of rendering the subject more easily understood, a certain latitude of expression has been assumed throughout, which will, nevertheless, betray no one into error.

We have seen that zoophytes are either simple or compound; and that some of the latter are composed of organic or living parts, and of inorganic, or parts wherein no symptom of vitality is demonstrated.

Besides the Hydraoid and Ascidian Zoophytes, there is still a third class, more recently distinguished as *Asteroidal* Zoophytes, wherein none are known in this country to exist as single animals, but all are compound, and one section consists exclusively of organic parts, as the *Lobularia*.

Another section consists of the combination of organic and inorganic parts, the latter being a shell or bone, and this comprehends the *Virgularia* and the *Pennatula*.

The asteroidal zoophytes are composed of two distinct portions, first a hydra or polypus, whose nature seems different in several respects from that of the others which have been described. It is considerably larger than that belonging to either the hydraoid or ascidian zoophytes; the tentacula are uniformly eight, of triangular shape, pectinated or bordered by a number of short processes, and containing a stomach, from which several slender tendrils, supposed to be intestinal organs, visibly descend to the lower part of the zoophyte.

While quiescent the hydra is retracted into this lower part, which, large and fleshy, serves as a polyparium for many hundred hydræ, whereof a specimen may consist. Being somewhat of fleshy substance, these zoophytes are by some denominated *carnose*, and by some, *asteroidal*.

The vital functions of the carnose portion are not evident; it seems of later formation than the hydræ, and its bulk is constantly augmenting. The lowest part much resembles the aspect of leather, and appears to be quite indolent. It is the higher part that is covered by hydræ, and the portion of the surface farthest removed from them becomes gradually smoother.

As the tendrils, or intestinal organs, descend, nutrition is probably thus transmitted, and it is here that the germ and embryo of the young are generated.

In so far as hitherto ascertained, the asteroidal race is infinitely less diversified than the hydraoid or ascidian zoophytes. There is nothing of that great variety of form and character displayed by them. The structure of the members of the race is neither equally understood, nor in many points are their habits and peculiarities, alike familiar to naturalists, no doubt owing to their being much more unmanageable, as well as to complete ignorance of their food. The difficulty of preserving specimens any considerable time in vigour, also impedes our investigation of their history. Like many other aquatic animal productions, they are comparatively torpid and inactive. Some are rooted to the same spot, incapable of detaching themselves. The motion of others, though they are not fixed, is extremely equivocal; and all observers have shewn themselves much perplexed regarding it. But it is certain that none belonging to Scotland come under the description of *floating*, or even *buoyant* zoophytes.

For all these reasons, I cannot be so diffuse on this as on various other subjects. But there being many who have never beheld living specimens, and who may be much misled by judging of dead ones, the appearance of animated and vigorous asteroidal zoophytes will, perhaps, compensate for other deficiences. The few illustrative figures are carefully and correctly executed.

All the Asteroidal Zoophytes are marine productions. None of them belong to the fresh-waters of Scotland; nor have I heard of any in those of other countries.

All are compound, as above said; the individual hydræ being connected with a substance common to the whole. The hydra, like that of the genera already described, is solitary only in its origin, and the life of each in the most numerous society is independent of the condition of the others. If any common functions are carried on by them they are unknown, farther than that the mass may be benefited by the whole. Thus it is sensibly enlarged; and by some absorbent faculty, through whatever medium it operates, a specimen, though small and flaccid, can resume greater intumescence, than previously, by new absorption. Nevertheless, this intumescence does not visibly affect the individual hydræ themselves, for they become no larger, but the common basis appears to receive all the liquid imbibed.

The external operation by which all the race is affected has, much influence on the appearance of specimens, but the means by which it reaches them is not obvious. It is either beneficial or prejudicial, but nothing can be more different than specimens in either state. Being soft and fleshy, their dimensions and the protrusion or contraction of the parts would preclude their identification as the same object in their opposite condition.

All when in the highest vigour are beautiful and interesting objects: their luxuriance consisting in the amplitude of the whole subjects, together with the ornamental display of a multitude of peculiarly formed hydræ.

I cannot do more, however, than submit to the reader a very scanty assemblage of general observations on each kind of the *Carnose* or *Asteroidal* Zoophytes which have occurred to me.

§ 1. LOBULARIA.—ALCYONIUM DIGITATUM.—*Dead Man's Hand.*—*Mermaid's Glove.*—PLATE XLII.—The various names bestowed on this marine production, shew the vague resemblance it bears to other subjects, and the indefinite sentiments prevailing on its nature, or, to speak more correctly, it seems that no just opinions have been formed regarding it; neither can we affirm that the quality of the vernacular names is at all inferior to those by which it is characterised in the *Systema Naturæ*.

If the latest be adopted here, it is not from conviction of its right to preference.

The *Lobularia* is of extremely varied form, parts, proportions, and dimensions. In its more simple state, it may be compared to a short cylinder, entirely covered with a profusion of hydræ, by which it is rendered a very interesting object. In its older and more complete state, it may be compared to several cylinders, connected with a common basis, alike covered by hydræ, and presenting the rudest resemblance to the human hand. All the fingers, as they may be called, are very obtuse; they are seldom nearly of equal length or thickness; and the growth of the subject seems to be irregular in proportion to the number of its parts.

The whole product consists of a solid, compact foundation below, serving as a basis, from which the single or greater number of fingers are prolonged, rising three, four, or five inches high.

While inactive, the surface of the higher parts is studded by a multitude of distinct, minute stars: the lower part, foundation, or basis, is smooth, and of fleshy consistence; it spreads a little beyond the ordinary diameter of the rest, and adheres so firmly to the subjacent substance, that it can be seldom detached without laceration.

Thus all is quiescent, motionless, apparently devoid of life, affixed to a shell or a stone.

But as symptoms of animation, and of that action capable of being shewn in a stationary subject commence, the numerous stars barely indicating a diversity of the aspect of the superficies become gradually prolonged into so many beautiful *asteroidal hydræ*. I call them by this name, assuming the same license of characteristic expressions as applied to the tenants of other zoophytic genera.

Rising from their retreat, the hydræ are dispersed in ornamental array over the surface of the specimen. The body of each extending as a cylinder, dilates above into eight pectinate triangular rays, with the mouth in the centre, which communicates immediately with the cavity of the stomach. From the base of this organ several delicate tendrils or vessels, whose precise character is not explained, descend into the substance of the specimen.

The hydræ in full vigour stretch nine lines from the surface of the mass, with which their bodies are incorporated as an integral part. Thence their size exceeds that of any of the hydraoid or ascidian inhabitants of the other zoophytes of Scotland. Each side of the tentaculum is bordered by cylindrical fleshy prongs, shortening towards its extremity, whence the pectinate aspect. Thus, when completely expanded, a specimen covered by a profusion of such pinnate organs, is a beautiful and ornamental object.—Plate XLII. fig. 1.

But this display is so rarely to be obtained from larger, that the naturalist must be content with its exhibition from smaller specimens. The hydræ contract without any obvious cause; they sink amidst the fleshy portions, and often remain long in retreat, therefore the subject is unmanageable: they shun the light; but the recent element, a genial atmosphere, and the approach of night, seem to influence their evolution.

When recovered from the sea, the Lobularia is always in a contracted state; probably it becomes so during its passage upwards, if expanded when below. A smaller single specimen contracted, somewhat resembles a fungus of the Phallus kind, consisting of a head rather enlarged, with the rest downwards of inferior diameter. It is only those of more parts, and greater dimensions, that can be compared to other objects.

In contraction a specimen is hard to the touch. One of ample size, completely distended with the hydræ displayed, requires a cubical vessel of seven inches to contain it; that is, the side of the cube must be seven inches.

The Lobularia can evacuate itself at will, whether in or out of its element, but the means of effecting either this, or of attaining intumescence, is obscure. Evacuation is a speedy process; repletion occupies many hours. Therefore the absorption is much slower than the discharge.

But all its sensible changes and motions are very slow. Nothing more is to be observed of the prolongations or fingers than their inclining imperceptibly to either side, or slight curvature over the common basis. The hydræ are leisurely evolved, and gradually retracted.

The superficies of the basis is smooth, and close to the place of adhesion, very like leather; its substance porous, the pores larger as lower, tending to an oval form, and separated by thin parietes.

It needs scarcely to be explained, that no hydræ belong to the smooth or to the lower portion.

Contact with the Lobularia imparts a most nauseous odour to the hands, of which they cannot be easily divested.

The Lobularia is either of fine rich orange colour, or white as snow. It is not easy to pronounce which of two luxuriant specimens, with the numerous hydræ in full display, shall be deemed the more elegant. Both are beautiful.

No difference of species is indicated by so striking a diversity of colour. On one valve of a very large mussel, an ample white Lobularia, with eleven or twelve extremities, was seated; the other valve sustained an orange specimen, about half the size, with six or seven. Both were in admirable perfection. Farther, two Lobulariæ adhered to the shell of a *Tritonium undatum*, the one orange, four or five inches high, the other white, in immediate proximity. A white specimen, between two of orange colour, occurred on a third occasion.

Circumstances have induced me to conjecture that the white colour might be converted to orange. But I cannot say that this has been confirmed by actual observation.

The colours distinguishing each specimen are not superficial; they belong to the whole, penetrating from the surface to the centre. If the surface be white, the centre is white; if the surface be orange, so is the centre; at least such is almost invariably the case.

Nevertheless some peculiarities should be noted.

The Lobularia propagates by means of ova, which I have never seen unless of an orange colour. These ova are generated below, and approaching maturity, rise towards the surface, like those of some other zoophytes already described. On November 3, several specimens of the Lobularia, all white, reached me from the *Mar Bank*. They invested the tube of the

Amphitrite ventilabrum, which always rises erect from some solid substance if attaining large dimensions. Such specimens are generally of very irregular growth, and especially of variable thickness. Here vivid orange ova lay at the bottom of the flesh of the Lobularia, almost close to the dark tube invested by it, though the specimen itself was pure white.

Returning to the colour of this product: some orange and some white Lobularia are occasionally found intermixed in the same group.

Among several thus originally constituting a group, I remarked two that had been accidentally rent across, perhaps in removal from the sea. The whole interior of one of them was perfectly white, but covered as if by an orange coating a line thick. The other resembled it, being of similar character, but the exterior orange coating was thinner. This separation was only of colour not of substance, the orange and the white portion being incorporated together.

A group of the faintest carmine, once occurred on the shell of a *Venus Islandica*. This, which is one of our largest Scotish bivalves, serves frequently as a foundation for other subjects.

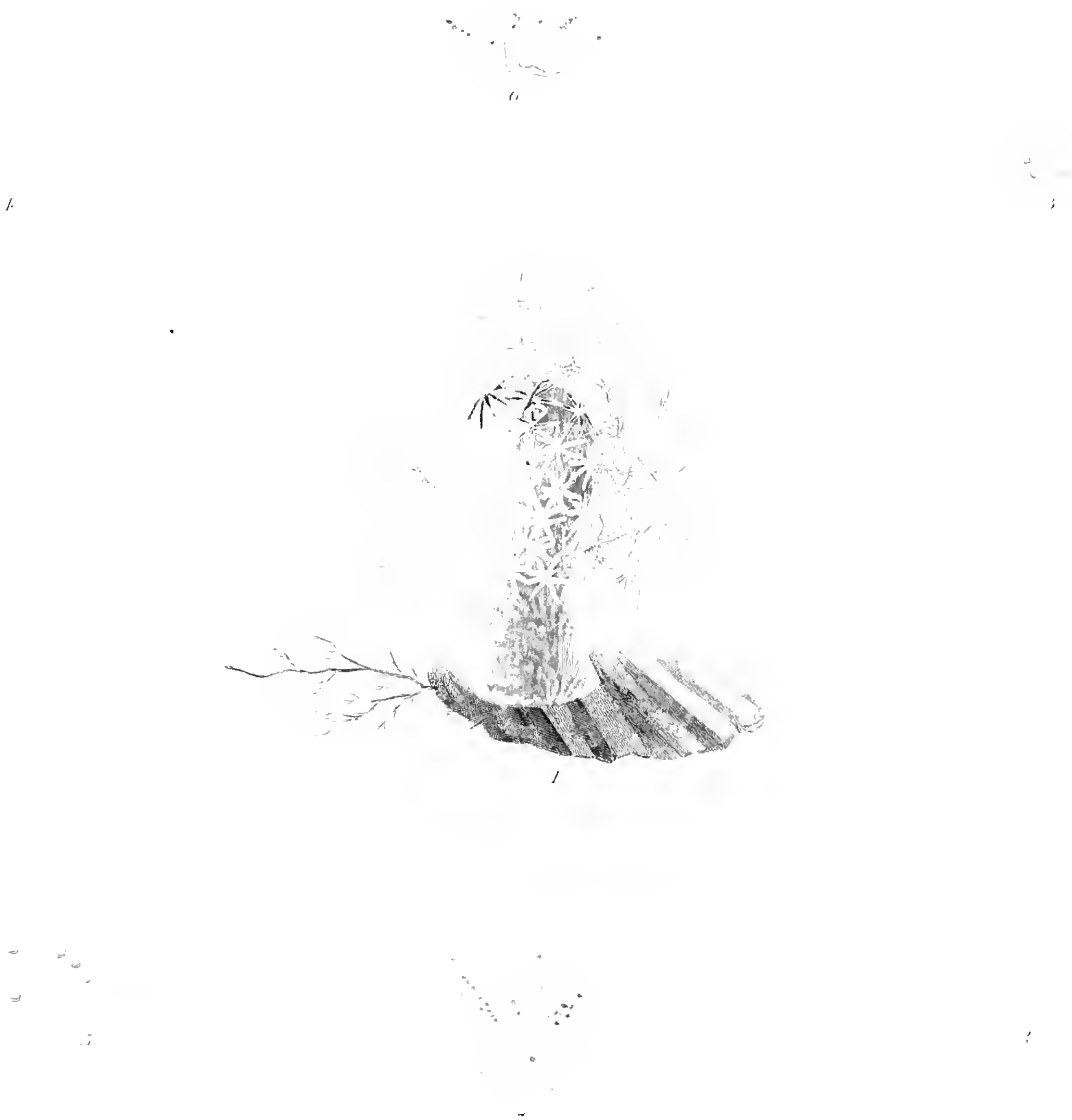
The orange ova are grey in an early stage, and seem to be attached to the lower part of the receptacle of the hydra. Some are solitary, others composing groups of five, six, seven, or more, as approaching maturity, when their vivid colour affords a fine contrast with the white of the Lobularia as they rise towards the surface. Next they are produced free.

At first the nascent hydra is single: it gains one companion, then two, three, or a greater number.

But it is plain that the earlier generations are overwhelmed, and their site obliterated, by those of later origin.

The Lobularia is the prey of the *Doris Hombergii*, therefore obtaining recent specimens is of some consequence to the naturalist desiring the preservation of that animal for permanent study. The food of the *Doris* tribe can be seldom discovered.

This product is commonly rooted on hard solid substances, though specimens of smaller size grow also on the marine Algæ and the Corallines. But above all, the tube of the *Amphitrite ventilabrum*, is most profusely invested by it in a single stratum and otherwise. Among a multitude of



such specimens, all have been white. A small specimen once occurred on the back of a living crab.

Both white and orange Lobularia are very common in the Scotish seas. I have seen at least fifty specimens at once laying on Newhaven Pier, which had been accidentally brought up by lines and dredges.

Plate XLII. Fig. 1. Lobularia displayed in vigour.
2. Part of the surface. Hydræ retracted, giving it a stellate appearance.
3. Ova enlarged.
4. Ova more enlarged.
5. Yellow ova in a white Lobularia.

§ 2. Virgularia.—Pennatula mirabilis.—*Sea Rush.*—Plate XLIII.

We have had already some singular examples of conformation and properties among the Rare and Remarkable Animals of Scotland, passing under our general review. But I know not that any of the whole is more entitled to be distinguished than the product now before us, whereof every naturalist enjoying the enviable prerogative of personal experience has expressed the highest admiration, Opportunities of doing so, however, are seldom granted, for the Virgularia is never readily found; it dwells in few places, and these of limited extent. Neither can I certify from what I myself have seen, or from the narrative of others, that in this country it has occurred entire and unmutilated on any occasion whatever. I have not had the good fortune of finding a representation of it in a perfect state, nor even the slightest notice of its habits. No doubt such accounts are extant, though, with too many others, it has not been my lot to benefit by them.

The Virgularia in vigour, bears a considerable general resemblance to a feather, much more so, than to either a rod or a rush, whence the synonym *Pennatula* is perhaps to be preferred, as more expressive than the indefinite appellative recently conferred on it, which can have resulted only from ignorance of its real conformation.

Like the former, this product belongs to the *Carnose* or *Asteroidal* zoophytes, though exhibiting the greatest external difference of form and appearance. It consists of a long, slender, round shell or bone, invested by a fleshy coating, which expands from each side into a number of lobes. also fleshy, bordered by several asteroidal hydræ.

Thus is it displayed in vigour amidst its native element the sea. But when contracted, or in that state which is too often represented by authors, with all the parts shrivelled up, and clinging closely together, to recognise it for the real subject is impossible.

For the most part the Virgularia is procured in portions four, five, or eight inches long, with the central bone protruding from one of the extremities, which denotes its mutilation. But these are only fragments, for its natural and entire dimensions greatly exceed them. The largest I have ever had extended 23 inches in length, of which the bone occupied 18; nor was this a complete specimen. It had been mutilated for a considerable time, as another animal had established itself a parasite on the portion of the bone exposed. Beyond the two extremities there is naturally a fleshy prolongation from each of them, so that this specimen must have extended at least 30 inches previous to mutilation. In greatest breadth, a fine specimen expands about an inch between the opposite hydræ, terminating the extremity of the lobes. The whole is of beautiful straw colour, presenting an object whose interesting appearance can be sufficiently appreciated only by beholding the living creature in vigorous display of all its parts.—Plate XLIII. fig. 1.

The fleshy portion of the stem of the Virgularia, which environs the bone, is susceptible of considerable intumescence. It is of smooth and uniform surface where flattened for about a fourth part of the circuit. Each side of the circuit expands into a number of oblique thin flattened lobes or leaves, arranged nearly as pairs; each of these lobes being internally subdivided into eight or ten cellular compartments. An asteroidal hydra rises to display itself from each of these receptacles, fig. 2, a section comprehending three pair of leaves; fig. 3, the same enlarged.

The hydra seems precisely the same in all respects as that of the Lobularia described in the preceding paragraph. Its cylindrical body rising from the margin of the leaf, dilates above into eight triangular pectinate tentacula; each side of these organs is bordered by a row of about sixteen subordinate extensile prongs or teeth, one also terminating the extremity. The stomach within is exposed to view; and the tendrils or vessels alluded to in the hydra of the Lobularia descending below. Nothing of any of these parts is seen in the contracted animal; nor distinctly, unless considerably enlarged, fig. 4. Only one is displayed, fig. 5, which is a lobe.

The true position, whether vertical or horizontal, in its native abode, is much controverted, which cannot be surprising when the form of the Virgularia is beheld out of it. Judging by mutilated specimens, I long concluded with many others, that, rooted by the lower extremity, it stood erect. Probably, however, it lies flat on the ground, and there are some reasons why it should be so. There is little doubt that resemblance has a great influence on opinion, whence they who see a slender looking stem below, with the portion above it diminish to a terminating point, will compare it to a rush, or some slender vegetable product springing from the earth. The bare bone, fig. 6, almost invariably protruding from mutilated specimens, transiently viewed, is not very unlike a stem: the rest is contracted. Hence an erect position might be ascribed to the Virgularia.

Besides the large specimen mutilated, as already referred to, other two occurred afterwards, with the lower extremity quite entire. One consisted of a fragment extending several inches, occupied by the central bone above, but descending three inches still lower by a fleshy cylinder, smooth, soft, and flexible. The other was also a fragment about nine inches long, six of which environed the bone; but the remainder free of it, was smooth and fleshy. The extremity was white, and there the figure somewhat irregular. The fleshy prolongation of each being free of the bone, exactly resembled a yellow worm, about an eighth of an inch in diameter. A large proportion of the latter fragment, fig. 7, was smooth externally, nor did the lobes visibly descend much more than an inch from the higher part of the fragment where the bone was exposed.

On decomposition the fragment did not prove so free of bone as had been supposed, for, with decay of the flesh, it was discovered tapering downwards, until resembling the tenuity and flexibility of a hair. Perhaps both extremities of the bone of an entire specimen will prove of this peculiar character, or nearly so.

If the lower part of the flesh remains smooth and of vermicular aspect, the upper portion is probably continually extending by lobes giving birth to new hydræ.

It is not unlikely that the origin of each lobe is a hydra, terminating the higher extremity of an entire specimen.

From all concurring circumstances it may be reasonably inferred, that the Virgularia lies horizontally at some depth on the bottom of the sea. The soft extremity below has no external character corresponding with the presence or the office of a root. Besides, the bone seems entirely deficient of all the qualities of a stem, and too little adapted for resisting the greater and more frequent injury to which the product would be liable if growing erect.

Nevertheless in saying this, it is only mere conjecture. It would be very desireable to ascertain what is truly the fact, which might not be easily done.

I call this hard, internal central substance, bone or shell, which is the name given to it by all naturalists. Perhaps there is a greater disparity between its length and diameter than in any other substance of the kind. There are some very slender bones indeed, but I believe none of such comparative disproportion.

Probably the diameter of the bone of a full grown specimen is not above a thousandth part of its length. I found by actual experiment that fifty portions were confined within the limits of an inch; no more than the fiftieth part of an inch being thus the diameter of each. Therefore the preceding bone of 18 inches actually extracted from a specimen, exceeded its diameter 900 times. Whence it is no exaggeration to affirm, that the length of the central bone of a full grown specimen may be a thousand times its diameter.

Nothing enables us to indulge the slightest conjecture of its use. In respect to the bones of many animals it is otherwise. But here we can hardly allow its protective utility, for it seems scarcely calculated for protecting itself, far less the softer, more tender, and delicate parts, the first exposed to injury.

I am indebted to the skill of two distinguished chemists for an analysis of this singular organization, Dr Andrew Fyffe, Professor of Chemistry in the University of Aberdeen, whose residence in Edinburgh was long of eminent service to various departments of the arts. Further, to Dr David Boswell Reid, whose zeal and activity in promoting science in the same city, have left a blank, not to be easily filled up, by his removal to the metropolis.

From a quantity of the bone with which I supplied Dr Fyffe, he found it to consist of 85 parts of carbonate of lime, and 15 of animal matter, blended throughout with the former. In like manner, Dr Reid found, from a quantity with which I supplied him, the principal ingredients to be phosphate of lime, carbonate of lime, and animal matter; the latter in considerably quantity, " leaving, when the earthy matter was dissolved in acid, a pulpy jelly." On the whole, he was disposed to consider the substance more as *bone* than *shell*, though different from any bone or shell he had previously met with.

I question whether the Virgularia has any proper locomotive faculty whatever; whether it can really shift its place by its own exertions. If so, it may be from some inducement, and by some means, which are not obvious. The parts move very little in confinement; yet the body can twist itself, if it may be so described, in such a manner as to form a spiral around the bone. A section, six or eight inches long, standing inclined in a narrow jar, will be found to have arranged itself in a single volute throughout, or into two, three, or four, between night and morning. The whole can relax again into a straight line by their obliteration. But when laid horizontally in a wide vessel, I have not observed any specimen turn itself over, whether the position of the edge of the lobes bearing the hydræ be upwards or downwards; that is, whether the Virgularia lies on what may be called the back, or on the front.

The lobes have an independent power over their own position, assuming greater or less obliquity, and closing by reciprocal approximation. They exhibit nothing more. The aspect of the hydræ is more delicate than that of the others; they have all the motions peculiar to those of the asteroid zoophytes.

Each organ of this remarkable object has a distinct action free of all the other parts. Each lobe, each hydra, each of the pectinate tentacula, and each of their prongs, can move at will, while the whole of the rest of the zoophyte is quiescent. Therefore, in a specimen even shorter than that before described, with the bone extending 18 inches, above a million of separate fleshy parts are under the common controul of the subject.

But how this controul is exercised, or how its effect is imparted, is not easily explained. The mass of the *Cristatella vagans* possesses the power of effecting progression, while sustaining hundreds of independent animals. The flesh of the *Virgularia* enjoys some peculiar power of winding as a spiral around the central bone, while thousands of hydræ, independent so far as to testify individual action, are incorporated with it. What a marvellous work of the creation!

This, like a vast proportion of the tenants of the deep, is a nocturnal animal. All the parts attain their greatest dimensions, and testify more lively action, after the light has fled. The whole remain contracted during the greater part of the day, and the organs are seldom displayed before five or six afternoon, and towards evening.

On removal of a specimen, when finely distended, from its own element, evacuation of the contents follows, whereon such contraction and alteration are concomitant, that it could not be known for the same subject. Its repletion is attended with equal difficulty as that of the Lobularia.

The fleshy part of this zoophyte seems regenerated to a certain degree, when some circumstances indicate the termination of both extremities in such prolongations. Specimens partially mutilated may be sometimes preserved by retaining only the part which is entire.

With this view a section was cut out of a specimen, thus injured before reaching me, which would have speedily perished. The ends were sundered, the middle preserved, and suspended in a jar of water by a silk thread passing loosely over the upper part. In three weeks it continued healthy; the flesh had grown over both ends, and the original hydræ belonging to the section were occasionally displayed.

Of several other sections removed in like manner from larger specimens, one exhibited an ample reproduction in three weeks, consisting of about an inch of flesh generated beyond the lower extremity of the bone, which augmented considerably in three weeks more. The prolongation of a third was less. These new parts were of paler colour; they shewed spontaneous distension; the flesh curving nearly at right angles to the bone. The hydræ were often finely displayed.

This bone is never reproduced.

A specimen once occurred with a double central bone extending about two inches, but terminating abruptly, fig. 8. The bones were unequal, a longer and a shorter, the longer extending so regularly, that the shorter might have been almost considered a fragment accidentally or supernaturally introduced along with it amidst the fleshy substance.

When wounded, a whitish matter exudes from the injured parts.

A musky odour, not unpleasant, is emitted by the Virgularia.

Perpetuation.—Yellow corpuscula are visible within the distended lobes of the Virgularia, some in motion, others at rest. Their inaccessibility to the microscope precludes accurate determination of their form, for they are indistinctly seen, as in fig. 7. Some minute animalcula are likewise perceptible traversing the contents, or revolving on an axis. Besides these, other substances, which might be thought large yellow ova, are imbedded in the flesh, but too much obscured by the thickness of the parts to afford a clear and satisfactory view, fig. 9.

About twenty specimens of this zoophyte having been obtained in the middle of May, very minute yellow ova were discharged from them at the bottom of a tall cylindrical jar, therefore inaccessible to microscopical observation. But some specimens having been laid horizontally above watch-glasses in a wide shallow vessel, enabled me to secure several corpuscula there, on escaping from the fragments. All appeared yellow, opaque, solid, and consistent, some almost spherical, others as if losing their regular shape, fig. 10. Several corpuscula, much more minute than those represented, were intermingled with the rest.

When thus produced externally, it is probably from as many embryos having burst a delicate integument investing them.

It is very remarkable, however, that the propagation of the Asteroidal

Zoophytes, should be effected apparently after the same mode that experiment and observation demonstrate as belonging to the Hydraoids.

During the course of another summer, many specimens, or rather fragments, of the wonted dimensions, towards eight inches long, being procured and introduced into glass cylinders, several globular yellow corpuscula, such as already described, appeared on the 6th of June. But they also proved inaccessible. The specimens affording them having been removed in two days, elongated ovoidal corpuscula, which I concluded to be the preceding now farther developed, were observed swimming in the water.

Two vigorous specimens being deposited in glass jars on June 13, a number of minute yellow corpuscula lay under one of them next morning: and on June 16, several were swimming here as elongated ovoids, ten inches above the bottom. By transferring these and others to a suitable position for microscopical inspection, they were found in narrow resemblance to the *planulæ*, so often described as among the transitions undergone in the course of the changes of other animals. They were yellow, smooth, uniform, void of visible external organs under the magnifying powers employed, and endowed with swift, active motion, whether by crawling or swimming in all directions. I could not do otherwise than identify their nature with that of the planula, fig. 11.

On July 14, two specimens of the Virgularia were lodged in a vessel and removed on the 17th. Corpuscula had issued from them on the 16th, which becoming elongated, continued swimming like planulæ in the water. On the 25th, three nascent Virgulariæ were discovered at the bottom of the vessel, but in such a position that inspection by a lens only could reach them. All lay horizontally. The body of each was elongated cylindrically; and one extremity inclining upwards, terminated in an asteroid hydra with eight tentacula, figs. 12, 13.

The mode whereby Nature effected the perpetuation of this zoophyte, was thus ascertained to correspond generally with that of the hydraoid Sertularia: the corpuscula from the adult developing as a planula, attained maturity by the evolution of a terminal hydra.

From preceding and subsequent inspection, I found a slight adhesion of the nascent Virgularia to the surface of the substance whereon it lay.

As the position of these nascent hydræ proved inconvenient for observation, the removal of some to watch-glassess was safely effected.

Now and subsequently I observed that the originating product had a slight adhesion to the surface whereon it rested; that the anterior part, being a hydra, had considerable action, and that the posterior part, smooth like the whole body, flattened itself together with the extremity. The tentacula are then armed with few pinnæ or prongs, and perhaps not with above ten for a fortnight, short and stout, the largest highest on the rib. No resemblance of internal bone can be discovered; but the stomach is seen with four organs, tendrils, or vessels, descending from the base. I thought that the current of a fluid carrying black particles upwards towards the hydra might be discerned.

Nascent specimens have a tendency to invest themselves with mud.

Observations on the originating zoophytes were protracted above a month, without leading to any discovery of consequence. They survived somewhat longer, but, like all the other hydræ under similar circumstances, they ceased to unfold; yet enough was exposed to prove their nature to a certain extent, along with some of the laws by which the perpetuation of the race is regulated.

Indulging conjectures regarding the incidents of futurity is perilous: however, the survivance of a nascent animal might shew it to be the first of an originating lobe, that the flesh is carried up in a solid mass beyond the bone, and that in this manner both ends of the Virgularia are fleshy.

Depositation of the matter constituting the elements of the bone is probably very slow, and in some proportion to the sustenance taken by the product. Whatever may be the use of the bone, it is in no ways incorporated with the flesh. Its form is cylindrical in the middle, and gradually attenuating towards the extremities, as already signified. The lower extremity tapers to a point, running down for some distance not thicker than a horse hair, and somewhat of cartilaginous texture.

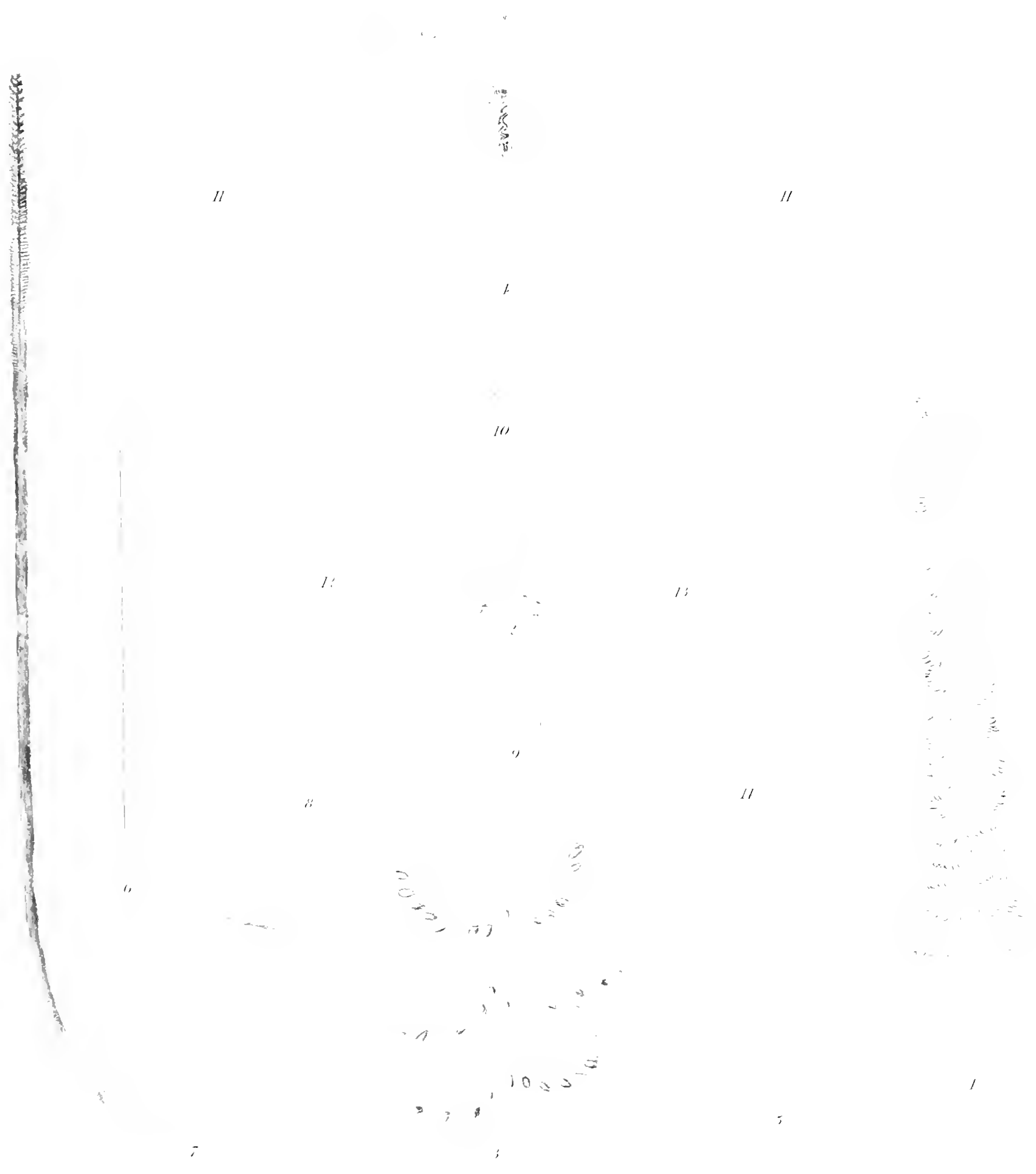
The spots inhabited by the Virgularia are certainly extremely circumscribed; and it is seldom that specimens extending more than six or eight inches can be obtained. Nevertheless, some of these spots are sufficiently known to a few of the fishermen of this country, who can anticipate a successful search for them with their rude apparatus. I am confident, however, that larger and better specimens might be obtained through the aid of a better contrivance.

PLATE XLIII. FIG. 1. *Virgularia.—Pennatula mirabilis.*—Sea Rush.—Specimen as recovered from the sea.
2. Section.
3. The same enlarged.
4. Hydra enlarged.
5. Lobe with one hydra displayed.
6. Bone.
7. Fragment of a specimen, with the lower extremity fleshy and entire.
8. Double bone invested by the flesh.
9. Corpuscula within a lobe, as obscurely exposed through the flesh, enlarged.
10. Corpuscular embryos or ova discharged by the Virgularia. enlarged.
11. Planulæ enlarged.
12. Nascent Virgularia from a planula, June 29, enlarged.
13. Nascent Virgularia, July 12, enlarged.
14. Nascent Virgularia with a dark central line, enlarged.

§ 3. PENNATULA PHOSPHOREA—*Sea Feather—Cock's-comb.*—PL. XLIV. —The name which seems by common consent to have been bestowed on this zoophyte, is so truly expressive of its resemblance to a feather, that, amidst the numerous recent changes, no one has proposed to alter it.

In general nature, there is much analogy between it and the subject of the preceding paragraph.

When completely distended, the Pennatula of the Scotish seas stretches between four and five inches in length, by nearly two inches in breadth. Its external form consists of two parts, very unlike each other, namely, the shank, extending half of the whole, smooth and round, half


11
11
4
10
9
8
11
6
7
3
5
1

[illegible]

an inch thick, constituting that part which may be compared to the quill: the other, of far larger dimensions, composed of broadened, flattened lobes, to be compared to the feathered portion. Thus the Sea Pen is a very natural name.—Plate XLIV. fig. 1.

A slender bone, attenuated towards one extremity, and sometimes hooked, occupies the centre of the smooth round portion. Therein it may be indistinctly recognised through the skin, when the animal distends itself with water, as this renders the parts more transparent, fig. 2.

The size of the animal is infinitely reduced by evacuation, when it appears inactive and inanimate. No one could anticipate the effect of intumescence from its form in a contracted state.

The whole of what we shall denominate the upper part, consists of a series of lobes, diverging from either side of the middle. Ascending, they commence above the smooth shank or quill, and each pair gradually enlarges, until gaining the extreme breadth described as two inches, from which in corresponding manner they decrease up to the summit of the product.

Several hydræ issue from the upper edge of each of the lobes, their number being regulated by the dimensions of the lobes themselves, figs. 3, 4. There are twenty-eight hydræ across the whole specimen represented, fig. 1, that is, fourteen on each side of the rib interrupting the two leaves. This hydra is precisely of the same formation as the others described in the present chapter, having eight pectinate tentacula, figs. 5, 6, 7.

The appearance of the skin of the Pennatula is very peculiar, fig. 8. Numerous red shuttle-shaped spiculæ are incorporated with the surface, many of them separating spontaneously and readily, fig. 9.

The whole zoophyte is variegated white, red, and yellow, being a beautiful object when displayed in full luxuriance.

The hydra of the Pennatula, though identically of the same nature, and corresponding in general description with the two preceding, rises from a kind of calyx, consisting of eight flat, red pieces, which open as it issues forth to expand its pectinate tentacula, and close down around it on contraction.

The position of the bone is much shifted within the shank by distension of the parts, and it sometimes protrudes from the extremity. But whether by an orifice there, is doubtful. It is somewhat under three inches in length, about the fortieth part of an inch in diameter, generally waving at the ends, and the lower extremity reduced to the slenderness of a hair. Its position and adherence within the shank are not well understood. It rather seems as if the upper end were invested by the flesh, though slightly, for it slips out of the shank as if quite free. However, the lower end is naturally hooked like a shepherd's crook, the curve an eighth of an inch deep, narrow, and occupied by a whitish fleshy substance.

I procured sixty-four specimens at once early in May. All excepting twelve appeared to have been injured: the bone was either broken, or it protruded from the extremity of the shank. These specimens were in a contracted state, but being disposed under suitable treatment in several vessels, sufficiently replenished, the bone was next day retracted, and covered by almost the whole; and some of the specimens extended four inches and a half.

A considerable bulb is formed by the lower extremity, which, when swollen, extends beyond the bone. It may be conjectured that this extremity is pierced by the bone on contraction, and that protrusion ensues in consequence. But there may be a natural orifice.

It is not evident that the Pennatula enjoys any proper faculty of progression more than the former. A great recurvature can be formed by the upper part or feather, which the bone does not rise high enough to obliterate. The animal has also much controul over the dimensions, reciprocal position, and direction of the lobes. Certain parts may be distended disproportionately compared with the rest. All the hydræ have separate and independent action. But farther than complete distension of the whole specimen, whereby its previous contracted dimensions may be quadrupled, no farther approximation to motion is betrayed. Neither does such distension, though to the utmost, reduce its specific gravity sufficiently to produce an equilibrium with the water. Thus the animal cannot swim. Neither have I ever seen a reversed specimen, that is, laying flat with the hydræ downwards, regain the natural position, which I conclude is laying flat with the hydræ turned upwards.

The native situation of the Pennatula is said to be on a muddy bottom. Indeed, a small quantity of mud is always discharged by specimens when recovered from the sea.

Perpetuation of the species probably ensues after nearly the same fashion as that of the preceding. Yellow corpuscula are generated in the lobes, from March to September. After a fine specimen had been a fortnight in my possession, I observed several on the 1st of April. I have seen them earlier.

Such bright yellow corpuscula appear at various intervals in the distended lobes of the Pennatula, without any regular arrangement. They are equally conspicuous through the flesh from behind as in front. But they have been chiefly liberated by decomposition of the animal.

This Pennatula is of difficult preservation, even for a brief period. It is extremely subject to decay, then resolving into a mucous or ropy matter, so tenacious that a thread may be drawn out, two feet in length, without breaking. Innumerable small spiculæ are now disengaged.

Nothing can be more diversified than the appearance of the corpuscula when liberated. At first they seem for the most part globular, smooth, and solid. If in that state they have cilia, I have failed in detecting them. Should all these corpuscula be globular originally, their figure may undergo some modification while yet retained by the specimen.

The decay of several Pennatulæ, of medium size, in the middle of July, exposed some reddish-orange corpuscula, whereof three globular and three a little elongated, were selected and committed to watch-glasses.

The form of all was lost by farther elongation. Some extended nearly a line next day, the whole substance appearing fleshy: the anterior portion, of variable shape, more or less corrugated, somewhat as a leech. In other two days, they had advanced farther. Two pair of flexible organs seemed to be seated on the anterior part, that wherein there was greater motion by different curvatures. These animals evinced no progression on the glass, neither did they adhere; but they could roll over.—Fig 11.

To gratify the curiosity of some learned naturalists, I exposed them too early and too freely to view: consequently they perished. At this time the subjects of observation amounted to nine.

I have obtained similar corpuscula from the Pennatula at other seasons, round like a barrel, and with a prolongation quite as great or greater than any of the preceding. But none lived long enough, or exhibited sufficient characteristics to sanction positive conclusions. It is singular, however, that such animals can survive amidst the putrescence of the substance of the Pennatula. I considered them as advanced far beyond the state of ova; nor had the skilful naturalists who saw them, any doubt of their animation.

Like other Asteroid Zoophytes, this is strictly a nocturnal animal. It enlarges remarkably as evening comes. It is then that the lobes are swollen; and the hydræ most amply displayed in vigour, while the whole variable organic structure expands by intumescence.

PLATE XLIV. FIG. 1. *Pennatula phosporea.*—Sea feather.
2. Internal bone.
3. Section.—Lobes.
4. Section shewing the form.—Lobes.
5. Hydra unfolding.
6. Hydra displayed.
7. Hydra.—Pectinate form viewed in front.
8. Portion of the surface of the skin.
9. Spiculæ.
10. Corpuscula from the lobes.
11. Nascent Pennatulæ.
All the figures of this Plate, except the first and second, are enlarged.

3

4 8

2

1

10 9 11

7 5 6

Cicindela

CHAPTER X.

ACTINIA:

THE ANIMAL FLOWER.

Plates XLV., XLVI., XLVII., XLVIII., XLIX.—Systematic naturalists, in subdividing the order Zoophytes, have reserved a place for reception of one large family denominated *Helianthoids*, thus named, I presume, as expressive of form and beauty.

Herein are specially comprehended two genera, the *Actinia* and the *Lucernaria*. The former is well known as attracting equal notice and admiration; numbers have fallen into my possession; and I can speak freely of its nature. The latter is of rare occurrence;—I have met with too few specimens to enable me to say anything satisfactory on the subject.

Many of the lower animals are void of all resemblance of those objects familiar to the eye: they are unsightly misshapen masses, deficient of external symmetry, of subordinate parts and regular proportions; scarcely exhibiting symptoms of animation.—They sink amidst the mud, they burrow in the sand as an asylum: They seek for shelter in the cavities of shells, they retreat under rocks or stones, or dwell habitually in the recesses of the deep, as if withdrawing from the light of the upper regions, unable to bear its impressions, or to conceal their deformity. It is otherwise with the numerous tribe of Actinia. Some are distinguished by the beauty of their form: some by symmetrical proportions, or by the radiance of their colours. Rows of delicate organs, arranged in concentric circles, ornament the surface; or deep-waving lobes, bordered with luxuriant fringes, are pendent from the margin. Many are green, or red, or yellow, or variegated of diverse vivid hues, equalling the tints of the loveliest of the roses. Hence has the Actinia been distinguished by simple but expressive names;

the Sea *Anemone*, the *Daisy*, the *Marigold*, the *Animal Flower*, or by such botanical synonyms as comparison with vegetable efflorescence would justify.

Neither does the Actinia secrete itself from view, or always linger in submarine caverns, remote from human knowledge. Dispersed along the shores, implanted on naked cliffs, multitudes remain after the tide recedes, often hemispherical, as so much ripening fruit, inviting the touch of the beholder, and as it flows in return, expanding like the most brilliant flowers, to be invigorated by the waters.

The general nature of the Actinia approaches so nearly to that of the hydra proper, as to induce their incorporation in the same genus, by many naturalists, and it has been often designated a gigantic polypus. Its alliance with the hydræ of the Medusa, previously discussed so much at large, is no less intimate. If, on the whole, the Actinia and the hydra may be separated, it is evident that they should not stand far asunder. They shew numerous analogies in structure and habits,—those unerring guides to kindred or identity.

It is in habits, however, that the stricter correspondence will be found, for the actual organization of the hydra is not yet sufficiently explained: and the same may be perhaps affirmed, though less decisively, regarding the Actinia. The larger size of the latter adapts it better for exposure of the parts. But I am not ignorant that certain chimerical views are entertained regarding the anatomy of both.

In as far as hitherto established, neither the hydra of the fresh-waters, nor any of the Actiniæ of the sea, pass through the same order of metamorphosis as the *Hydra tuba* to reach the Medusarian state. Though the transitions of the Actinia be sufficiently singular, none have been ascribed to the Polypus, nor is any relation to the race of Medusæ manifested by either. Both are believed to be perfect animals, in the form under which they are represented by naturalists.

Though many analogies shew the reciprocity of nature in the Polypus and Actinia, they are nevertheless distinguished by a noted difference, as will be discovered by those who are enabled to study the history of each in detail.

In general description, the Actinia consists of a fleshy pillar, spontaneously affixed by the base to some solid substance, for temporary or permanent security. It does not seem to dwell naturally in a pendent position. The summit or capital of the pillar dilating as a circle, wider than the base, is environed by one or more rows of stout or slender tentacula; also in some species, instead of tentacula, simply in circular arrangement, the capital forms several circumferential waving lobes, with their margin finely fringed by a number of delicate feelers. The mouth is always in the centre of the disc or upper surface of the animal.

All the parts are susceptible of extraordinary dilatation and contraction, dependent chiefly, if not entirely, on repletion with food, or distension by water.

This is a powerful, fearless, and voracious creature. Having chosen a spot for firm adhesion, it spreads abroad its numerous tentacula to the utmost stretch in quest of prey. Nothing can escape their deadly touch. Every animated being that comes in slightest contact, is instantly caught, retained, and mercilessly devoured. Neither strength, nor size, nor the resistance of the victim, can daunt the ravenous captor. It will readily grasp an animal, which, if endowed with similar strength, advantage, and resolution, could certainly rend its body asunder. It will endeavour to gorge itself with thrice the quantity of food that its most capacious stomach is capable of receiving. Nothing is refused, provided it be of animal substance. It is in the highest degree carnivorous. Thence do all the varieties of the smaller finny tribes, the fiercest of the Crustacea, the whole vermicular race, leeches, and the softer tenants among the Testacea, fall a prey to the Actinia. Though the flesh of the terrestrial animals be greedily swallowed, this proves a less congenial aliment, for it is shortly rejected. Not so with that of the others: it is retained longer, and, if supplied sparingly, it is entirely absorbed into the system. A very copious quantity is ultimately rejected by the mouth, after an irregular interval. Sometimes the residue of what has been devoured in the sea, is thus discharged eight or ten days after removal from it. When retained a considerable time, the substance is always rejected as a spherical or ovoidal mass, of gelatinous appearance externally, with the interior darker. That portion of the food subject to digestion has been consumed. Specimens have disgorged a ball of what might be thought most grateful, within four hours of feeding.

The remarkable voracity of this creature warns the naturalist to beware of its presence among his collections, otherwise they shall assuredly perish. Simple contact of the tentacula is the prelude of destruction. Some animals, as if conscious of their inevitable fate, seem paralyzed by the touch, and yield without a struggle. Others, whose size and strength should insure indemnity, are held in its relentless grasp; the tentacula crowding faster and faster around, until the victim is speedily swallowed alive.

From the incapacity of resistance, it has been supposed that the captor can discharge some deleterious fluid on its living prey, depriving it instantaneously of sense and motion. But of this I have seen no confirmation, and in many cases it is quite evident that superior power is the only means employed for victory.

The Actinia absorbs some of the testacea entire, even those of considerable dimensions. Two or three days after a mussel has been thus swallowed, the shell is rejected, quite empty. It may be asked, "How are the contents consumed?" In explanation, it is to be observed, that as the bivalves weaken, which constantly ensues, if their condition be unsuitable, the shells gape, and in this manner admit the access of the digestive fluids.

But the Actinia is capable of enduring protracted abstinence with impunity, plainly indicating its precarious supplies. The smallest portions of food prove restorative. By abundance its dimensions are immediately enlarged and its strength renovated. It seems as if having never suffered. Yet this is a creature capable of surviving one or two, perhaps three complete years, without farther sustenance than the water can afford.

Naturalists affirm, but erroneously, that the only orifice of the animal's body is the mouth. Masses of indigested food are rejected, indeed, by the mouth, and those large in quantity; but there are many other orifices, numerous, it may be, according to the species. Copious streams issue, like so many artificial jets, from the tentacula of the *Actinia crassicornis*: bright purple flakes are discharged by a dilatable aperture of each tubercle belonging to the *Actinia mesembryanthemum*, as may be seen on the sides of its vessel, some time after the animal has fed. Likewise, long white tendrils, of uncertain nature, occasionally protrude through the sides of the *Actinia maculata* and of the *elegans*. Evidence of these facts may be obtained on sudden removal of a turgid specimen of the first from amidst its element, or by suddenly pouring off the element from around it, when streams will spout high from the distended tentacula; and the tendrils will be exhibited by the others, on sustaining any irritation or pressure. None of all these apertures, however, can be detected by simple inspection. The skin is too intimately united, or it is too firmly closed over them. The tips of the tentacula resemble perfect obtuse cones: the tubercles are smooth and uniform, unless when opening in thin ragged edges: nor can any mark denoting an orifice be discovered on the sides.

One author is said to have proposed a generic distinction founded on the diversity of the pores of the skin,—an equivocal guide.

Certain organs belong to the interior of the Actinia, which are very long, slender, and apparently tubular. They protrude along with inversion of the stomach. But they are tubular only by the folding of the sides together, for they can spread out like a very thin flattened membrane, an inch wide. I have seen them do so, particularly in the *Actinia crassicornis*.

The active faculties of the Actinia being truly confined to simple extension, expansion, contraction, and the slowest motion, utterly disqualify it for the pursuit of prey. As the tide flows, it swells to its utmost dimensions, and remains stationary, awaiting the accidental contact of that congenial to its appetite, which it may seize, retain, and destroy. Thence have the provisions of Nature rendered the stomach susceptible of extraordinary dilatation, so as to be susceptible for reception of whatever shall be casually presented. On the other hand, as little pabulum may be afforded by large substances, the animal is guarded from perishing by that famine which it must frequently suffer in patiently enduring long abstinence.

The whole body of some species is endowed with an external adhesive faculty: the basis of all possesses it in the highest degree. The skin of the *crassicornis* is often covered by sand or the fragments of shells: the tentacula constantly retain every thing coming in contact with them. But this adhesion is the exercise of a peculiar faculty: it is optional; substances are allowed to pass over or to fall from the tentacula at will: nor is it obvious how adhesion, either there or to the rest of the body, or of the base itself, is effected.

Excessive turgidity or intumescence is derived principally, if not exclusively, from the quantity of water absorbed, besides the animal's gorging itself with food. Evacuation of the water is followed by contraction. Sometimes what are apparently fine and ample specimens, discharging the water, prove incapable of replenishing themselves. They diminish to small dimensions and perish. This evacuation is occasionally attended by eversion of the stomach. A very large specimen of the *crassicornis* has distended itself to unusual size, so that the skin seemed comparatively thin. Eversion of the stomach, evacuation and contraction of the tentacula followed, the animal quickly died. The like has been witnessed of the *Dianthus* or *Plumosa*. It is by water alone that the tentacula are distended. Nothing is so grateful to the animal, so salubrious and invigorating, as frequent and abundant supplies of this element. It is infinitely enfeebled, and indeed the adhesive power is lost, by remaining in what is unchanged for months. But, although pining to a tenth of its natural size, and remaining pertinaciously contracted by neglect, it speedily expands after the longest intervals, to enjoy that which comes recent from the sea, and gradually recovers its pristine vigour and beauty.

If the water is renovated every fourth or fifth day, it will be found sufficient.

The size and appearance of the Actinia may be therefore considered as absolutely dependent on the renovated element, on sustenance and heat. In common with most of the soft-bodied animals, it contracts during cold weather, and expands under a genial temperature. Farther than this, there is no reason to admit its susceptibility of atmospherical or meteorological influence, far less that it prognosticates what shall ensue.

The remarkable distension adverted to above, without any obvious cause, is generally an unfavourable symptom, and very ready to delude the naturalist, though a prelude to decay and death: and the protrusion or eversion of the stomach becomes alike fatal. But at other times the stomach may be everted and replaced without any evil consequence.

The skin is cast very often, especially after feeding greedily, as well as from continued abstinence. It seems to be distempered also from exposure by evaporation of the water, and then separates. This exuviation extends in some species to the tentacula, the skin coming off in rings or belts. In the natural state, the Actinia is freed of the slough by the washing of the waves, and in confinement the body will be encircled as by a girdle, when it should be cut asunder with scissors, or brushed off with a feather, which will induce the expansion, and promote the beauty of the specimen.

The Actinia is endowed with a very slow locomotive faculty, rarely exercised, and then accomplished only by extending one edge of the base imperceptibly over the adjacent surface and withdrawing the other. Thus is the most languid and tardy progression effected. But a specimen will remain a long time stationary, either contracted in crevices, shewing itself only as incited to swell by the flowing tide, or closing itself up as the sea recedes, when adhering to the open surface of rocks. Its abode is permanent also in those larger or more diminutive pools, always full, where it may remain constantly displayed. Besides this, the Actinia can detach itself entirely from its position when it is floated away reversed, doing so perhaps during exuviation of the base.

The difficulty of removing specimens from their native site is a great obstruction to the study of those which the observer would select in preference. In confinement, some quit their hold when remaining dry for a considerable time: others are disposed to shift their place, or to detach themselves, if the water be rendered very impure. But no effect is thus produced on many; nor does any thing whatever induce them to move or to abandon their fixture. They remain to perish. The only practicable method to obtain a desirable object, is, where possible, to cut the hard surface below it, a tedious and precarious alternative, yet one wherein I have repeatedly succeeded.

The senses of the Actinia seem to be extremely obtuse, and its perception alike obscure and imperfect. Naturalists debate whether any nervous system exists in this animal; but, as in other animals, if nerves be the medium of transmitting impressions, it is obvious, that those of which the Actinia is susceptible, must be referred to the same channel, or to some adequate substitute incorporated with its substance.

Yet the creature seems neither sensible of the presence of its favourite prey, when in its immediate vicinity, nor does it resort to the quickest and easiest means of preservation when it is itself in peril. The prey may be within a hair's-breadth, but it is seized only on actual contact. There is no spontaneous extension of the numerous external organs capable of all inflection: no searching activity or otherwise to reach it: in strict conformity here with the nature of the *Hydra tuba.* More singular still, should the vessel be gradually emptied, or the water evaporate so as to leave these animals totally or partially dry, they never lower the base for immersion in the residue,—not even when the tentacula can reach its surface.

The Actinia is remarkably tenacious of life. Abrasion of the skin is injurious, but it can endure extraordinary laceration, without destruction, and it manifests extraordinary reproductive powers in the recovery of mutilated parts, whereof some detail will be found in the works of most authors who have treated of its properties. But the cruel experiments proving them are most reprehensible.

In some countries, the Actinia is occasionally an article of food: but I have not heard of it being used as such in the British Islands. Its hardy nature and easy preservation, render it an interesting and useful subject for the enquiries of the naturalist.

The appearance of the animal is so liable to the influence of both external and internal causes, that much precaution must be employed in giving the true resemblance of specimens. It is here that there have been frequent and extraordinary failures. It should never be attempted unless from the living animal, from good specimens, and these in the best condition.

This genus could admit of convenient subdivisions, assuming the most prominent external features, or the peculiarities of their nature, as the type. But all these conditions should be well understood.

The Actinia is very far removed from the Holothuria, with which some authors nearly approximate it. Indeed, I have seen no correspondence between them.

§ 1. Actinia mesembryanthemum — Equina.* — Plates XLV., XLVI., XLVII.—I took a specimen of this Actinia in August 1828, at North Berwick, where the species is abundant, among the crevices of the rocks and in the pools remaining still replenished after the recess of the tide. It was originally very fine, though not of the largest size: and I computed from comparison with those bred in my possession, that it must have been then at least seven years old. During two months, as afterwards, it continued in great vigour and of ample dimensions, being at that time delineated.—Plate XLV.

While considering such animals mature, we must allow that their organization receives subsequent accessions, nor can I say at what period, certainly a distant one, they cease to grow.

Firmly affixed by the spreading base, the disc of this species expanded above is begirt by a triple row of tentacula, each extending an inch. Their number augments with age, and hence, at the latest period of observation, they had here amounted to about 100, in twenty years. The whole are unequally divided among the three rows; the inner row being composed of fewest, but they are the largest.

At the external root of the tentacula of the outer row, there is a number of apparently solid tubercles; each, however, is pierced by an orifice, which opens and dilates occasionally, some time after the animal has fed.

* I find it a vain attempt to reconcile the numerous synonyms abounding in different authors, with the different species falling under my observation. The accurate resemblance of the figures given here to the originals, will prove the reader's best guide. Naturalists will find valuable auxiliaries in the works of Lamarck and Dr Johnston. But, greater confidence may be reposed in those of the latter.

The colour of this species might mislead the most experienced observer: nor shall I speak too positively of the subject. It appears to me, that, taking the widest latitude, it may possibly range, through the medium of varieties, from liver-brown to fine and vivid vermilion; that the former belongs to the ordinary and more common portion of the tribe; that the specimens so distinguished have purple tubercles, the base surrounded by a purple ring, and that a purple line or patch from the disc penetrates each of the opposite sides of the mouth. On the other hand, those characterized by fine vermilion colour, have pure white tubercles, resembling a row of pearls; and are without any other distinctive marks.—Plate XLVI. fig. 1.

I feel disposed to conclude that the two may be ultimately determined one species, but until identified as such, it will be expedient to reserve a paragraph for the latter, which, besides, will extend our knowledge of the genus, and perhaps encourage other naturalists to investigate the fact. Therefore, what is said at present must be held as more peculiarly applicable to the former.

The skin of the adult is liver-brown; but in earlier stages, the colour is lighter, and the surface of the animal is sprinkled with fine, oval, green specks, in longitudinal rows, which remain conspicuous for three or four years at least. They are best seen after exuviation: for, when the animal has cast its skin, the new surface is clearer: whereas they become altogether obliterated with age.—Plate XLVII. fig. 1.

The under surface of the base is always green.

The natural and favourite position of this species is in horizontal fixture, by application of the base to the side of a rock in its native state, and to the side of the vessel which contains it in confinement. But it is in so far different from any others, that while remaining in pertinacious adhesion to the same spot, whence they cannot be dislodged, the *Actinia mesembryanthemum* generally detaches itself, and drops down on pouring off the water, which proves a great convenience to the observer. The success of this expedient, however, is not invariable.

Hence, he must avoid consigning any new specimen to a phial, or a deep jar, wherein, falling to the bottom, it may prove inaccessible, or where

Actinia Mesembryanthemum
Survived 20 years in Captivity
Produced 334 young

it may adhere in such a manner as to render removal impossible. Such is always the case with the *Gemmacea*, and usually with the *Dianthus*. On finding a specimen regarding which the collector is doubtful, it may be wrapped in moist sea-weed, a wet cloth, or wet paper, where it will be quite safe for many hours; and if wanting a sufficient vessel for its deposition, he may first use a small saucer, which can be afterwards lodged in a larger vessel.

The *Actinia mesembryanthemum* is a bold and hardy creature, feeding voraciously, like the rest of its kind. A small quantity of water suffices for it in case of necessity, wherein it may be kept uninjured for a long period, in a vessel of very moderate capacity, but entirely covered by the element, or frequently washed with it. Free of that timidity also, inducing many of its kindred to contract on exposure to the light, new facilities are gained for the convenience of investigating its nature.

It is difficult to determine whether animals, especially those of prey, are truly solitary, or whether they dwell in society. This Actinia is often found single. Yet, from its prolific qualities, a numerous colony may be soon reared around it. There is no difficulty either in feeding or preserving it, from the variety of substances devoured, and the slight humidity that may be enough.

This Actinia must be deemed a long-lived animal. Naturalists, indeed, as if desirous of proportioning the existence of most animals to the transience of their own observations, are too prone to abridge that to which a longer period is allotted among the humbler orders.

The specimen, Plate XLV., still surviving, cannot be much under thirty years old. Another, which must have been of equal age with it when taken, has lived thirteen or fourteen years in my possession. Therefore, both being yet in great vigour, and likely to survive, the Actinia must be judged a long-lived animal.

Perpetuation.—The propagation of the race is not less remarkable than that of many of the preceding tribes with which we have been engaged in detail; and, notwithstanding the vast disproportion of size, together with the discrepance of aspect and conformation, we shall find some striking analogies with those which are minute.

The *Actinia mesembryanthemum* is a genuine hermaphrodite, at least in the ordinary acceptation of that character. There are some learned men, indeed, so averse to admit the possibility of progeny being derived from a single parent, that they resort more to hypothesis than to demonstration, for the sake of establishing their opinions. Thence they endeavour to find the actual functions of two in one, rather from illusion than reality. In the Actinia, each solitary individual bears the elements of its offspring in its own body, which, brought to maturity, is produced by the mouth.

By the word hermaphrodite, it is not necessary to understand that such a union of animal organization is indispensable, as, by concourse of different parts of that organization, being should be given to an individual of the race; there is no reason why a germ,—an organism should not be derived from the parent, which shall develope into complete form, more than that some organic part of the parent's body shall originate or be repaired from some analogous source, though the derivation of the elements of the offspring from a single individual should be through some physiological process yet unknown. The origin of animals is the most mysterious part of the operations of the Divine Power for preservation of the universe.

There are several obscurities involved in the perpetuation of the Actinia which require elucidation, and especially such as might explain the place and description of the ova.

But I am compelled to advance *per saltum*, and to view the offspring in a state of farther progress.

The Actinia is always disposed to affix itself to the side of its vessel, preserving the body in a horizontal position. Then, while the tentacula are vigorously displayed, a number of dark substances may be occasionally seen in the tentacula forming the lower half of the circle, but none are found in the distended tentacula of the upper half. The observer having enumerated ten, fifteen or twenty occupying the tentacula, may miss a portion of them, or even the whole, on returning to inspection after a brief interval; all have disappeared, nor may he ever see them again.

Under favourable circumstances, however, minute corpuscula, as well as larger and denser substances, are found in the distended tentacula, one or more in each, the corpuscula in motion, the others at rest.

The latter are so many young in different stages, some apparently so mature as to be ready for production, and I have no doubt that they would be produced were it not from some singular faculty of retention in the parent. They are frequently withdrawn for many months to come: or they are returned, occasionally to the tentacula, or shifted to a different position.

Meanwhile, as these internal corpuscula continue in view, they pursue an irregular course among the liquid contents of the tentaculum. wherein they bear no inconsiderable resemblance to the *Animalcula infusoria*, only, surpassing the size of the largest.

At first sight the observer will be disposed to class the animals before him with the numerous parasites infesting so many living creatures, and he may naturally enough look for them in vessels containing Actiniæ. But his search will be vain, for, unless on the rarest occasions, they are never to be seen at large.

Instead of awaiting so uncertain an event, a more ready expedient can be resorted to in amputating the *gravid* tentacula, for the sake of obtaining their contents.

I was originally inclined, as others would be, to view the corpuscula as parasites, or *Animalcula infusoria*, which, by some means, had obtained a lodgement in the Actinia. Thus, while at least seven different tentacula contained embryo Actiniæ, so far developed as to bear a general resemblance to the parent, I observed the active corpuscula single in one tentaculum, and two or three in others. Single corpuscula were then found in several more, and some tentacula contained both corpuscula and embryos.

Neither of the two being confined to any season of the year, allows greater scope for experiment. Therefore, having inspected a distended tentaculum, towards the end of October, I severed it from the Actinia with sharp scissors, receiving itself and its contents in a watch-glass. Scarcely had it fallen there, when a large embryo was discharged, and immediately afterwards, two active corpuscula also escaped from the section. The former lay still. It consisted chiefly of several obtuse prominences.

But the latter, of reddish colour, and globular figure to the eye, exhibited much activity in rotatory and progressive motion, describing an orbit, and revolving as if on an axis. In none of these latter could any subordinate parts be discovered.

Subsequent experiment led to very interesting results.

Numerous corpuscula are contained in the tentacula of the *Actinia mesembryanthemum*, dwelling there as in their native abode, from which they are occasionally withdrawn, or resort to some other part of the body for a season. Their presence, their number, and their disappearance, are alike irregular. None are seen for long intervals: there are also periods when some are always to be found. Availing ourselves of such opportunities, the tentacula may be amputated, when the corpuscula will be discharged from the sections.

These corpuscula are the embryo Actiniæ in an early stage. Nothing can be so unlike the race: their form is such as almost to defy description.

All are red, opaque, solid: some flattened, some elongated, some with irregular prominences, as if composed of two or three or more unequal spheres. They cannot be referred to any known familiar objects for comparison. Their motions are no less diversified, evidently affected by considerable specific gravity, and regulated by the cilia which surround their circumference, whatever be its outline. The motion of each individual is either progressive, gyratory, advancing by irregular courses, or in curves, and by ascent or descent,—quicker or slower. Where the body is composed of united spheres, the motion has appeared to be a horizontal revolution, on an intermediate portion, where the point of union of two constituted the axis.—Plate XLVI. fig. 2.

A satisfactory view of the embryonic corpuscula may be obtained by amputating the tentacula. But they generally perish in a few days, whereby the purpose of protracted observation is defeated.

This species of Actinia is viviparous. It produces its young by the mouth. The body of the parent is then greatly compressed, and, to judge by appearances, it suffers in genuine labour. As the half digested food is disgorged by the mouth—not without an effort—we may presume that in consequence, the young are sometimes also disgorged along with it. The specimen represented Plate XLV. having had a copious meal of an embryo skate, taken from the capsule, retained the food during twenty-four hours, when it was rejected, together with a numerous brood of thirty-eight young Actiniæ, some of them very large.

On a similar occurrence, rejecting the digested food, a different specimen disgorged fourteen animated beings, after having been ten months in my possession, and having been previously sufficiently prolific of progeny in maturity.

Six of the fourteen proving to be such corpuscula as above specified, they were carefully separated, committed to various vessels, and set apart for more attentive investigation.

They differed in nothing of importance from those extracted artificially from the tentacula. All were very minute, and they continued so for some time. Four were spherical : two consisted of two spheres united, exhibiting motions peculiar to their form, while the courses pursued by the others, resembled those already described. Sometimes they reposed ; sometimes they moved : their excursions were longer or shorter, though always laboured, as if the power of their natatory organs was inadequate for overcoming the resistance. I could not view these beings otherwise than as living and active animals.

It is seldom, however, that so numerous a mingled brood appears. About two months earlier, the same Actinia produced nineteen young, large and small, in the course of a night. Also, a month later than the birth of the fourteen animated beings, eight corpuscula, endowed with lively motion, appeared in the vessel, along with another litter of young. They were separated and removed.

The motion of these embryonic corpuscula subsisted eight days ; but the shape of some was changing, and elongating prominences were rising on others. Their form improved, when I concluded that they would certainly become Actiniæ. The rudiments of tentacula became visible in the largest in ten days more, and in other two days they proved six in number. The motion of the rest had now relaxed, and they also exhibited obscure indications of tentacula. They had become elongated caps, with a convex base. Some were still void of any perceptible prominences. An internal organization could be discerned through the side of others. Nineteen days subsequent to production, eight or nine tentacula appeared on one which had then affixed itself by the base, other three of the young animals into which the gemmules had developed were adhering. Of five of the original corpuscula, one was still a minute dark conical figure, a mere speck without external organs, each extremity being convex. The remaining four, as just remarked, had fixed: their shape was cylindrical, with originating tentacula, irregular in number and dimensions,—the largest having about twelve, the smallest about seven.

Thus, whatever may be the form of the *Actinia mesembryanthemum*, in its earliest elementary existence, it becomes visible as a ciliated gemmule, traversing the fluid contents of the distended tentaculum of its parent, and it is sometimes accidentally discharged by the mouth. The utmost irregularity distinguishes its appearance, figure, size, and motions. None of that organization, characterizing its future shape and aspect, meets the view. But its activity relaxes, the cilia decay, or are incorporated with its system, indistinct prominences announce incipient tentacula, it affixes itself securely by the base, and then are due proportions moulded, along with acquisition of additional parts, as the original gemmule is unfolded in a perfect animal.

Thus will a remarkable correspondence be discovered between the origin and progress of the Actinia, and the earlier and subsequent advances of several of the zoophytes described in these volumes. At first all are endowed with the faculty of progression, speedy in proportion to their size, and the organs effecting it: metamorphosis next succeeds, whereby an animal altogether different in external aspect, structure and habits, succeeds: one which becomes permanently affixed, or which remains for the most part stationary.

But the external production of the corpusculum is certainly a deviation from the ordinary course of propagation. Apparently it ought to be retained until becoming a fœtus, during which state it does not necessarily occupy the tentacula. No uniformity governs the date or duration of its presence, or its position there; nor are gemmules to be seen in the majority of the tentacula. As many as eight may appear in one: and in another some embryos may be intermixed with some of the fœtus far advanced.

In respect to all these facts, the greatest irregularity prevails throughout.

The period of gestation is long: and, by a strange anomaly in the animal economy, it is, beyond any question, arbitrary. Embryos have appeared in the tentacula five months preceding their birth: eight months have intervened between the production of two successive broods. An Actinia, as alluded to in the following paragraph, taken in autumn 1805, produced two young after a year's captivity, and a third in April 1807.—Plate XLVI. fig. 4.

The transparence of the distended tentaculum exposes the embryos in all their different stages, some very minute, others obviously too large for their prison: and many so mature, that not only incipient prominences are seen, but the tentacula of the farthest advanced can be enumerated. Yet, the largest are not the first produced: they may be preceded by many of much smaller dimensions.

Assuredly none have any adhesive faculty during retention, otherwise they could be scarcely withdrawn at pleasure, as occurs continually, and for an indefinite time. Those once seen may be never seen again under the same conditions; for neither the same embryos, nor the same number or distribution of the tentacular contents, are returned after having been withdrawn.

During a genial evening of June, a nascent Actinia was found reversed immediately under the site of the parent, which, though greatly contracted, and the mouth protruding in a conical form, still retained its horizontal position. It had been fed on the preceding day, and was now casting its skin, as very common after repletion. But, being relieved of the slough, instead of expanding as usual, it remained compressed, the tentacula flaccid, small, and empty.

In half an hour three minute organs were issuing from the mouth; more came in view:—I recognised them as tentacula; and in another half hour a large fœtus was expelled, which, falling to the bottom, lay reversed like the former. Nevertheless, when a third half hour elapsed, it had affixed itself; and it fed. Thus, ocular demonstration ascertained the fact, realizing before me, as it must have done to others, the ancient fable of parturition by the mouth!

The parturient animal is always extraordinarily compressed: the whole exterior parts are languid and inactive: the internal contents distending the body have been discharged, and, for a considerable time, it remains contracted to a tenth of its original dimensions.

One day in October, the same Actinia, Plate XLV., being much compressed at noon, as before, and the mouth protruding conically, an embryo, or rather a mature fœtus, dropped from it reversed. Contracting itself still farther, other four followed the first within half an hour.

These facts, I say, are to be very rarely witnessed. Parturition is an incident so transient, that it may readily escape the most diligent observer. I have repeatedly watched its most common symptoms, yet disappointed of the issue, for after great compression, during many hours, Actiniæ have resumed their wonted size. I doubt whether naturalists have not rather indulged in conjectures regarding this subject, than have spoke from actual experience and demonstration.

It becomes important, therefore, to verify such remarkable deviations from what is the common course of the nature of the animal world.

The vessel containing the specimen, Plate XLV., having been emptied on May 23, it was replenished within an hour. Then, the Actinia contracted greatly; the tentacula dwindled down, and the mouth projected considerably from the circumscribed disc. Thus did the specimen appear soon after replenishment. Now a large fœtus was observed within the orifice: it was advanced slowly, but none of the tentacula were visible: there seemed to be some adhesion of the side, whereon it lay in a horizontal position, not by the base. As the young animal was farther advanced, it turned round, but still lay on the side. Four tentacula appeared, next another, and when still on the margin of the orifice, five could be enumerated. It was gradually detached, and having at length hung by a single tentaculum, dropped to the bottom of the vessel on its base. The nascent Actinia affixed there almost immediately, and the complement of tentacula seemed, in a few minutes, to be eighteen. It was of large dimensions, and of a dull reddish colour.—Plate XLVII. fig. 2. Parturition here occupied fifteen or twenty minutes.

A very long period sometimes intervenes without progeny: or many young are produced within a limited season. One appears daily for several days, or several in the course of a day. Six were produced within twelve hours in July, seven within twenty-four in August, and nine within as many in October. The litter of thirty-eight must not be forgot.

As nearly as I could compute, the specimen represented Plate XLV. produced 334 young in the course of twenty years. It continued breeding during more than nineteen, though most irregularly, both in respect to the number of the different broods, and the intervals between them. Only forty-one were produced in the course of the last thirteen years, and in some of them but a single individual. That which was produced 23d May 1844, in the seventeenth year of its captivity, is represented Plate XLVII. fig. 2.

But, other specimens of the *mesembryanthemum*, have been proportionally more prolific. One which was above four years in my possession, produced no less than 200 young in the course of fourteen days. The colour of all was very vivid; but they were of very unequal size. I could not discover any monstrosities among them. None of the progeny of the specimen of Plate XLV. were monstrous, during a number of later years; though several were so of earlier date.

The greatest disparity of size, colour, and in the progress of evolution, prevails among the young,—nothing inferior to what is witnessed among the gemmules. Some are produced as if in imperfect advance from the embryonic stages,—small, misshapen, with marginal stumps; abortive, or few and distorted tentacula. Others, again, are full-grown, fine and florid, their external organs completely developed, and as if ready to live independently. Of seven produced at once in April, one equalled the united dimensions of all the other six; and of two produced in May, one was so minute, as scarcely to equal the fifteenth part of its fellow. Farther, of six produced in July, one nearly white, was not under a line in diameter; another, still later, was scarcely visible; but in two days eight stumps indicated originating tentacula; another of the six was red, with twenty-four tentacula, spreading five lines between their opposite tips. The last but one of the whole, from the aged specimen so often referred to, was almost white, very small, and with ten tentacula; the last of its progeny that I saw, was of pale colour, and of considerable size.

The dimensions of the individuals composing a brood are neither affected by the number, nor by the season of the year. The largest ever occurring was nearly twice the size of that just specified, with twenty-four tentacula on its birth in December, and the mouth tinged with purple.

How these nascent animals are nourished to become so large is problematical.

Feeding certainly promotes fertility. But the ovarium, if there be such a collective portion of its organization, may be exhausted at last in the Actinia. Whether there may not be a new depositation for the elements of germs continually going on, whether this takes place only at intervals, or whether only the evolution of pristine principles from first to last brings the progeny to light, is too abstruse a question for discussion here.

Many observers have alluded to the change of the Actinia's colour with the season of the year, also to the delicacy of its sensations, as indicating the perception of meteorological alterations. As to the former, now when we are on the subject of its early and progressive stages, we may remark, that there is no absolute rule either then or at any subsequent period of existence. Specimens appear darker or lighter, more vivid or duller, but not according to the season. Neither, as above said, have I seen much of the latter. The greatest and most sudden change seems to go no farther in effect than produced by temperature. Perhaps there may be some tendency to contraction during the predominance of the north wind, which in itself has always a noted influence on the temperature of the atmosphere; nay more, its prevalence has undoubtedly a universal, and, in general, a pernicious effect on all the animated beings of this country. An attentive observer will readily discover it by the distempers of any city, or of any district of Scotland exposed to its influence. The true colour of the *Actinia mesembryanthemum* is probably to be discovered only in the young. No one inspecting the dusky adult would conclude that the whole surface at first consists of darker red, entirely sprinkled over with green specks. But, except in that solitary instance lately quoted, all the purple is of late origin, that is, appearing after the lapse of several months. Some of the smallest of the young are absolutely white when produced; others are quite florid, and these are commonly of larger size.

Thus, the real maturity of the young cannot be estimated by the lapse of time, nor otherwise than by its aspect at the moment of its birth: —a very remarkable fact in physiology, and one which may lead to new theories of evolution and increment.

Certainly the parent enjoys the faculty of introducing the embryo into the tentacula, for it is not bred there originally. Neither is its transference thither for the purpose of attaining maturity: for although some be seen within them of large size, this is no certain prelude to production. Those, even the largest, are sometimes withdrawn to protracted concealment. The birth of a large fœtus, visible in the tentaculum, may be preceded by that of a small one, then or previously unnoticed. On the 4th of May, a tentaculum was distended by the presence of a very large fœtus, obviously stretching its arms, and spreading the base. It was withdrawn entirely on the 7th. A very minute pale young Actinia, with eight prominences, denoting incipient tentacula, was produced on the 14th. In nine days, another of florid colour and large size, with twenty-four long and slender tentacula, followed it.

Parturition among the higher and more perfect animals, seems the necessary and irresistible consequence of maturity. From dissolution of that connection between the fœtus and the parent, which has been essential to the preservation of life and the progress of increment, birth ensues by expulsion, as the simple operation of Nature. It can be neither accelerated nor retarded by the parent,—hence so many animated beings have a wonderful anticipation of the approaching event, inducing them to prepare for that which tends to conservation of the world. Obscure exceptions to the general law may perhaps occur; but they are inexplicable.

A certain power or influence seems to be exercised by the Actinia over the production of its young, which may be compared to parturition, if that word may be conceded as the most expressive, if not the most appropriate, of the event. How far that influence may extend, whether to selection of any particular embryo or fœtus, to be ushered into existence, and the reservation of others, it is vain to conjecture. However, we are entitled to assume that the young successively discharged are not in their natural order, from the great disparity that appears among them.

Some may ask,—Is not all this purely the result of accident? for, may it not be concluded that, by simple distension of the parent, the corpusculum, embryo, or fœtus, is conveyed into the tentacula, and that, either in its progress thither, or in return to the stomach, if not harboured there, that is in the stomach, it is discharged by chance. This would be a plausible argument were its conditions granted. But such postulates are not recognized. On these occasions, it is not known that the parent is distended by water. The young are sometimes disgorged with the rejected food, which affords much probability of their occupying the stomach. There is greater difficulty in accounting for their presence in the tentacula, and uniformly in the lower half of the circle formed by them, which is well exposed by the parent, amply displayed, as adhering horizontally to the side of a glass vessel.

We must always beware of allowing too much to animal instinct, a great portion of which would be required in allotting so many different powers and selections.

The general provisions of Nature are directed to the safety of the early embryo and of the later fœtus, in their connection with the parent. Thence of the corpusculum or gemmule, which, as we see in activity, remounts towards the original condition, the difficulty of its preservation, should it be exposed, must be evident. Nevertheless, there are some stages, wherein, as we have observed, premature production is not clearly injurious, and others wherein artificial birth is not fatal to the young.

Thus, on July 25, the tip of a tentaculum containing an embryo, was severed from the specimen represented Plate XLV. Next day the supposed embryo was expelled as a fœtus. It adhered the day after, displaying twelve very irregular tentacula. On the 9th of August it fed, and on the 12th it was delineated.—Plate XLVII. fig. 4; front, fig. 5;

front enlarged, fig. 6. When the increment of this young animal had advanced so far that on September 13, the divergence of the tentacula was equal to three lines between the opposite tips, they had become regular and symmetrical. But the creature had then grown very pale, almost white. A circle of Prussian blue environed the base on October 11, when the mouth was also tinged. In three weeks longer, its skin, beautifully studded green, had attained the natural hue.—Plate XLVII. fig. 1. The tubercles, however, were not very conspicuous, eleven months from its origin. But, before being a year old, embryos appeared in the tentacula, though none attained such maturity as to be produced until October 14. Therefore, this young Actinia did not begin to breed before it was between fourteen and fifteen months old. In the course of four years, its progeny amounted to 64. The green speckling of the skin remained still conspicuous, and it had become a fine specimen, fig. 7; but soon afterwards it perished accidentally.

An embryo of the Actinia, therefore, extracted artificially from the parent, may survive uninjured, and prove prolific.

Monstrosities.—Nearly the fortieth part of the 334 young produced by the specimen, Plate XLV., consisted of monstrous animals, the monstrosity being rather by redundance than defect. But the same proportion has not prevailed among other specimens: it has been smaller. Neither has it been as great among its own later offspring as among the earlier.

One was distinguished by two mouths of unequal dimensions in the same disc, environed by a profusion of tentacula. Each mouth fed independently of its fellow, and the whole system seemed to derive benefit from the repast of either. In three years this monster became a fine specimen: its numerous tentacula were disposed in four rows, whereas only three characterize the species; and the tubercles, of vivid purple, regular, and prominent, at that time amounted to twenty-eight. It had now produced twenty-eight young, having commenced breeding when between thirteen and fourteen months old. Many more issued from it afterwards, seven in one night, and fifteen in another. This double-mouthed Actinia survived within a month of five years.—Plate XLVII. fig. 3.

Another and more frequent kind of monstrosity, consists of two bodies united after various fashions, according to the specimen : or in their being sustained by one common base. This occurred in no less than four of the progeny of the specimen, Plate XLV.,—all produced within six weeks. Each body is then provided with its own external organs, sufficiently numerous ; and each having its own single mouth in the centre of its disc.

Of these four, one extracted from a tentaculum, became very vigorous, prolific in time, and it perished after surviving about three years : other two perished in the same manner, after proving prolific. The fourth, of similar conformation, was of fine red colour, but grew pale in a month, though afterwards acquiring the ordinary hue. A sensible disparity of size at first distinguished the two bodies, which diminished with age, rendering them of more equality. All blue parts were vivid in four months, and in six, the triple row of tentacula peculiar to the species, environed each disc of this monstrous specimen. It will be recollected, that there is originally only a single row, more or less numerous. Now, the colour was light, the circumferential ring of the base of beautiful blue. The tubercles were conspicuous, but neither large nor vivid. Embryos appeared long before maturity in the tentacula ;—the first of large size, and almost white, being produced when the creature was exactly a year old. In the course of three years, its progeny amounted to sixty. These were produced at very irregular intervals, and the disparity among them was great. Whether one of the bodies was more prolific than the other, could not be ascertained. Nor was an accurate account of the subsequent progeny preserved.

This animal survived ten years. It had become fine and vigorous when delineated at the age of six. Some green speckling of the skin continued visible in the course of the seventh year.—Plate XLVI. fig. 3.

A monstrous young Actinia, whereof the two bodies exhibited much disparity of size, was taken at Eyemouth, and it survived several years.—Plate XLVI. fig. 5.

Although the colour of the Actinia is not dependent on the season, it is subject to alteration, either from the state of the skin, or from other


9
3
2
6
11
10
4
1
5

causes. The aged specimen was rather reddish-brown when taken; it underwent successive modifications: and at that period, when I conclude it cannot be under thirty years old, it is rather of a dull greenish cast, the tubercles blue, the ring of the base narrow and faint.

From the facility of observation, and particularly from admitting the means of removal in general, by simply pouring the water off most specimens, from their feeding and breeding so readily, this species is peculiarly adapted for the study of the inquisitive naturalist.

Plate XLV. *Actinia mesembryanthemum*, or *Equina*: taken in 1828—delineated in October 1828. Produced 334 young. Still survives in 1848.

Plate XLVI. Fig. 1. *Actinia cerasum*, so denominated provisionally, as it may prove a variety of the *Actinia mesembryanthemum*.
2. Ciliated corpuscula or gemmules, from the tentacula of the specimen, Plate XLV.
3. Monstrous progeny of the specimen, Plate XLV., delineated when six years old. It survived ten years.
4. Specimen of the *Actinia cerasum*, taken in 1805.
5. Monstrous specimen, taken at Eyemouth.

Plate XLVII. Fig. 1. *Actinia mesembryanthemum*. Speckled skin of a young specimen.
2. Progeny of the specimen represented Plate XLV., produced in the seventeenth year of its captivity.
3. Monstrous *Actinia mesembryanthemum*, with two mouths, survived nearly five years.
4. *Actinia mesembryanthemum*, young extracted from a tentaculum; profile.
5. Disc of the same.
6. Disc, shewing the irregularity of the tentacula, enlarged.
7. The same animal when a year old.

§ 2. Actinia cerasum—*The Cherry Actinia*.—Pl. XLVI., XLVII. —I cannot affirm positively that the subject of this paragraph is a distinct species. Indeed, I am induced to conclude that it is a variety, though a very great one, of the former, the *Actinia mesembryanthemum*.

My reasons for doing so will appear in the course of the narrative. Having no theories to maintain, I give them freely, for I look no farther than to establish the truths of Nature. We know the wonderful diversity of aspect subsisting throughout the animal world, shewing only the difference of individuals, without subdividing either the genus or the species.

Therefore, to avoid precipitation, and that the observations of the more skilful may aid the solution of our embarrassments, let the name now given be accepted as provisional; and let the present paragraph be considered as an appendix to what has been already said of the Actinia. As such, it is an amplification, containing some novelties; if proving to relate to another subject, it will stand apart.

I have not seen any specimen of what is here provisionally denominated the *Actinia cerasum*, of equal size to those of the species *mesembryanthemum:* and its appearance is always more light and delicate. But mere appearances are so deceptive, and both dimensions and proportions so variable and dependent on accidental causes, that the greater reserve practised in regard to these, the less hazard of error.

There are some distinctions to be noted. 1. The native *Actinia cerasum* is always of fine red colour; sometimes of the richest and most vivid vermilion. 2. The tubercles, like so many beautiful pearls, are of the purest white. 3. There is no circumferential ring of the base, the under surface of which is itself red.

When expanded, it resembles a brilliant flower, unfolded to enjoy the sunshine.—Plate XLVI. fig. I. When contracted, it is like a fine ripe cherry.

These, I say, are the general features. But, without now entering more particularly on the subject, the analogies are so strong in other points to the *mesembryanthemum*, besides some obscurities requiring elucidation, as to render it expedient to be content with simple statements.

A specimen, previously referred to, taken at Blackness Castle, in the year 1805, though often neglected on account of repeated long or necessary absence, exhibited corpuscula in the tentacula, and produced young at distant intervals during its survivance, which was nearly six years.—Plate XLVI. fig. 4.

Another specimen of shorter survivance, afforded a series of continuous and satisfactory observations.

This, in very fine condition, was taken at Blackness Castle also, where some of these animals occur, affixed to stones of moderate size, therefore proving more manageable.

The tentacula were so numerous here, as to render it doubtful whether their disposal was in three or in four circular rows. The tubercles rising above the proportion of hemispheres, resembled most narrowly a circle of pearls set in some artificial ornament; but they were smaller comparatively than the wonted blue tubercles of the *Actinia mesembryanthemum.* No circumferential ring surrounded the base; yet the opposite sides of the mouth were faintly tinged blue.—Plate XLVI. fig. 1.

This specimen was very prolific, and chiefly in the earlier part of the year; all the young, with a single exception, being of a fine bright red colour. But this, which was of monstrous configuration, originally vivid as the others, became quite green subsequently, and continued so, thence affording good grounds for rating the parent only as a variety. The monstrosity consisted in the union of two bodies by the middle. Each had its peculiar organs in perfection, tentacula, mouth, and separate base. In six weeks, while still red, the specimen was scarcely as large as represented, Plate XLVI. fig. 6, its growth being slow. It had become pale-green when five months old, fig. 7. The lower part had a very singular appearance, its shape and the two bases being so different as they approached or receded from each other; also each was liable to be detached, whether from the base casting the skin or otherwise; and the bodies, besides separating far asunder, threatened the rupture of the connecting flesh, fig. 8. Both fed copiously, but neither did any speckling of the skin, nor any purple tinge, distinguish them. Let me remark in passing, that I could never distinguish any green speckling stain the skin of the *red* progeny of the *Actinia cerasum.*

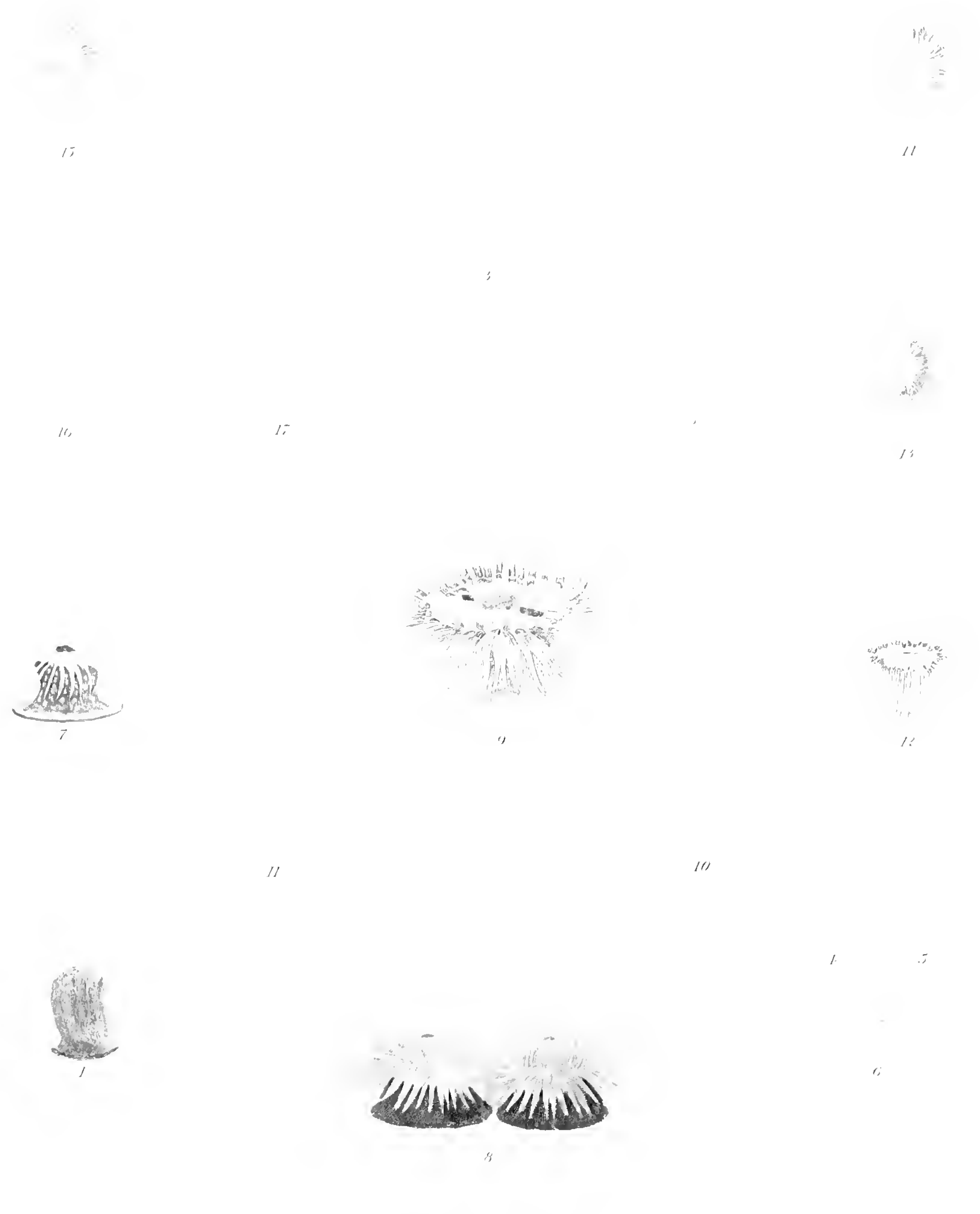
This monster was produced in the year 1835. Its first descendant, just when fourteen months old, was a small green Actinia, of its own colour. All its subsequent progeny, sufficiently numerous, were green, though sometimes very pale. On replenishing its vessel in July, a litter of no less than sixty small greenish young immediately followed; and in two months, another litter of forty-three, also green, augmented the number,—nor was the animal's fertility yet exhausted.

In three years and nine months this monstrous subject had attained ample dimensions.—Plate XLVII. fig. 8. But when about six years old, the vessel containing it having been too much replenished, one of the bodies rose over the edge; the connecting flesh was twisted, and as had been often threatened previously, it now rent asunder.

Each body being preserved as an independent animal, both adhered again by their respective bases to the vessel, but declined much in size. Nine months later they were washed over from the injudicious replenishment of the vessel, and one was lost. The other preserved never became large and vigorous; however it continued breeding. Its latest progeny appeared when it was seven years old, the young being still pale-green. The whole offspring of this monstrous specimen was nearly of the same hue.

Numerous corpuscula or gemmules are lodged in the tentacula of this species or variety with white tubercles, such as seen in the *Actinia mesembryanthemum.* Twenty could be enumerated in a single tentaculum. I did not neglect endeavouring to ascertain their nature, with the view of farther illustrations.

While endeavouring to sunder a tentaculum of the specimen, Plate XLVI. fig. 1, three were accidentally severed, which soon discharged twelve or fifteen corpuscula, of great disparity in size and conformation: all opaque and solid, tended to irregular rotundity. One might be the fifth of a line, or the sixtieth part of an inch in diameter, and some quadruple the size of others. It is impossible to convey a correct impression of the shape, motion, or peculiarities of these creatures by description. Some were cubical, or of cushion form, with very obtuse angles, others enlarged by encircling protuberances, Plate XLVI. fig. 9. Two were still more remarkable, unlike any that I had ever seen. A short cylinder, resembling a funnel, projected from each, fig. 10. One of them continued revolving horizontally while the funnel was downward, the other tumbled over frequently in the water. Their motion was moderate, and although all such



Actinia

animals are provided with cilia, the specific gravity of both seemed to counteract their exertions in swimming.

A few corpuscula, alike irregular and mutable, appeared occasionally in the vessel. None could be preserved permanently.

The parent of these corpuscula, as also of many young, and, among others, of the monster, proving so prolific, survived two years and two months under observation, when it died.

The young of one of the most beautiful specimens I have ever had, which was about half grown, was of the finest vermilion, equally vivid as itself, and of remarkable size.

The red becomes duller with age, but I have not observed any adult converted to green.

Some districts seem to abound more than others with such florid Actiniæ. They are found in all parts of Scotland.

On the whole, I am disposed to view the red Actinia with white tubercles, as a variety of the Mesembryanthemum.

§ 3. Actinia gemmacea—crassicornis.—Plate XLVIII. Figs. 1, 2.—This is the largest Actinia in the Scotish seas, unless some specimens of the *Dianthus* or *Plumosa*, may rival it in size; and it is one of the most abundant.

Perhaps it appears in equal variety as any other,—so great, indeed, that I doubt whether some of those now named as of the species, might not be separated, or at least distinguished as varieties.

Every different naturalist seems to have given this animal a different name, which is well exposed in Dr Johnston's useful and laborious work. If similar contributions be wanting here, let me repeat, it is because that has been already done so efficiently, and because every thing described is now represented from living specimens.

The *Actinia gemmacea* rises at least four inches high, and expands somewhat more between the opposite tips of the tentacula. These have much appearance of distribution in four rows, and of standing there in alternate arrangement, so that of two lines radiating in the same direction from the centre of the disc, one would pass through a tentaculum of the first and third row, to reach the circumference; and the other through the next in the second and fourth. Yet, there may be, in fact, only three rows, as is more probable, for it is not easy to determine parts, proportions, and positions, liable to incessant modification and change. These organs are comparatively short, stout, and very obtuse, more so than those of any other species I am acquainted with.—Plate XLVIII. fig. 1. In some, which I cannot remove from the species, they are longer, more slender and delicate, and that especially, as I have thought, in specimens of uniform colour. Numerous tubercular prominences, in perpendicular rows, resembling low blisters, with an adhesive faculty, cover the skin of larger specimens, which are thence profusely invested by grains of sand, fragments of shells, and the like.

No species is equally diversified in colour and aspect. Red is usually predominant: It is so among nine-tenths of the other kinds, and sometimes universal of a specimen. The surface of many is variegated red and white, like a rose; or with orange, green, and yellow intermixed. One occurred almost totally white; another wholly primrose-yellow, with scanty transverse red streaks, interspersed around the lower portion; the base, of dull yellowish-brown; and a reddish patch was on the upper part of the distended tentacula. In numerous specimens these organs are red, belted with pale colour, almost white; and the base is occasionally finely variegated. It may be truly affirmed, that the diversities baffle enumeration and description.

This Actinia is often a beautiful, though a coarse looking animal.

The skin is not cast in nearly the same quantities as by the *mesembryanthemum*. But eversion of the stomach is not uncommon. It seems incident to the species. A large specimen sometimes distends itself with water: eversion of the stomach soon follows, after which the animal generally dies without recovering its natural form.

Numerous spiral white filaments are seen near the bottom of the stomach, the use of which is not sufficiently understood. They seem tubular, but having seen an instance of one, in particular, protruding and spreading up the side of a glass vessel, until expanded as a thin membrane, an inch broad, probably the tubular appearance is derived from approximation of the edges.

If a vessel containing a turgid healthy specimen, be suddenly emptied, strong jets of water issue, an inch or two in height, from the extremities of the tentacula; as well as from orifices among the tubercles in the higher parts of the body.

This species dwells at half-tide in crevices of the rocks, or adhering to stones of moderate dimensions, buried in the sand, amidst which it sinks down on recess of the sea. It is also found in deeper water, frequently affixed to the larger shells, from which it cannot be detached without difficulty, though some are induced to separate from impurity of the element. In captivity, care must be observed to select a suitable vessel for its reception, as specimens usually take possession of the angular part at the bottom, where they adhere most pertinaciously, for a very long time, and from which it is impossible to dislodge them. The most convenient method of preservation, seems to be laying the animal, when the base is free, in a glass vessel, an inch deep and three inches wide, for large specimens. By immersing this in a glass jar, four or five inches wide, and six or eight deep, the subjects will be always accessible on pouring off the water by which the jar is replenished, as they do not shift their position.

This species is not so easily preserved as the *mesembryanthemum*: it is alike voracious, and its position among the Crustacea straggling over the shore, renders it a terrible and ferocious destroyer.

Plate XLVIII. Fig. 1. *Actinia gemmacea.*
2. Younger specimen.

§ 4. Actinia elegans.—Plate XLVII. Figs. 9, 10, 11.—This is one of the most beautiful and elegant of the whole tribe of Actiniæ, which I am unable to identify with any of those described by preceding authors. If otherwise, the correct representation offered here, together with some peculiarities, will enable the learned to correct my error.

This elegant animal rises about fifteen lines in height, and expands above two inches, between the tips of the opposite tentacula, which are long, taper to a point, and are disposed in three rows. The mouth in the centre of the disc, is distinguished by a number of, even thirty, prominent internal flutings, probably variable, from the faculty of modifying them. For the most part, the body is of reddish-brown or orange colour, the upper part spotted white. The tentacula are belted black and reddish alternately, from the root upwards; and a broad white line generally runs across the disc.

This is a very beautiful animal.

When suffering pressure, or any annoyance, long, slender, white filaments protrude from all parts of the body; and when the water is poured off, they issue from the mouth. I know that some naturalists have assigned certain characters to similar cords or filaments protruding from other species. But it seems extremely doubtful whether any accurate theory is yet entertained on the subject.

The Actiniæ of this species are strictly nocturnal; they are impatient of light, and prone to contract during the day. In common with their race, their size diminishes with confinement; and in exuviation they cast off a quantity of greenish skin.

Specimens have survived three years in my possession, without producing living young. Thus the nature of their offspring is uncertain.

Two days after three of these Actiniæ had fed on mussel, a multitude of minute, dingy yellowish, homogeneous, flattened, ovoidal corpuscula, lay motionless in the vessel containing them. Numbers produced subsequently, were swimming actively a few days later, on the 2d of October, chiefly below. They were apparently soft, of faint yellowish-green colour, some of ovoidal, or flattened ovoidal shape: some with a long transparent-like horn in front, visible chiefly as the animal pursued a steady, horizontal course. The body of some was rather truncate; that of others resembled a thick hollow skin: one with the long projection seemed open behind like a cap. Many could not be the subject of comparison to any familiar figure. Considerable disparity of size prevailed, and the softness of the body was evident from the alteration of its proportions.

These corpuscula were visible during the whole month of October. Though carefully preserved, they afforded no definite result.

This Actinia seems to inhabit deep water.

PLATE XLVII. FIG. 9. *Actinia elegans.*
10. Corpuscula from the same, enlarged.
11. Other corpuscula, a group delineated in October, enlarged.

§ 5. Actinia explorator.—*The Searching Actinia.*—Plate XLVI. Fig. 11.—The aspect of individuals belonging to the same species of the Actinia, is diversified in such an extraordinary manner, as at one time induced me to conjecture, that, notwithstanding the colour and dimensions of the present subject, it might be a variety of the last, the *Actinia elegans.* But nothing has corroborated the fact; neither can I identify it with preceding descriptions.

In as far as I have observed, the *Actinia explorator* is entirely littoral,—dwelling chiefly in the crevices of rocks, covered by the flowing tide, or protected among stones which are not likely to be disturbed.

The largest specimens rise about two inches high, and expand nearly as much between the opposite tips of the tentacula, which are about half an inch long, and disposed in a triple row. The body is quite smooth. Both it and the base are dingy white: the disc mottled grey, produced by the alternation of lighter and darker ellipses, in singular and beautiful arrangement; and the tentacula are belted with black.—Plate XLVI. fig. 11.

Probably this animal is of various shades, from dingy white to liver-brown, at least I have been led to associate it with specimens found in different parts of the Scotish seas. Some of these were sent to me from the west, by Sir Walter C. Trevelyan, Baronet, a gentleman much and usefully devoted to literary and scientific pursuits.

A remarkable property of this species is the spontaneous enlargement of one or more of the tentacula to an immoderate size above the rest, such as I have not observed incidental to any other of the tribe. The first time it occurred being at night, I conjectured that either some unusual organ was protruding, or that a worm was involved among the tentacula—both alike improbable. Several years afterwards, the fact was confirmed by new observations.

A small specimen, not exceeding half an inch in diameter, exhibited two tentacula, both enlarged at once to an inch and three quarters in length, whereas the tentacula of the largest specimens do not extend above one-third as much, in their natural proportions.

During this state, the tentacula are extremely flexible, waving from side to side, and evincing motions quite different from the common tentacular action.

It is generally, though not invariably, at night, that a single tentaculum shews this remarkable change. From its ordinary extent of about half an inch, it enlarges to gigantic dimensions, sometimes becoming four times as long, greatly thicker than usual, and distended to transparency. It is then seen rising from among the rest, curving over to the opposite side of the disc, and as if searching around. Thus it continues for a certain period, when it is reduced to its wonted dimensions, like the remainder.

None of the Scotish Actiniæ, one excepted, have tentacula equal to those now described. That species is said to want the faculty of withdrawing them when extended, of which I have never had a specimen sufficiently vigorous to enable me to judge. But from those falling into my possession, they seem to exceed the size of the tentacula of the present species.

The species now named *explorator*, is prolific. Above sixty young were produced during the course of a night, in a vessel containing two small specimens. The young are usually pure white, and large in proportion to the parent.

Perhaps these animals breed throughout a considerable portion of the year.

The *Actinia explorator* is strictly of nocturnal habits. It stretches itself up so as to become as tall as possible at night, which perhaps indicates its natural abode, as deep in the crevices of the rocks, from whence it rises for opportunities of capturing its prey.

PLATE XLVI. FIG. 11. *Actinia explorator.*

§ 6. ACTINIA LACERATA—*The Ragged Actinia.*—PLATE XLVII. FIGS. 12, 13, 14, 15, 16, 17.—Amidst the numerous embarrassments obstructing the discrimination of species and varieties of the Actinia, it is fortunate to meet certain immutable features, so prominent as to distinguish some of them, so definitely from all others, as to leave no liability to error.

Actinia

The subject of this paragraph, rises about an inch in height; and the distance between the opposite tips of the tentacula somewhat exceeds two inches. The specimen selected for representation rose nine lines; it was less in diameter, and provided with between seventy and eighty long tentacula, disposed in a triple row, the innermost consisting of only eighteen The body of the animal is universally of gallstone yellow; short white lines descend from the external roots of the tentacula to the base. A double belt of faint brown encircles the tentacula, which are longer in proportion than those of any other species I am acquainted with. Their recurvature, and the contrasting colours of the body, render this Actinia an interesting object.—Plate XLVII. fig. 12.

When these organs are retracted, the animal is flattened down as thin as a card, the surface resembling a star, with forty or fifty white lines radiating from the centre.

This is a timid creature, very impatient of the light, contracting hastily on exposure to it; and remaining long in that state. But it displays itself at night, seldom appearing earlier, and then stretches itself as high as possible.

It does not feed readily, and exuviation seems to be continually going on.

Perpetuation.—Regarding this subject a remarkable analogy seems to subsist, though after a different form, between the propagation of the *Actinia lacerata* and that of the hydra, whose history has been already so copiously illustrated.

When specimens stretch as much as they can at night, it may be called their active state. When contracted, thin, and flattened, they are in a passive state, and it is then that the configuration of the base is exposed.

Whether, as in some other Actiniæ, the young be ever produced by the mouth, I cannot affirm. The observer, without ocular demonstration of the fact, may be here betrayed into error, for he will frequently find small vascular specimens along with adults. But, during a large portion of the year, particularly in August and September, nor perhaps excluding any month, the great irregularity of the base of adults cannot escape his notice. It is unequal and ragged to the eye, though all the other parts be regular, smooth, and even.

This irregularity, at first hardly sensible, and requiring a lens to discover it, gradually increases more distinctly, becoming such as delineated of a specimen on September 3.—Plate XLVII. fig. 13. Next we behold diminutive fragments of the margin separating, which consist of the elements of embryo Actiniæ, consolidated there, and developed into independent existence, as seen in fig. 14, fourteen days subsequent to the preceding representation. But the rapid progress of the subject now produces such an alteration, that in a single day two originating Actiniæ unfolded their external organs, and besides these, a multitude of fragments was advancing.—Fig. 15.

Thus, an uncommon mode of propagation is effected, by the spontaneous separation of fragments from the margin of the base of the parent Actinia, each containing the elements of its progeny, and by progressive evolution unfolding as a new animal.

But a considerable interval elapses during this generative process. The marginal irregularity of the base consists in the incipient separation of various solid parts, whose connection with it is about to be dissolved. Here let the reader recollect what has been said of the separation of the young pullulating from the body of the *Hydra tuba*. He will find nearly the same general principles now in operation. The fragments of the Actinia withdraw gradually from the base, though still connected by a ligament, continually refining with its extension. This ligament is elevated somewhat above that part of the surface of the vessel interposed between the parent and the young. Not lying flat on the glass, it belongs rather to the side than to the under surface of the base of the parent.

In proportion to the progress of the embryo, and the maturity of the young, the ligament is prolonged and attenuated, fig. 16, until connection with the parent is entirely dissolved by its rupture.

It is not quite obvious how the prolongation is effected, unless by contraction of the basis, and recession of the fragment from the point it originally occupied. The basis becomes quite ragged and disfigured by the separation of many fragments.

Among the fragments themselves there is no uniformity, but considerable disparity of shape and dimensions. Some are rudely triangular, rudely elliptical, or otherwise, but always moulding into due form and proportion with the advancing evolution of the young animal. At length the ligament ruptures, and leaves the new Actinia to enjoy its independent existence.

The fragments are not detached from around the base in regular order, but from some part where it is unequal ; thence the size of the base is not regularly reduced.

From what has been said, it will appear that perpetuation of the race of this species of the Actinia may be probably identified with gemmation. I have never been able to detect any preformation of the embryo in the flesh of the margin of the base or its inequalities, either by inspection or microscopical observation. But it is generated thence after a fashion certainly presenting a near analogy to the gemmation of the embryo and advance of the young of the *Hydra tuba*, to the connection by a ligament with the parent, and to the rupture of that ligament on attaining sufficient maturity. All the irregularities seen in the one are witnessed in the other, and many points of correspondence.

These facts will go far to prove the kindred of the Actinia and the polypus.

The *Actinia lacerata* is prolific. A specimen obtained in the latter part of November lost a large fragment, rather elliptical, from the base, on December 12. Besides this, eight fragments were found on March 12. to have separated subsequently, wherein the organs of some of the young animals were in display. The number had increased to twenty on April 16, and to thirty on May 12, when all were removed from the vessel containing the parent. The young thus removed were replaced by a new generation, amounting to seven, on July 16, which were shifted as the others from the vessel. But this being the season of multiplication, the margin of the parent's base had thickened in various parts, so as leave a rude resemblance to an irregular string of beads towards the end of July. So evident a prelude to evolution, was followed by the production of twenty young within a month, and of as many more in three months;

therefore, according to the nearest computation, above seventy young were evolved and detached from the base of the parent in the course of a year.

At a certain stage the young of this species appears vascular, elongated, and transparent, or nearly white. The internal structure is well exposed, shewing the stomach as moulded to the form of whatever may be the contents which have been absorbed, while the orifice contracts and closes over them. The tentacula, still very short, remain distended. On adhesion the preternatural elongation is lost: but the young Actiniæ continue for a long time free.

Many of the brood appear monstrous originally. Permanent monstrosities, however, are rare. Among numbers, only a single individual had two discs crowning one body,—and the double disc of another was separated by a shallow cleft.

Apparent monstrosity seems peculiarly incident to the young of this species. Many set apart by me in that belief, invariably became symmetrical. Seven or eight young were produced by the specimen fig. 12. fifteen months after it came into my possession, and a number subsequently. One of the young, which at first appeared monstrous, became gradually symmetrical. In twenty weeks it was three lines high. It was vigorous and beautiful in thirty-five weeks, resembling a minute pillar, with the capital and base twice the diameter of the shaft. Twenty-seven slender, delicate, blue tentacula, spread an inch between the opposite tips. The disc always convex, was of a fine deep orange colour. At nine months old it began to breed by losing portions of the base; and its progeny amounted to forty in eighty days.

The preceding is the only definite mode of propagation I have witnessed, though sedulous attention has not been wanting to discover whether there might not be some other. In three successive years a number of white or grey spherules appeared from adults on July 25, 26, 27 respectively, which speedily decomposed notwithstanding my precautions to preserve them.—Plate XLVII. fig. 17.

If some specimens, such as that represented fig. 12, have survived above three years in my possession without perpetuating their race by any other method than mutilation of the base, that I could discover, I am induced to conclude that the vascular young found in the same vessel, have originated unobserved from the same source.

The adult seldom shifts its position; it continues adhering many months to the same spot, therefore, although profuse exuviation of the upper parts takes place, probably very little skin separates from the under surface.

When the water proves vitiated, this Actinia, instead of closing itself up, or endeavouring to escape by quitting its place, merely stretches itself as high as possible to shun the deleterious influence of the surround-medium.

PLATE XLVII. FIG. 12. *Actinia lacerata*, the Ragged Actinia, adult.
13. Embryonic fragments separating spontaneously from the margin of the base, September 1.
14. The same farther advanced, September 17.
15. The same, September 18.
16. A portion of the base from which embryonic fragments are withdrawing, but still connected by a ligament.
17. Corpuscula or gemmules produced in July, enlarged.

§ 7. ACTINIA MACULATA—*The Spotted Actinia.*—PLATE XLVIII. FIGS. 3, 4, 5.—All the preceding Actiniæ have a general correspondence in external shape, and it may be in general habits. When completely displayed they rise as a cylinder, with a summit of expanded tentacula, and an expanded base, both of more ample diameter than the body. But the form of the present subject presents considerable difference, and its habits, with its natural abode, seem to be also somewhat different.

I have never seen the *Actinia maculata* but of a flattened figure, even when displayed, and much more so than is incident to the others, for it will be recollected that the flattening of the *Actinia lacerata* is consequent on the contraction of all its parts. The favourite position of the present subject is to remain permanently seated on the same shells that are usually occupied by the hermit crab, with which the Actinia must be carried about in its excursions. The base spreads over the surface, so as to be accommodated to the curvatures of the shell, which may contribute to the security of its adhesion.

The body of the *Actinia maculata* is yellowish, of various intensity, according to the specimen, speckled with vivid purple. The tentacula are very numerous, proportionally small and slender, arranged in a triple row, and the exterior of the root surrounded by a narrow purple ring.

On the slightest shock, long slender filaments, either white or purple, according to the specimen, issue through obscure low papillæ on the surface of the skin.

The aspect of this Actinia is much affected by its position. If its nature be to invest a convex surface, one which is flat may be less congenial. Thus the specimen, Plate XLVIII. fig. 3, which is seen there as seated on the shell of a hermit crab, having detached itself, diffused the base on the bottom of a glass vessel, not unlike the wings of a butterfly, fig. 4. But until the animal adheres, the basis remains a long time with its whole under surface merely folded together.

Specimens feed readily on such substances as Actiniæ usually receive. All are very greedy of worms.

Thousands of minute opaque bright-yellow spherules are produced by these animals in July, August, September, and October. Several hundreds, or greater numbers, appear at once; and the same Actinia has produced them repeatedly. But, spite of careful preservation, nothing satisfactory resulted, fig. 5.

All the colours of this Actinia, one of the most beautiful and picturesque of the tribe, are revived, and become much more vivid on renewal of water recent from the sea.

Naturalists speak of a horny membrane, or expansion of the skin, over the shell, to which the Actinia affixes itself; but this seems to be only its own skin, which may be thickened or consolidated under some circumstances, by a certain secretion from the body. I have not seen it otherwise than quite flexible and fragile.

I have been indebted to Sir Walter C. Trevelyan, Baronet, for some fine specimens from the Island of Arran.

Plate XLVIII. Fig. 3. *Actinia maculata* seated on a shell occupied by the Hermit Crab.

4. The same specimen, having quitted its original position, and now adhering to the bottom of a glass vessel.

5. Vivid yellow spherules, as produced by the *Actinia maculata*, enlarged.

§ 8. Actinia dianthus—plumosa.—Plate XLIX.—Of all the Actiniæ inhabiting the Scotish seas, the species about to be described is probably the largest, and certainly it is the most beautiful. The Gemmacea alone may rival its size.

Naturalists in general are too inattentive to the condition of the animals on which they offer their comments, and the qualifications of the artists they employ, for too many delineations are insufficient and unsatisfactory, whence much embarrassment results to their fellow-students, and infinite obstruction to the progress of science. Doubts of identity are excited, synonyms are endlessly multiplied, and unnecessary discussions ensue, which would be all repressed by faithful representation of such an animal as is the subject of this paragraph, for no correct impression can be otherwise imparted of the peculiarities of its form and aspect. To submit the figure of that animated being which the author describes to the reader, cannot but be an indispensable introduction to all commentary on its nature.

The *Actinia dianthus* or *plumosa*, which latter should be deemed its more expressive name, rises at least six inches high; the head or disc expands quite five inches, and the portion or pillar under it is three in diameter. This latter, which is properly the middle part of all Actiniæ, is not much dissimilar from the corresponding portion of the others already described; but the higher is entirely different, being of such appearance and character as are difficult to be explained in words, or to be understoood, without ocular inspection.

The mouth occupies the centre of the disc as usual. It is prominently fluted, and environed by a row of tentacula rising from the surface of the disc along with some others, and at some distance. Towards what may be called the exterior of the margin, the disc subdivides into an indefinite number of five or more lobes or compartments, whereof all the marginal curvatures are fringed by a triple row, composed of shorter tentacula, giving the whole a luxuriant and agreeable plumose aspect. These marginal tentacula, encircled by a ring, are of much smaller dimensions than the others.

One great peculiarity of the species consists in a kind of shoulder or slight enlargement of the highest part of the body, with a smooth, lighter, and more transparent skin extending from the body to the disc. It is of a different texture from the rest, and from the ordinary surface of most Actiniæ. The head or disc unfolds from this skin, as from a sheath.

Remarkable diversity of colour is incident to the *Actinia plumosa*, in no respect depending on its dimensions, or on the seasons. It occurs of snowy white, of peach-blossom, lemon-yellow, orpiment-orange, and the like; but it is equally beautiful under every hue.

The observer, however, may be greatly deluded by the aspect of younger animals; and I acknowledge that previous to more intimate acquaintance with the nature of this Actinia, I was led to consider the young and the adult as belonging to different species.

The skin, also, is always separating profusely, especially when specimens are sickly, which much affects the colour.

Long slender filaments issue through the sides of the *Actinia plumosa*, as from some of the others before described.

The adult has the faculty of altering the number of lobes or compartments forming the plumose margin of the disc; and it is from this that naturalists seldom coincide in their account of them. But the young have merely a great abundance of tentacula, bordering the circular disc, which at an early stage exhibits no divisions. The evolution of the higher portion, as from a sheath, together with the peculiar character of the intermediate skin, are quite decided.—Plate XLVIII. fig. 6. A monstrous young *Actinia plumosa*, consisting of two separate discs, each with its peculiar set of tentacula, as belonging to earlier age, demonstrated the same features, fig. 7.

A surprising accession to the number of these organs ensues with time and increment. On gross computation, I found that a fine lemon-yellow large specimen expanding completely five inches, with a vivid orange, fluted mouth, could not have under a thousand tentacula: its luxuriant aspect is indescribable.

Corpuscula or gemmules tumbling over in their motions amidst a fluid, are seen in the distended tentacula, as in other species, but I have never seen either these or the young in their earlier stage.

The adult seems to dwell in deep water; but I have observed some of smaller size, affixed like so many white nipples to the roof of rocky cavities situated at about half tide, of which the larger expanded an inch and a half when removed.

Specimens of different colour, whether or not of the same kindred, are occasionally associated together; and one of large size is sometimes surrounded by a number of Actiniæ, as if its offspring. Of four specimens obtained at the same time, one was pure white, the others of three different shades of orange.

On a different occasion, two fine, large, beautiful specimens, were seated on the back of a living crab, almost entirely covering the surface: the smaller of the two is represented in Plate XLIX. Though the shell extended seven inches, it was surprising to me how the crab could exist, or govern its motions, under so cumbrous a load. It died, indeed. but possibly from some previous maltreatment consequent on its capture: when no little contrivance was necessary to separate the Actinia for preservation.

These Actinæ shift their position spontaneously, but no treatment whatever can induce them to do so. A fine and ample specimen being seated on a stone too large for reception in any of my glass vessels, I laid it over the mouth of a wide jar, eight inches high, expecting that the animal would detach itself and drop down within. It extended gradually indeed, stretching far, but at last the body, very strong in appearance, ruptured asunder close to the base: to preserve it was impossible.

A vast proportion of the body is vascular, and the skin is extremely thin and dilatable.

This species is less hardy than most of the tribe; some specimens have survived during several months.

PLATE XLIX. *Actinia dianthus* or *plumosa*.

PLATE XLVIII. FIG. 6. Young specimen of the same.
7. Monstrous specimen.

The preceding detail does not comprehend an account of the whole Actiniæ that have fallen under my observation. Of this animal it may be truly said, that none is better adapted for protracted study. The natural vigour of most individuals, their promiscuous appetite, their tenacity of life, together with its uncommon duration, unite them with those living beings from which the physiologist may more readily advance his knowledge, than from almost any of the other animated works of the creation. He has neither to contend with the obstacles opposed by minuteness or delicacy, nor is his progress liable to be obstructed by the rarity of subjects.

It may be deduced from what has been so copiously said, along with many examples which are not specified here, that,

I. Considerable resemblance subsists between the nature of the Actinia and the Hydra proper, as also with the *Hydra tuba*, or *Strobila* of the sea.

II. Its senses are extremely obtuse, and its instincts scarcely demonstrated.

III. It feeds voraciously on almost every animal substance, absorbing smaller portions into its system, and rejecting the residue of larger portions as a ball by the mouth.

IV. It enjoys a vigorous reproductive faculty, whereby immoderate wounds and lacerations heal, and lost parts are restored.

V. It propagates by two distinct fashions, as seen in different species, between which there is no obvious immediate analogy.

(1.) By gemmules generated internally, which appear moving in the tentacula, whither the parent can introduce or transfer them, and from whence they can be withdrawn; and when matured as young, they are produced by the mouth.

(2.) By solid fragments separating from the margin of the base, which are shapeless at first, and are next developed into perfect animals.

Actinia Plumosa

VI. When in the gemmule or corpuscular state, the offspring is ciliated, and endowed with the faculty of rapid motion. In metamorphosing to the fœtal state the cilia are lost, and as the young Actinia is evolved, its tentacula appear, and it affixes by the base.

VII. Certain species of the Actinia may survive during thirty years.

EXPLANATION OF THE PLATES.

PLATE XLV.—*Actinia mesembryanthemum* as delineated October 1. 1828, which still survives in 1848, after having been about twenty years in captivity, and is conjectured to be scarcely less than thirty years old.

PLATE XLVI. FIG. 1. *Actinia cerasum*, adult, conjectured a variety of the Mesembryanthemum.

2. Ciliated gemmules from the tentacula of the subject, Plate XLV.
3. Monstrous progeny of the same subject.
4. Monstrous specimen taken at Eyemouth.
5. *Actinia cerasum* taken at Blackness Castle in 1805.
6. Monstrous specimen produced by fig. 1.
7. The same farther advanced, being five months old.
8. Monstrous bases of its two bodies.
9. Ciliated gemmules from the tentacula of fig. 1.
10. Other ciliated gemmules from the tentacula of fig. 1.
11. *Actinia explorator*.

PLATE XLVII. FIG. 1. Speckled skin of the young *Actinia mesembryanthemum*.

2. Young Actinia produced by the specimen Plate XLV. in the seventeenth year of its captivity.
3. Monstrous disc of a specimen having two mouths.
4. Young *Actinia mesembryanthemum* artificially extracted from a tentaculum, profile.
5. The same, front.
6. The same, shewing the irregularity of the parts, which subsequently became symmetrical; front enlarged.
7. The same young when a year old. Part of the tentacula omitted, to shew the form and dimensions more distinctly.

PLATE XLVII. FIG. 8. Monstrous Actinia (being the same as Plate XLVI. figs. 6, 7, 8), represented when three years and nine months old (p. 222).

9. *Actinia elegans.*

10. 11. Spherules or gemmules from the same, enlarged.

12. *Actinia lacerata.*

13. Embryonic fragments separating from the base of a specimen, September 1.

14. The same as on September 17.

15. The same as on September 18.

16. Portions receding, still connected by a ligament.

17. Corpuscula or gemmules from an adult, enlarged.

PLATE XLVIII. FIG. 1. *Actinia gemmacea*, adult.

2. Younger specimen.

3. *Actinia maculata*, seated on a shell occupied by a Hermit Crab.

4. The same, having quitted the shell, and affixed itself to the bottom of a glass vessel.

5. Spherules produced by the *Actinia maculata*, enlarged.

6. *Actinia plumosa*, young.

7. *Actinia plumosa*, monstrous, young.

PLATE XLIX. *Actinia plumosa*, adult.

CHAPTER XI.

MISCELLANEOUS SUPPLEMENTARY OBSERVATIONS.

THE introduction of a few additional illustrations, derived from several subjects of the preceding comments, will prove a competent corroboration of their nature. They are merely accessories, it is true, but not the less useful as such, where we must avail ourselves of many feebler auxiliaries in establishing the facts of history.

Long researches and anxious study at one time unavailing, are suddenly and easily satisfied at another—affording the more encouragement to steady perseverance.

1. HYDRA TUBA, Vol. I. Chapter III. § 1. p. 76.—PLATE XX. FIGS. 6, 7, 20, 21, 22.—Vol. II. PLATE L.—Notwithstanding what has been already so copiously said on the subject, the history of this animal, and indeed of all the Medusarian tribe, is involved in the greatest obscurity, so great, that I believe we must trust as much to accident as to industry for the requisite illustrations. Neither can any hope be entertained of procuring such as shall be intelligible, without embellishing the fruits of farther research by correct delineations. Nearly the whole which have been hitherto presented, at least which have fallen under my cognizance, are either erroneous, or not to be readily comprehended.

The subject, however, we shall allow, is one of much difficulty; it demands an uncommon store of patience, and a wide range of opportunity. But fragment after fragment, contributed from all quarters where observation may be made, and the matter attentively prosecuted, will accomplish most of what is desirable in the end.

My own remarks, though deduced from practical experience, are offered with considerable reluctance, nor can I feel otherwise than diffident, from conscious inability to decide whether the animals were in a permanent or only in a transient state.

The metamorphoses undergone, especially by marine products, are so extraordinary, that, without having beheld them under their different phases, due reserve ought to guide us, both in regard to what may be seen by ourselves, and as to what may be affirmed as having been seen by others.

Recurring to the earlier portion of this work, it is there explained, that a peculiar roll appears on the disc of the *Hydra tuba* in the course of spring, which, advancing from an imperfect state originally, at length resolves into a number of minute Medusæ.

Though hundreds of these minute Medusæ, such as above described, have been thus bred in my possession, and have committed themselves to the surrounding element, as the roll pendent from the hydra gradually dissolved, the survivance of none of the whole exceeded sixty days; nor, in the course of that time, did the smallest sensible change ensue, either by organic increment, or the evolution of additional parts. They perished in the precise state wherein they were first recognised.

I have not heard that any other naturalist has been more fortunate,—that he has succeeded in preserving those component portions of the medusan roll under uninterrupted observation until some farther evolution, alteration, and increment, admitted their identification with adult animals.

If this has been actually done, my ignorance of it must plead an apology for protracting the narrative. I have observed it affirmed, it is true, that older and larger Medusæ are the adults of the younger and smaller tribe now referred to. But I have not seen any demonstration of the facts, possibly owing to my very limited sphere of information.

Recurring to the subject discussed in Vol. I. p. 127, and in relative passages, it will be remembered, that after an embryonic roll generated on the disc of the hydra advances, all the tentacula disappear, and that the dissolution of the roll succeeds by the successive liberation of minute Medusæ composing it: that a smooth, fleshy bulb or fragment, nevertheless re-

mains behind, which, instead of becoming a Medusa like the rest, is gradually evolved as a perfect *Hydra tuba*, with a suitable complement of tentacula.

It seems from the preceding passages, that a hydra undergoing the changes which take place in spring, was recovered from the sea affixed to a large shell, a *pecten*, along with many others, on March 21; that the individuals of a medusan roll generated there were advancing to maturity on March 27, and that all had been liberated by the 5th of April.

Had this medusan roll been affixed immediately to the shell, the spot which it occupied would have remained bare, but the elementary, smooth, fleshy bulb intercepting it, which is not dissolved like the rest, had attained the general shape of a hydra on March 27, with tentacula then extending, Vol. I., Plate XX. figs. 6, 7; its form was subsequently perfected, as seen fig. 20, and progeny generated by gemmation is represented figs. 21, 22.

We had left it there; but considering the importance of prosecuting the history of this elementary bulb still farther, I followed its progress with the utmost care.

The form being then developed as a perfect hydra, I did expect to see the nature of its race displayed on return of the accustomed season, especially as the gemmation of the young seemed to prove its integrity—that it was quite entire in all respects.

The faculty of perpetuating the kind seems commonly reserved by nature as a test of the maturity of the parent in almost every tribe, that maturity being determined in general by the age or the size of the individual.

But the *Hydra tuba* apparently affords a remarkable exception, in so far that it is not shewn to be dependent on age or dimensions that young are developed from the parent: nor is it shewn by any authentic observation at what precise period of the animal's existence the medusan roll, presuming that to be the progeny, is generated.

The fleshy bulb having become a hydra, its offspring amounted to seven in 125 days from liberation of the Medusa, Vol. II., Plate L. fig. 1: the young are omitted. It fed copiously, and became of a fine yellow colour, and had enlarged considerably above its original dimensions; eight of its progeny also surrounded this hydra when it had survived 237 days as an independent animal, fig. 2.

On January 17, a favourable view enabled me to ascertain that its long, flowing, silky tentacula, amounted to sixteen.

From its increasing dimensions and fine condition, I was induced to expect early promise of the medusan roll. Prominent indications of progeny appeared on February 7, fig. 3, which were stronger in a fortnight by the germination of three young hydra with originating tentacula, fig. 4, whereby and the preceding figure the individual is seen singly, but slightly exceeding nature.

The proper breeding season was now passing away. The animal had been fed abundantly, and very carefully treated; it had grown much, and was in great vigour. But my expectations of the medusan roll were utterly disappointed—nothing of the kind ensued. Progeny continued to germinate from the side without the smallest semblance of Medusæ on the disc. Many of the same original colony affording this specimen had been also preserved, though none of them treated with equal care; in respect to which also, the season elapsed without the metamorphosis of any.

On April 11, above a year from liberation of the Medusæ, the subject of this notice, with four of its germinating young, and surrounded by fourteen free, is represented fig. 5.

Thus it appeared that the metamorphosis of a hydra developing from a bulb, which had been the site of a roll dissolving in Medusæ, did not necessarily contribute to the formation and resolution of the like on arrival of the proper season in the following year.

Neither was it proved that the hydra having once undergone such a metamorphosis underwent it again: which was in conformity with the inference previously deduced from colonies and their descendants having remained for years unchanged.

A fellow naturalist, residing at about the distance of 200 miles, having acquainted me that a colony of hydræ, whereon he was engaged, had perished accidentally, thus interrupting his progress, I hastened to supply the loss. The *pecten*, originally bearing about 110 hydræ, was now broke down, and one of the pieces, with a sufficient number, being dispatched by a public conveyance for him, reached the place of its destination in safety, just at the date of the drawing, fig. 5.

In a year and nine months from the date of acquiring the *pecten*, I grossly computed that fifty hydræ, old and young, yet remained on the principal portion of it. Many had been there from the first, and, no doubt, about that time, several had lost the medusan rolls. But neither they, nor those on a smaller portion reserved, manifested any symptoms of metamorphosis on expiry of the year, that is, on arrival of the second season: nor has the naturalist above specified signified that Medusæ have come of his colony.

Recurring to the subject of this paragraph, as delineated fig. 5, I found its progeny amounting to twenty-nine, mostly dispersed over the surface of the watch-glass, besides a confused group around the original parent, fig. 6, which animal, *a*, together with the largest of the young, are represented separately, fig. 7.

Such was the appearance of the subject a year and nine months after losing the roll of Medusæ.

I was no less curious to discover the result on the return of still another breeding season. But it passed as before. Nothing definite ensued. Neither the parent animal, nor any of the others, exhibited any symptoms of metamorphosis.

Therefore, the precise circumstances antecedent to the formation, and consequent on dissolution of the medusan roll, are still wrapt in mystery. All that can be positively affirmed, concentrates in our having once beheld the roll as if implanted on the disc, that it divides into minute Medusæ, but leaving a shapeless fleshy bulb behind, which developes as a fine and perfect hydra, and is prolific of progeny in its own likeness; also, that during two complete years, comprehending the breeding season of each, after having remained behind as freed of the minute Medusæ, the developing hydra neither generates another roll nor undergoes the slightest metamorphosis.

PLATE L. FIG. 1. Hydra of Vol. I., Plate XX. figs. 6, 7, 20, 21, 22, as appearing 125 days after losing the roll of Medusæ.

2. The same, 237 days from liberation of the Medusæ. Its own progeny here omitted.

PLATE L. FIG. 3. The same original hydra 308 days after dissolution of the roll.

4. The same, in 322 days. Both in this and in the preceding figure, the progeny omitted.

5. Original hydra and its descendants, as appearing 371 days after liberation of the Medusæ.

6. The same, as in a year and nine months.

7. A separate view of the parent, *a*, and one of the young, then nearly of its own dimensions.

8. The original hydra, *a*, and the colony generated from it, as seen two years and two weeks subsequent to the dissolution of the Medusan roll, which crowned it when a fleshy bulb.

Nothing farther ensued while remaining under observation, unless continual gemmation of the young.

II. MEDUSA.—Though I have nothing of real importance to add on the history of the Medusarian race, for it is alike unprofitable to write or to read of subjects imperfectly understood, still the accurate representation of a few species may prove acceptable to the naturalist.

§ 1. MEDUSA AURITA—PLATE LI. FIGS. 1–4.—This animal, sometimes sufficiently abundant in our seas, resembles a flattened bell or inverted saucer, six inches or less in diameter. The circumference is divided into numerous lobes, with a fringe hanging downwards. Four appendages descend from the under surface, which are much contracted in the morning, but relax as the day advances. One side of each is bordered by a fringe, extending a little farther over the extremity. Perhaps there are, in fact, only two appendages, each being cleft.

The colour of this Medusa is variable, generally bluish, with many red streaks, sometimes vivid.

Four circular chaplets are seen near the convexity during summer, being the ovaria, which come to maturity in August and September.

The Medusa is incessantly collapsing during ascent in its vessel. It always endeavours to gain the highest point, and will sometimes remain there very long stationary.

I have endeavoured to feed various specimens with different animal substances. But I cannot affirm that it was with certain success.

As they weaken they cease to ascend, then die, and dissolve at the bottom of their vessel.

The general size of most specimens is three or four inches in diameter.

Plate LI. Fig. 1. *Medusa aurita*, upper surface.
2. Profile.
3. Under surface.
4. Gland or ocular speck, enlarged.

§ 2. Medusa capillata—Plate LI. Figs. 5, 6.—This animal is one of the most beautiful of the tribe. It generally appears in June, July, and August, when it is from three to six inches in diameter. Some, of smaller dimensions, also occur at the same time.

The surface has the appearance of being divided into three concentric portions: of which the central part seems reticulated by the intersection of darker lines, and the circumference consists of a broad white margin. In a specimen expanding six inches, the central part was an inch and a half in diameter, and the circumferential belt half an inch broad. The portion interposed between them is fine azure-blue, which is not superficial but deeper seated, under a transparent gelatinous covering.

Sixteen blue radii diverge from the circumference of the central circle, towards the marginal belt, with white lines dividing them. The circumference is partitioned into eight principal lobes, each of which is subdivided into two lesser lobes. A number of bundles of tentacular organs hang down from the under surface, at some distance within the margin.—Plate LI. Fig. 5.

Medusæ of this kind swim by collapse of the body, like the former. I know not whether they are equally vigorous, but more of them than of others are seen in shallow pools left by the tide, from which they are probably unable to escape.

Multitudes of white, fleshy, solid looking planulæ are discharged by the *Medusa capillata* in August and September, which are very minute.

nor differ in anything from those of the *Chrysaora*, the subject of so copious a commentary in the preceding volume. It appeared to me, that, while moving, the broader extremity was always in advance.

Plate LI. Fig. 5. *Medusa capillata.*
6. Planulæ from the same.

§ 3. Medusa crinita.—Plate LII. Figs. 1, 2.—This animal is so transparent that it can be hardly seen amidst the water.

Specimens, of different dimensions, have occurred in May and in July: that wherein the parts were best exposed, in the latter month, is represented Plate LII. fig. 1. A larger specimen, taken in May, formed about the fourth or more of a hollow spherical segment, bordered by about 120 tentacula. Another, of nearly the same form, was six lines in diameter, and between two and three in height. About 24 long extensile tentacula, originating in a bulb, and very slender, hung down from the margin. In the centre of the concavity was a tubular proboscidal organ, with the mouth at the extremity, and four prongs around it. Besides this, four equidistant cylindrical organs, possibly indicating the site of the ovaria, are connected with the under surface. But all these parts are very obscurely distinguished. Two cross lines, probably denoting vessels, divide the upper surface in quarters.

This animal swims by collapse of the umbrella, and thus seeks the surface. The specimen, fig. 1, was quite vigorous and active, but the parts became disordered, and it decayed in eight days.

Plate LII. Fig. 1. *Medusa crinita.*
2. Another specimen.

§ 4. Medusa proboscidea.—Plate LIII. Fig. 1.

(A.) The specimen, fig. 1, was taken accidentally in a jar of sea-water, on June 5.

Some of the Medusan tribes are thus brought under notice, but only on emptying such vessels, for, in their native abode they would be invisible.

Medusa

This specimen bore considerable resemblance to a small thimble or Chinese bell, nearly half an inch in diameter, rather more in height, and in shape forming above half an ovoid. Owing to the thickness of the transparent gelatinous substance of the upper part, it seemed a double bell, or one bell covering another, which, I apprehend, is from the upper and the under surface being a little darker than the matter between them. Four equidistant tentacular organs, of extraordinary length, extending not less than six inches, descended from four knobs, each with a black speck on the edge of the bell. The microscope shews their curious structure, that they are as if composed of three united warts, each with a convex edge, which is furnished with a row of strong black bristles. These compound enlargements are set at intervals on the tentaculum, near its lower extremity. But this apparatus can be seen only when the animal is too weak to traverse the water. A long proboscidal organ descends from the centre of the concavity of the bell, dilating at the extremity.

The circulation of a fluid through channels of the bell, is discovered by the descent of dark particles from above.

This animal is extremely transparent: it is often difficult to be discerned amidst the water. Motion results from jerks, or leaps produced by collapse of the body. The tentacula extend as the Medusa rises and falls, or remains stationary.

PLATE LIII. FIG. 1. *Medusa proboscidea.* Body, *a* : tentacula, *b* : proboscis, *c*.

(B.) The variable figure of the umbrella, and indeed of the whole other parts peculiar to the Medusarian race, tends greatly to embarrass our discrimination of the different species.

Animals which, if not to be identified with the former, stand in immediate kindred to it, have occurred on several occasions, in May and June. The largest were about five lines in diameter and six in height, and forming a considerable portion of a sphere or of an ovoid. In such specimens, the proboscis extends completely two inches, and the tentacula three. But it is impossible to assume what may be the extreme dimensions of such ductile parts. The tentacula contracted, Plate LII.

fig. 3,—extended, Plate LIII. fig. 2. The proboscis shows much action; lengthening, shortening, and curving. In some specimens, this organ seems full at first and afterwards empty. I call it a proboscis, from not observing any other organ corresponding to a mouth. I have seen it extend three inches, even from a smaller specimen, and the tentacula five. Under the microscope, the latter prove to be of beautiful structure. In itself each of them seems tubular. It is visibly traversed by a fluid, but, whether from absorption only, I cannot affirm. This tube is externally loaded with numerous organic parts, which resemble beads when it is extended.—Plate LIII. fig. 3. These beads, if considerably magnified, seem rough, and totally covered with short spines.

Once I procured between forty and fifty specimens, the last surviving a fortnight.

Plate LII. Fig. 3. *Medusa proboscidea*,—tentacula contracted.
4. Young?

Plate LIII. Fig. 2. *Medusa proboscidea*,—tentacula extended.
3. Portion of a tentaculum, enlarged.

§ 5. Medusa (tima, *Eschscholtz*).—Plate LII. Fig. 5.—A modern author, Eschscholtz, has established a genus of the Medusa under the name of Tima, of which a rude representation of one species, named *Tima flavilabris*, is given in his work.—Plate viii. fig. 3, *a*. Eschscholtz says it inhabits the Atlantic Ocean, north of the Azores.

I received a fine specimen of one of the same genus, on December 12, from an intelligent fisherman, Alexander Wood, at Cellardyke, on the coast of Fife, about forty miles distant. It had no yellow mouth, as I conclude the name given by the preceding author imports.

The body of this specimen was an inch and a half in diameter, the umbrella forming a hollow segment of about the third of a sphere. Twelve tentacula descended three inches from their origin on the margin; and from the cavity, an appendage consisting of three organs resembling chains, which terminated in three leaves, extending half an inch. These leaves are an inch and a half distant from the summit of the umbrella, and they are connected by short small cylinders to the chains. Many knobs on the

Medusa [illegible]

margin of the umbrella were interposed between the tentacula. These organs, the tentacula, never extended until two or three afternoon. Their upper part was spiral, of a purple colour; and they had so strong an adhesion to whatever came in contact, that portions of them were ruptured.

This animal, with the preceding exception, was quite transparent: the waving of the organs formed an agreeable spectacle, as it ascended by collapse of the umbrella.

In time it began to decline, but not before an accurate delineation was executed, while in its utmost vigour. It survived ten weeks.

I understood that this specimen was taken east of the Isle of May.

From some fragments remaining, the fourth part of the appendage had been probably lost.

PLATE LII. FIG. 5. *Medusa* in ascent.

I have seen other kindred species, of which the four leaves, somewhat larger, spread out in close application to the glass.

§ 6. MEDUSA FIMBRIATA — *The Fringed Medusa.* — PLATE LII. FIGS. 6, 7.—Our diffidence in discussing either the formation or the habits of animals, should be in exact proportion to their rarity and the duration of survivance.

This is one of the smaller of the Medusæ, in fact a microscopic subject: the diameter not exceeding four lines, the umbrella somewhat convex, with a fringe of 106 tentacula, which extend about a fifth of the diameter of the body, or less. Two cross lines, at right angles, pass through the centre of the convex surface, and run down to the circumference, where each terminates in two knobs. Thus the animal seems divided into four portions, fringed respectively by 24, 26, 30, 26 tentacula, making up the complement to 106. The proboscis issuing from below is rather of a square form.

This animal moves by slight collapse. It is absolutely transparent, scarcely to be discovered in the water. The proboscis is grey.

Only a single specimen has occurred, which was in May. It afforded two satisfactory drawings.

Plate LII. Fig. 6. *Medusa fimbriata.*
7. The same, under surface, enlarged.

III. Beroe.—Later naturalists have subdivided the Medusarian race into numerous parts, established from very unequal distinctions, some being important, some but trivial, slight, or equivocal.

Perhaps the time has scarcely arrived for a systematic arrangement, but the reader will derive much information on the subject, from the useful and laborious work of M. Lesson, who has taken a very comprehensive view of its whole details.

§ 1. Beroe ovatus.—Plate LIV. Fig. 1.—This genus, which frequents the Scotish seas in considerable variety, forms one principal section of the Acalephæ. But I have not understood that any personal injury is suffered by the contact of any species.

Like the subjects of the section we have left, they seem to be migratory animals. Invited by the light and the heat, they rise to the surface of the sea in genial weather, principally during the middle of summer and the earlier part of autumn. None are seen during winter.

The earliest which I have had, was on the 5th of February, on passing accidentally into a jar of sea-water during its replenishment.

But the history of the genus is in every respect obscure. Like the Medusa, the Beroe has a constant tendency to seek the surface of the water. When specimens are vigorous, it is strongly demonstrated; when weak, they always remain below, from inability to sustain themselves.

Some are beautifully phosphorescent, as may be seen on pouring them along with the water, from one vessel into another.

Many species, dwelling in our seas, approach an ovoidal form—very irregular in some, and interrupted by rude appendages in others.

Lérine

A number of longitudinal ribs, generally eight in any species I have seen, traverse the animal, which in some are crossed by ciliated belts, forming the natatory organs ;—perhaps also discharging other functions. These organs are wonderfully tenacious of life : portions continue in motion after the rest of the animal has decayed.

The mouth, at one extremity of the specimen, is for the most part extremely dilatable.

The two species of this genus best known in Scotland, are the *Beroe ovatus*, and the *Beroe pileus* or Pleurobranchia.

The *Beroe ovatus* is an ovoidal, transparent, or watery-blue animal, about two inches in length, and half as much in its largest diameter. There is a cleft at one extremity, generally closed, which can dilate as a circular orifice. Eight ribs, broadest in the middle, and diminishing towards each end, are crossed by bars furnished with numerous cilia, which cilia seem susceptible of some extension and contraction, if there be no illusion here, for such might possibly be occasioned from the expansion of other parts.

The dimensions of the ovoidal Beroe are very irregular. Of twenty taken in August, the largest was about two inches long ; but this exceeds the usual size.

The body sometimes appears streaked with red, and the ribs also reddish. The red seems incorporated with some integral part ; it remains at the bottom of the vessel after decomposition of the animal. Sometimes the whole body has a reddish tinge ; or it is iridescent, one rib appearing purplish, while another is green. The reddish tinge begins to predominate towards the afternoon. These creatures are continually ascending and descending, pursuing a horizontal or irregular course, and tumbling over in the water.

Having observed some minute transparent globules in the end of March, which were swimming in a vessel that had contained specimens of the *Beroe ovatus*, I subjected them to the microscope. As they proved to be of the same species, I concluded they were the young, not the fourth of a line in diameter. Under the microscope they appearged dingy-white, with red specks, and rather opaque.

The Beroe always decreases in size: one of two taken in August, somewhat less than fig. 1, became gradually reduced and enfeebled, until not above a line in length, though still entire, surviving three months in captivity.

PLATE LIV. FIG. 1. *Beroe ovatus.*

§ 2. BEROE PUNCTATA.—PLATE LIV. FIGS. 2, 3.—The nearest resemblance I have found to this animal is in the work of Eschscholtz, Plate III. fig. 1, *b*. But I shall not venture to identify it as the same.

This animal is an inch in length, the lower portion globular; the higher, a large expanding frill, nearly flat. I call this the higher, because it is always above as the animal swims. Eight ciliated ribs traverse the body, which is of a grey colour, and under the ribs there is a reddish tinge.

Specimens have been taken in March and in August, the largest, which survived a fortnight or longer, in the former.

PLATE LIV. FIG. 2. *Beroe punctata*, smaller specimen.
3. The same enlarged.

§ 3. BEROE BILOBATA, PL. LIV. FIGS. 4, 5, 6, (EUCHARIS TIEDEMANNI, Eschcholtz).—Although I cannot venture to refer the subjects of this paragraph, and the illustrative figures, to the genus *Eucharis* of the family *Mnemidiæ*, as instituted by *Eschscholtz*, there is certainly a considerable correspondence between them.

The animal represented here doubtless belongs to the genus Beroe. Its form can be more easily recognized from the figures than by description, and it is meantime retained under that genus.

(A.) Eight small specimens were taken accidentally in a jar of sea-water in the month of August. They were rather compressed ovoids, such as might be circumscribed by a circle half an inch in diameter for the largest, but not above a fourth of that for the smallest. The upper part consists of two large lobes considerably asunder, prolonged from the under or ovoidal portion. Four papillous ciliated processes are in the four angles of the two lobes.—Plate LIV. fig. 5. The lower extremity consists of two circular compartments separated by an interval, fig. 6. Both figures are enlarged. Eight vertical ciliated belts traverse the body. The inner belts on the compressed sides are crossed by twelve ridges, the outer by fourteen, which number is probably dependent on the age or the size of the specimen.

(B.) Two specimens much larger, may be possibly comprehended under the same genus, the one taken in February, the other in August.

The under extremity did not consist of two separated circular compartments, as in fig. 6.

The general conformation of the rest corresponded. Two lobes, far apart, prolonged from the lower ovoidal portion, constituted the higher portion; four ciliated tags, endowed with considerable motion, rose from the angles of the lobes. Eight vertical ciliated belts traversed the lower ovoidal portion.

This animal extended an inch and a half, fig. 4.

The other was quite as large.

These larger animals were transparent; a central channel throughout was visible, but I cannot determine the position of the mouth.

The body of all these creatures was quite smooth. Eschscholtz describes his specimens as covered with papillæ, and says their native region is the seas of Japan.

Plate LIV. Fig. 4. *Beroe bilobata.*
5. Specimen of the same, or a variety, enlarged.
6. Under extremity of fig. 5, enlarged.

§ 4. Beroe pileus—Pleurobranchia pileus.—Plate LIII. Figs. 4, 5, 6, 7.—This animal has attracted the notice of a greater number of observers than any other of the Medusan race; and it seems proportionably distributed throughout the world.

The body is a sphere deficient of a small segment; about six lines in diameter, though seldom occurring of that size.

Thus, it lies still and motionless, Plate LIII. fig 4. When about to move, eight ciliated ribs begin to display their action: the animal rises in the water, while two feathers, issuing from below, stretch during its ascent to an immoderate length, one side of each being meagrely furnished with cilia, fig. 5; fig. 6, the same slightly enlarged.

Now it becomes a very interesting object. Rising always higher and higher, until its globular body reaching the surface of the water, it is found impossible to get farther, its course is reversed; first shortening its long appendages, they continue to be gradually contracted, until becoming invisible. Such motions, ascent, extension, and contraction are constantly operating, so as to be a very amusing sight.

But confinement impairs the creature's activity. Instead of seeking the surface, according to its natural habits, it remains at the bottom of whatever vessel; the cilia of the ribs are yet in motion, while the appendages extend no more. Heat and light stimulate attempts to move; but the body at length falls to pieces, though the cilia of the fragments are still in action.

This Beroe is quite transparent. It has eight vertical ciliated shuttle-shaped ribs like those of the others, broadest in the middle, and diminishing towards each extremity. The action of the cilia rather seems to be successive as the animal swims, those of one rib striking the water after the cilia of the rib acting before it.

In proportion to the diameter of the body the appendages are very long. The cilia bordering one side are like themselves extensile, and become very slender. I computed seventy on one of those of fig. 5. Its fellow, originally as long, was accidentally mutilated, when it appeared to me that a considerable portion was reproduced.

The appendages can extend equal to many diameters of the body. Those of a minute specimen, not exceeding a line in diameter, were shot forth to the surprising extent of two inches, then resembling the finest hairs.

Motion is chiefly effected and regulated by collapse of the body, and the operation of the cilia.

These animals are not rare in the summer season. I was indebted to a distinguished naturalist, Professor Edward Forbes, of the London University, for four living specimens brought from the coast of Fife.

The specimen, Plate LIII. figs. 4, 5, had been washed ashore at St Andrews, where I found it; yet it survived a fortnight after having been carried fifty miles. These creatures seldom live long,—one which I took at Queensferry, in the Frith of Forth, in the year 1819, survived eight days.

July and August are the chief months when the *Beroe pileus*, and others of the Medusan race, are most abundant.

Plate LIII. Fig. 4. *Beroe pileus*, quiescent.
5. The same in ascent.
6. The same slightly enlarged.
7. Ciliated rib, enlarged.

I consider it unnecessary to prosecute this subject further at present. Doing so would be superfluous, so long as in ignorance whether the subjects are in a perfect, or only in a transient state.

IV. Valkeria spinosa, Vol. I. p. 251.—Plate LV.—The multiplicity of the parts composing this zoophyte, their extreme slenderness and delicacy, together with their reciprocal intricacy, are such as to render extrication a task almost hopeless for the representation of an entire specimen.

The arrangement of those parts, however, which are principal and subordinate, is extremely curious and interesting; and although this is to be exhibited from only a small portion, it will be sufficiently understood by a branch magnified, as seen in Plate LV.

V. Alcyonium, Vol. II. Chapter III. p. 50.—Plate XVI.—Whether this subject shall prove the *Alcyonium gelatinosum* on further investigation, or a variety of the genus, it has afforded what may be the ground of useful materials in natural history.

The surface of the Alcyonium is covered by a multitude of hydræ, sometimes shewing themselves readily; but in regard to this specimen, so few ever appeared, and then so transiently, that it was impossible to discover their peculiarities.

Nevertheless I preserved it, in hopes of seeing some of the old colony, or, should these have died, some of the new when regenerated; and, with this view, slices were taken at intervals of time from the surface.

No hydræ were seen during six months, including the whole winter; the last appeared on the 12th of December.

Gemmules in the substance of the Alcyonium continued in abundance. Those obtained on January 16, are represented Plate XVI. figs. 2, 3; others procured in the same manner from slices on the 30th of that month, figs. 4, 5; and those on March 12, fig. 6.

Great disparity of size and form were exhibited by the whole, and much variety in their motions: but I cannot say they were such as to constitute any notable distinction from what was exposed by those of the earliest period. They were alike active and vigorous, always ready to escape from the slices, but undergoing no metamorphosis whatever.

Their number apparently diminishes with the advance of spring. I found them until the first of May; but the last experiment produced only a single gemmule.

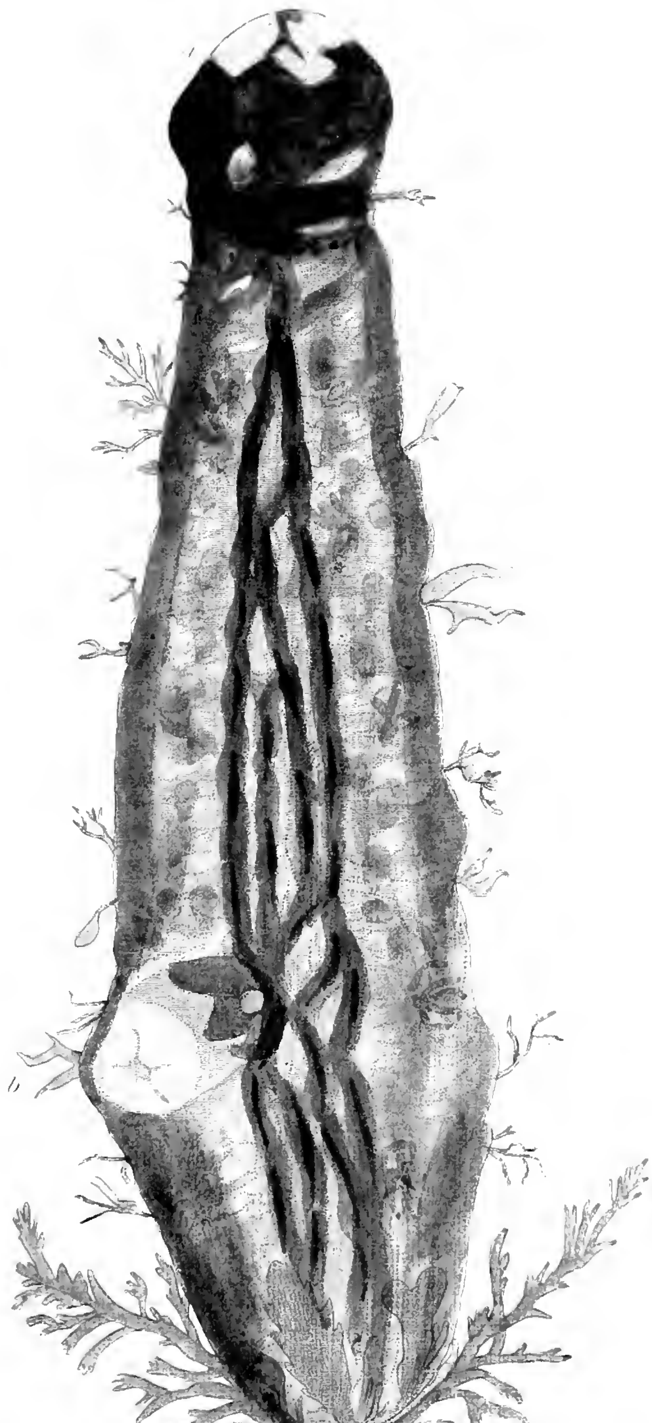
Many attempts for their permanent preservation proved abortive.

Thus the history of these creatures remains very obscure, and the purpose of their existence equally problematical.

I was not sensible of their production naturally during all the time that the Alcyonium was preserved. Bodies so minute generally attract notice on becoming stationary, and developing into different forms. None did so here.

It is far from improbable that they are the elements of regenerated hydræ clothing the surface of the product. Being somewhat sunk in the flesh, we have no means of discovering the progress of their metamorphosis.

The substance of the Alcyonium is obscurely and irregularly cellular. It is interspersed with numerous brown specks, which may be the remains of decaying hydræ.



Ascidia

PLATE XVI. FIG. 1. *Alcyonium gelatinosum?*
2. 3. Gemmules obtained on January 16.
4. 5. Other gemmules obtained on January 30.
6. Gemmules obtained on March 12.

VI. ALCYONELLA STAGNORUM, Vol. II. Chapter VI. § 2. p. 105.—The *Polype à pannache* of *Trembley* is not, as some suppose, the *Cristatella*, but the *Alcyonella stagnorum*.

That author observed the ova when detached from the decaying hydra passing below others, after the manner of those specified in the text.

It is difficult to comprehend the nature or description of the *Bell-flower* animal by Baker. He assigns the hydra forty tentacula: affirming that about fifteen hydræ compose a colony, which can shift its place; that the colony multiplies by division, when the portions separate, and sometimes withdraw.

Baker compares the whole colony to a bell about half an inch long, and a quarter of an inch in diameter.

But I cannot reconcile these peculiarities with the form and properties of either the Alcyonella or the Cristatella inhabiting Scotland.

VII. LOBULARIA, Vol. II. Chapter IX. § 1. p. 181.—PLATE XLII. FIGS. 6, 7.—On the first of June single ova were visible under the skin, in different parts of a fine large orange specimen, which was much distended.

Others appeared, besides, in several of the distended hydræ, being from one to ten in each, but not in any definite arrangement. Their position was between the stomach and the integument of the hydra, much reminding me of the aspect of the decaying Alcyonella. However, there was no motion here. The pectinate tentacula were never displayed: nor did the Lobularia survive to produce the ova naturally, having probably suffered some previous injury.

PLATE XLII. FIG. 6. Hydræ containing ova.
7. Three of the same, enlarged.

CHAPTER XII.

THE NATURE OF ZOOPHYTES.

THE vast expanse of the universe discloses innumerable legions of animated beings to the admiring gaze of mankind.

The air, the earth, the waters, are replete with occupants, which live and die; and which are regenerated in endless succession.

Each individual of the countless multitude exists during a limited period for itself: it passes away, but the elements of its race remain behind.

How have such myriads originated: when did they begin—whence have they come?

They are not of the present day only: they are not of any modern date: their dwellings in the world remount to an era preceding the records of men.

But questions so grave, so dark and deep, transcend the knowledge of mortals. The wisest among us can rest on no more than conjectures; and, entangled amidst a labyrinth, clouds of difficulties, which we vainly hope to dispell, cast their veil over our keenest efforts to elucidate them.

Thence have theories rose on theories: season succeeds season: but each of those offsprings of imagination vanishes; barren of truth its baseless foundation fails. The structure is overthrown. Yet generation follows generation: the uniform system rolls on unaltered: it has sprung from an immutable decree.

Cannot we penetrate the mist of time, to see that once

"The earth was without form, and void."

Now we behold it teem with living beings, until there truly seems room for no more. This is their appointed abode.

Some would assume that in the beginning, the concourse, concurrence, and coherence of certain indescribable atomic molecules, constituted the corporeal frame by their union. Some find its origin in a speck, alike unintelligible, among an imaginary mucus left on the shore, between sea and land, by the receding tide: some, unable to figure an active cause, maintain the self-existence of the worldly tenants from all eternity; while some discover the state of present perfection, from the throes of Nature having gradually completed the defective organs of primitive creatures by progressive developments.

But how could any or all of these effects have succeeded? Neither the confluence nor the coherence of unknown atoms, could have accidentally adjusted personal symmetry. They were incapable of thus leaving a cavity in the breast, to be afterwards occupied by the heart, or the brain to be covered by a protecting bone: nor could numerous channels be moulded, and then a vital fluid provided to fill them, for conveyance to the most distant extremities. Neither could the numerous nerves transmitting sensations have thus issued from the preceding most important part of organization.

No fortuitous confluence, or combination under any known or conjectured physical powers, could have fashioned the mechanism of the eye, or have prepared a place for its reception, connected with the brain. What possible concurrence, arrangement, or artifice, could construct an organ capable of bringing the knowledge of inaccessible, distant objects, as if in contact, to the mind of man?

If the reciprocal attraction and the spontaneous adhesion of the particles of matter can compose a definite form,—it is inanimate and perishable,—ready to be resolved into elements, from which precisely the like in figure and quantity may never result again.

But the animal frame is far from the product of fortuitous combinations: it is manifestly the work of some grand premeditated design. All its parts are relative and reciprocal: a specific purpose is effected equally by each and by their united co-operation.

Still would the end and purpose of the marvellous fabric have been nugatory, without that inimitable, conservative adjunct of the whole,—the spark of life.

A great, and intricate, a complex and perfect system is finished, such as no adventitious operation of laws merely physical could have produced.

The more we contemplate the symmetrical structures presented before us, the more do we find to admire: the more we probe into their nature and purpose, the greater our wonder. Every organ is disposed in its proper place, to discharge its proper functions: and the means of self-preservation devised from their united influence. Life is reposited in the common mass, along with that secret virtue during its subsistence, for continuing the race after the parents may have perished.

So many disclosures by the living world itself, must fill the contemplative mind with reverential awe and admiration. So many wise provisions, such extraordinary precautions, added to the anticipations of futurity, governing all in ceaseless harmonious order, could have no other source than the will of a Celestial Power.

I can penetrate no otherwise into the origin of animated nature presented before me. Inscrutable mystery veils the rest.

Conviction impells me to impute the whole to a Superior Being. Imagination cannot figure either the means, the time, or the purpose.

Let us therefore rest content with what is exposed to human view, in ascribing the only rational source of the Creation, to the will of its Supreme Author.

RETROSPECT.

Amidst the wonderful multiplicity of his works, it has pleased the Creator to diversify the appearance of living creatures in endless variety.

While a certain mode of life from form, from site and sustenance, is adapted for one, so is a different mode of life from form, from site, or sustenance, appropriated for another. Hence do aspect and habits impress themselves on those of mankind endowed with discriminative observation.

The numerous genera and species disseminated throughout the globe, seem pure, as when first originating from the *fiat* of their Divine Author, having never intermixed; and it seems his will that they shall thus continue to eternity.

To bring the vast multitude the nearer human comprehension, we endeavour to concentrate certain portions within a narrower circle, by such subdivisions as to our faculties include those individuals allied by external or internal form and habits.

By this means the diffusion and the refinement of knowledge are more speedily promoted.

Nevertheless, in allotting to many products an inferior rank in the scale, it is not from admitted imperfection, because nothing unfitted for its own proper condition can have come from the Author of the universe.

An explanation has been attempted here of the nature of some of the objects, whose history at present seems the most obscure. Therefore, after having been so long occupied with special details on the properties of zoophytes, it may not be inexpedient to terminate the subject by a few abbreviated general conclusions, as a compendium explanatory of their nature.

But, instead of descending to the regular detail of those minutiæ which would lead to that elaborate discussion, truly merited by so interesting a topic, and which could be expected only from a naturalist of the highest qualifications, experienced in practical observation, comparative anatomy, and systematic arrangement, I must confine myself to a narrative of humbler description.

1. Zoophytes are animated products, simple or compound, resembling the form and the efflorescence of plants. They constitute an immense proportion of the organic world, that which has received the smallest share of notice, and which is perhaps the least understood. It is only now that a ray of light begins to break upon them, disclosing their admirable beauty, their strange peculiarities, and unexampled properties—all calculated to astonish mankind, with yet another work flowing from the stupendous design of the universe.

As if appalled by the difficulty of the task, by the nicety of investigation, by the obscurities hovering over the theme, naturalists seem almost with common consent to have shrunk from it; for the most part merely skirting the boundaries—seldom advancing farther, with few exceptions, than simply specifying such external characters as are most obvious to the view, and often content with hasty inspection of some mutilated or depauperated specimen.

Thence much was left undone, and until recent years, a great preponderance of results deduced from such subjects as were never seen alive, in a perfect state, or amidst their native element.

It cannot be surprising, therefore, that erroneous or indefinite sentiments should have been entertained, and do still prevail, regarding the form, and peculiar habits of these creatures.

But this is not to be corrected otherwise than by minute, protracted, and accurate study on an extensive scale; for some stand so widely asunder, that assuming one, or even many, as a guide to others, would involve insuperable fallacies.

The aspect of every species must be viewed in all the transitions whereof it is susceptible, as the earlier may not be recognised from the later appearance. No reciprocal analogies are found in the various stages of existence.

All the Scotish Zoophytes, and probably those of the universe, are aquatic: most of them dwell in the sea, either in deep water or within the limits of the flowing tide. Some, but in small proportion, inhabit the fresh-waters; none are known to originate from the air.

As plants require a certain soil and climate, where they flourish best, so do such conditions belong to zoophytes. But the greater uniformity of aquatic than of atmospheric temperature, renders peculiar exigencies less obvious. Yet profounder depths are more congenial to many, for they are thence withdrawn in greater luxuriance than from shallower parts approaching banks, or which are in the vicinity of the shore.

The form and proportions of zoophytes are subject to such extraordinary modifications, as might almost excite a question whether they are governed by the same absolute principles regulating the structure of the more perfect animals. In these the number, and the use of many of the external organs, can be determined, in the others they are often variable, and their purpose must be conjectured.

In great preponderance, Zoophytes are fashioned as leafless flowering shrubs or trees, their flowers being living animals ; or they resemble some foliaceous vegetable, penetrated by innumerable pores, wherein living animals have a permanent abode, as they form a portion of its substance. They rise, besides as subgelatinous masses, in rude arborescent figure, the surface composed of numberless cells, with animated occupants: they overspread foreign substances, in carnose investment, or by encrusting calcareous tubes, plates, or rings, various in dimensions and arrangement.

All these are permanently rooted to the same spot; a few, but very few, comprehended under the general name of zoophytes, are free—enjoying the faculty of the slowest transition, capable of selecting their own abode, and spontaneously affixing and detaching themselves from it. Sometimes they submit to be borne away by the waters. All are of greater specific gravity than the elements wherein they dwell.

By an inversion of the common course of Nature, belonging to the higher orders of the animal world, whereby the power of progression is denied to them in the earlier stages of existence, the progeny of many zoophytes then possess it in greater extent, and from their origin ; but soon to be lost for ever, when rivetted to the same spot, there they live and die.

I am not sensible that the young animal, I should rather say the elements or larva, testifies any acute sense in the choice of the place where it shall dwell, otherwise it would certainly shun an unsuitable situation. Its abode seems chiefly the result of accidental circumstances: and it seems to be more from the concurrence of certain conditions, than by preference, that the position proves favourable.

Nevertheless, the elementary animals may be arrested in their courses; they may be rivetted unwittingly to the spot they are traversing, as assuredly is the fate of some originating simple and compound Ascidiæ.

Zoophytes are seated on rocks, on stones, or shells, or on animal and vegetable matter ; and the utmost luxuriance has been witnessed in their diffusion over a metallic substance.

Amidst the vast variety in all points connected with them, the ultimate dimensions which they attain seem yet unknown. Their increment and luxuriance are clearly dependent on situation, age, and sustenance. Some are single, scarcely discernible by the eye: nor are the finer members of the greater part to be recognised without resorting to the microscope. When plentifully fed, and kept in a salubrious condition, the organs previously diminishing are quickly invigorated and enlarged.

Hundreds invest a favourable surface, in a single stratum, never to be thickened: some are solitary: and masses of others are continually rising.

The mode of increment may be distinctly followed, whether by simple divergence from a stem originally single, or by superposition of successive strata, overwhelming the tenants of those below.

Every zoophyte seems originally single.

The food of the larger proportion of this extensive tribe is little known. There are certain genera, however, such as the Hydra and Actinia, which are ravenously carnivorous; and it is evident that the ascidian genera can derive beneficial aliment from mud intermixed with water.

Purity of the element wherein zoophytes dwell, seems more essential than sustenance. Slight contamination is frequently fatal, after the briefest interval. Neither can fresh or salted water be substituted for each other with impunity. Frequent humectation, and copious supplies of their native element are indispensable. Privation, even for a short period, is destructive of the more delicate species, for perfect desiccation is incompatible with the nature of the race.

Many may be, nevertheless, transported considerable distances with safety, in wet cloths, moistened moss, or leaves; and there is little doubt that, from the rapid transit of every thing in the present era, the naturalists of Britain might be gratified by receiving living zoophytes from the coast of America or the West India Islands. Capacious glass vessels, and occasional renovation of the water, would comprehend all that is necessary for such exotics.

Diseases are certainly induced by stagnant water, which shews the necessity of frequent renewal. Exuviation is probably incident to all. In some it advances profusely.

Though the life of many may be transient, and the existence of one generation only preparatory for that of posterity, thus fulfilling that paramount law of Nature, which derives one living being from another, examples are not wanting of extraordinary longevity.

The best means of preserving all for study, is avoiding their exposure to extremes of temperature, obscuring the light that falls on them, copiously feeding those whose sustenance is known, and keeping the whole in capacious vessels, very frequently replenished.

Zoophytes are a peculiar race of animal productions, participating in many respects of the properties distinguishing the higher tribes of the creation, intermixed with some analogies characterizing the vegetable world, while manifesting others found nowhere but among themselves.

2. Retaining these remarks in remembrance, as general principles, it may not be unprofitable to illustrate several chief elements of animal physiology by a few examples of the form, nutrition, and propagation of zoophytes, from practical observation, as an auxiliary to the naturalist.

In doing so, the entire race must be viewed as constituting two classes, without reference to the subdivisions by preceding naturalists above quoted; *first*, those entirely carnose, being free of other combinations, and somewhat resembling the substance of the higher animals; *second*, those whose carnose part is combined with coriaceous, ligneous, or calcareous matter, in different quantity and proportion.

Various other ingredients are known, which have been separated by chemical analysis, though we do not readily discover how they are generated and incorporated together, or moulded into form.

We must still preserve a certain latitude of expression, however reluctantly, regarding this subject, from inability to define, in ordinary terms, the precise manner wherein zoophytes, their parts and accessories, are compounded.

(1.) Zoophytes are in a simple, naked, independent state, as the *Hydra proper* of the fresh-waters, and the Actinia dwelling in the sea,—the former an animal of small dimensions, the latter often exceeding it many thousand times in size.

(2.) Zoophytes exist as combined with inorganic matter, as the Sertularia and the Flustra, growing, nevertheless, incorporated along with themselves.

A calcareous, cellular, or tubular secretion, seemingly derived from the tenant, is seen in the Lepralia, Cellepora, and Tubipora.

Farther, a substance partaking of animal nature, is combined with the living inhabitant of the Alcyonium and the Lobularia: nor do these differences now specified nearly exhaust the list.

Perhaps we denominate many substances *inorganic*, from our ignorance of their true nature, just as substances are designed *simple*, which chemists have failed in decomposing.

The zoophyte is, therefore, purely animal, as in the first examples; it much resembles a plant in others, and in a third instance, the living creature inhabits a dwelling secreted from its own organization.

The Hydra and the Actinia, both perfect animals, consist of a fleshy sac, and in this, as in other things, the *Hydra tuba* or *Strobila*, resembles them. They have a complete command over all their external organs, and they are capable of shifting their site. The faculties of the *Virgularia* and *Pennatula* are equivocal.

Nearly all the others, in as far as I am aware, are rooted to the same spot: they are denied the faculty of locomotion; but some, as the Vorticella and Pedicellina, can exercise a powerful influence over those portions which we deem inorganic in others, as the Sertularia, Tubularia, and Flustra. The latter can do no more than extend the tentacular organs, and slightly alter the curvature and direction of the hydræ. The faculties of the Vorticella and the Pedicellina, are greater. Certain species of the former can almost cast a knot on the stem; and the latter, by inflexion, can almost touch the root with the summit.

Zoophytes are naturally rigid or flexible: many require the aid of the surrounding element in sustaining them upright: some are flexible in early stages, and become rigid with age and increment.

The like disparity appears in the size of zoophytes, as among other classes of animals. The full-grown *Sertularia pumila* scarcely attains the height of an inch: the *Sertularia argentea*, or Cupressina, reaches three feet, and the *Alcyonium gelatinosum* two. Among the pectinate race, the Virgularia or Sea Rush equals the last. Numerous hydræ occupy the thinnest calcareous or membranaceous stratum, their polyparium, scarcely protruding the disc beyond the lip of the cell.

With few exceptions, nearly the whole animals combined with the inorganic portion, large or small, of this extensive *Order*, are very minute.

Some of the Medusæ are, indeed, gigantic creatures, comparatively, but I would purposely abstain from adverting to them, because I entertain many doubts whether they may not be found misplaced if included with the zoophytes properly so denominated. At the same time, their immediate relation to an animal not rejected from the zoophytes, must not be overlooked.

Very few zoophytes are distinguished by lively colours. Perhaps those of the Actiniæ are the most conspicuous for intensity and variety. In general a dingy hue predominates; also different shades of green and brown. Most of the Tubulariæ are red; some of the calcareous white. Yellow embellishes the whole or part of others, and this colour characterizes a remarkable proportion of the ova or the gemmules of various species.

3. In viewing the nature of vegetable products, different important functions are allotted to the different parts.

The race with which we are now occupied, is denominated the *Order of Zoophytes*, as if actually participating the nature of both the animal and the vegetable kingdom,—an opinion which, as already signified, does not rest on a sound foundation. Numerous points of resemblance appear nevertheless, though not sufficient to carry their kindred farther.

Root.—Zoophytes have no proper root to be compared to that of plants; or at most, remote analogies are presented by the means of fixture to the places where they dwell.

The root of vegetables generally dips into the earth, or it spreads over surfaces which it cannot penetrate, descends into clefts, and obtains security through numerous auxiliaries, bearing some proportional power below to the stability required above.

But the root of the fistulous, arborescent, foliaceous, and gelatinous zoophytes, does not exhibit that distinct and proper organization to which a similar purpose in the same extent can be ascribed.

The Sertularian zoophyte, in its origin, diffuses a few minute radicles, speedily disappearing, and just at that juncture when their presence might begin to be held important. If the root of the Tubularia be prolonged, it is apparently by descent of the stem, and owing to its fistulous formation, never spreading, nor does it pierce the substance to which it is applied. That of the Flustra is the original foundation-cell of the specimen; in all this specific portion, the root, seems quite insignificant compared with the dimensions of the rest in its advancing stages,—and inadequate to enable the specimen to resist the turbulence of the fresh-waters, or the concussion of the waves. On forcible divulsion of a specimen of the *Sertularia argentea*, two feet high, a scale of only a line in diameter, separated from the surface of the shell sustaining it. The root had occupied no more.

Recalling the mode of perpetuation explained above, we find the planula from the prolific vesicle contracting as a spherical segment; that the under surface breaks into radicles amidst an attenuating matter below, circumscribed by a circular outline. The radicles being from four to eight, are scarcely farther prolonged; their extremities cleave into two obtuse parts. At length as six or eight needles they radiate from the centre to the marginal circle, but along with the dissipation of the diffusing matter they also disappear.

Possibly the nature of the root might be elucidated from the structure of the stem. Many species of the Sertularia show vigorous reproductive energies; some are continually generating abortive filaments, along with prolific cells. A tuft of considerable dimensions, resembling mossy matter, always separates with the *Sertularia (nemertesia) ramosa* when torn up from its foundation. In this species, it is to be observed, the stem consists of an aggregate of numerous tubuli, insomuch that a transverse section of the stem of an aged specimen offers a rude resemblance to the microscopic pores in thin slices of wood. Likewise prolific vegetation is often ready to spring upwards from each of the sundered tubuli. On divulsion of a specimen of this product, six inches high, rising by a short stem half an inch across, diverging sparingly into boughs and branches, with about an hundred extremities, bearing thousands of hydræ, a tuft of an inch in diameter separated. The Sertularia now described consisted of a number of slender parts. A tuft separates also on rending the *Tubularia ramea* from its site. But all the descending part of the *Tubularia indivisa* appears to be a simple prolongation of the stem.

The original cell of the foliaceous zoophytes is horizontal; none other rise immediately above, and the animated leaf rises vertically from one side of it, leaving it thus to constitute the root. All the rest of the cells indent the vertical leaf of later origin, a natural device of the most wonderful description. The dimensions of the foundation-cell, however, are alike restricted as those of the root of most Sertulariæ.

All the provisions of Nature whereon human judgment may be exercised, seem so admirably adapted to the original condition of her products undisturbed, that the rivetting power of the root will be probably found proportioned to the rigidity or flexibility of the stem, and the violence necessary to resist divulsion.

Some may be sheltered from violence by their native site, that is the place best adapted for salubrity.

Should this be true, that product most imperfectly rooted should be the least exposed.

But zoophytes may attain considerable size without either sensible root or radicles. The *Alcyonium gelatinosum* has none. A beautiful fleshy-like specimen, above ten inches high, grew on a small shell of the *Venus Islandica*—one not fifteen lines in diameter. On disruption it separated quite clean and smooth, with a slight depression in the under surface of the adhering base, which itself was under two lines across.

The adhesion of the *Lobularia* is of a different kind, resembling that of the Ascidia. It is firm, but there are no radicles. On the contrary, a skin seems interposed to cover the integument of the base of the Lobularia, as it spreads and enlarges by successive generations; and it is so intimately applied to the substance invested, that divulsion uninjured is seldom practicable.

A few zoophytes, void of all fixture, are free. The Cristatella may wander at will by imperceptible progress; nor are the Virgularia and Pennatula necessarily stationary.

The Hydra and Actinia, together with the Lucernaria, always enjoy the privilege of selecting their own abode.

Whether zoophytes actually derive any nourishment through the medium of the root is questionable.

Notwithstanding the preceding contrasts, it cannot be denied that there is much intimate resemblance between zoophytes and plants. I only wish to express my opinion, that they belong strictly to the animal, not to the vegetable world. Though certain flowers follow the course of the sun, or close as evening comes, we cannot venture to affirm that these demonstrations are the effects of volition.

4. *Stem.*—Certain animals comprehended under the order of zoophytes have no proper stem whatever, though rivetted to the same spot; and the more important parts are elevated above the plane of position.

Where present, its nature is not always explicit: in form it is cylindrical, fistulous, plain and smooth, or composed of aggregated tubes, or it is flattened. According to age, size, and substance, it is rigid or flexible.

The stem of many of the fistulous zoophytes being a simple tube, is occupied by a kind of medullary pith, apparently compact, when vigorous and connected with the living hydræ, often seen abundant in decomposition, and copiously discharged from accidental ruptures of the *Tubularia indirisa.* It is not improbable that the elements of the future embryo have some immediate or remote connection with this medullary substance, being either lodged in, or nurtured by it, or secreted or reposited in its vicinity. The evolution of the young from the pith of the arborescent zoophytes may be distinctly observed.

The presence of the pith seems indispensable to the life and permanence of all the hydraoid zoophytes: with its decay and disappearance animation ceases, and specimens become transparent.

Whether a similar substance, or any other connecting medium, occupies the stem, or communicating channels with the cells and hydræ of the foliaceous zoophytes, is uncertain.

The stem of many hydraoid zoophytes is distinguished by divisions, nodes, articulations, or whirls, or by portions resembling joints. All these are larger or smaller, longer or shorter, more or less numerous, and generally very obscurely seen in the living product, on account of the pith; but sufficiently definite on its decay and disappearance.

These apparent subdivisions are extremely irregular, and often so indistinct, that their presence might be deemed questionable. Amidst such irregularity, however, they are not merely accidental indications; whence, naturalists have assumed them as their principal auxiliaries, in adjusting a systematic arrangement of zoophytes.

They are sometimes features of admirable regularity. A small specimen of one of the Campanulariæ, only three lines high, bearing five or six hydræ, exhibited twenty-four whirls, on the interval of the stalk separating two hydræ, and above thirty under the lower of the two, as prominent and distinct as if fashioned by the art of a practised turner.

The connection of the organic with the inorganic part, subsists under considerable modifications. Thus, the stem of the *Coryna glandulosa*, and the *Pedicellina*, as well as that of the *Vorticella hemispherica*, *socialis*, and others of their interesting congenera, seems almost, if not absolutely, organic. Either the hydra or the will of the product shews a common influence over each, and over all the parts; whereas the stem of the *Tubularia indivisa*, though flexible from incapacity to sustain itself, unless aided by the water, is under no control of the hydra.

As the stem of all the nascent Sertularian Zoophytes, in as far as I have observed, seems to be a simple diminutive tube, and as all the extremities, however numerous, resolve either into single cylinders or cups, bells, or the like, terminating these extremities, the mode whereby the compound stem of aggregated tubuli originates, is not evident. Yet they are only approximated. They do not form a solid cylinder, though on casual inspection resembling one, nor are they invested, like plants, by a common cortex. Farther, each of the tubuli being independent of the rest, it will prove barren, or productive if the stem be cut over, and the most luxuriant portion above removed.

Thus, ten or twelve out of twenty or thirty tubuli, composing a severed stem, may produce new shoots, ultimately bearing hydræ, though all the rest remain abortive.

It is from this approximated congeries of tubuli that sections of the stem resemble the most porous wood.

Shoots sometimes issue both upwards and downwards, from very vigorous sections; nor are examples wanting of hydræ being generated in opposite directions from the same section.

The inorganic parts diverge into many beautiful arborescent forms among the Tubulariæ, Sertulariæ, Flustræ, and Plumatella, dividing and subdividing, after various arrangement, as boughs, branches, and twigs, ultimately terminating in simple orifices, permanent cells, or deciduous bells.

Throughout there is nothing representative of foliage; but the vesicle and the hydra may be compared to the pod, or the pericarp, and the flower of plants.

5. *Hydra.*—Zoophytes, it has been explained, consist of two distinct parts, each with its peculiar qualities,—one being that where animation resides, the other wherein it is not evident. In the former, animation is demonstrated by spontaneous motion and activity; by the discharge of functions important for conservation of the individual, or for continuance of the race; which last, however, seems to be a physical result, not under any control. None of these qualities are sensible in the inorganic portion, which is nevertheless of indispensable use. Although void of action and evident sensation, and also of external impressions, it seems susceptible of nutrition, consequently of increment; it is a real skeleton.

The hydra or polypus is always in such a position as to be in immediate contact with the circumambient element. Salubrity is derived from its presence, and privation of it is followed by inevitable destruction.

The hydra is also in immediate connection with the pith, occupying all the tubular part of the skeleton, the outward or sustaining inorganic portions, and its development from it in the regenerating *Tubularia indivisa* is exposed by the transparency of the summit of the fistulous stem.

Perhaps the pith is consistent when in perfection, though resolving, from decay, it may be, into a tenacious ropy matter, where most abundant, as in the Tubularia, when it is profusely discharged; the transparence of the large tubular parts of some of the Sertulariæ exposes the pith, like a continuous slender thread, originating below, traversing all the skeleton, and terminating with the development of the hydra at the extremity. Though having had repeated occasion to refer to it as an important part of the organization of zoophytes, we must admit that all I have said is hypothetical, for its precise use is unknown. But we may justly infer, from evident facts, that it undoubtedly contributes to the vigour, life, and increment of zoophytes, as they perish inevitably on its permanent decay. Likewise, there is probably some immediate connection between the elements of the hydra and the pith, all as previously intimated. In the Tubularia, these elements certainly reside below, from which, by the regenerative energies of the species, new hydræ will be successively developed, as the stem is reduced shorter and shorter, by repeated sections, the hydræ being always produced from what remains next the root.

As a general principle, it may be advanced that the increment of the inorganic parts depends on the subsistence of the organic. The connection of the hydra with the pith, is immediate and obvious in the Tubularia and Sertularia. But the existence of the pith itself, and the reciprocal connection of the hydra with any similar intermediate substance, is not ascertained in the Flustra and other ascidian zoophytes. There the natural arrangement seems to be somewhat different. The correspondence of the parts is not yet discovered. Neither is it clear what precise connection subsists among the pectinate hydræ of the carnose zoophytes, or the nature of the polyparium itself, so that the reciprocal influence of the parts cannot be described. A medullary stump generally or always accompanies the deciduous head of the Tubularia on separation.

The great variety of external configuration exhibited by the inorganic portion, has afforded facilities for the arrangement of zoophytes by systematic naturalists.

But it is singular that so little aid seems to be derived as appreciable by our senses, from the organic parts. In as far as we can determine, the *same* species of hydra may be combined with an hundred different inorganic structures; another with fifty, a third with only ten. This is a subject which has not yet received sufficient notice; but it merits much attention.

From this fact it results, that the variety of the polyparia—the habitations of the zoophytical tribes are very numerous, while among the tribes themselves, the varieties are apparently very few.

We might be thence led to enquire whether it is the identical hydra that is so widely dispersed amidst different formations, whether each different polyparium is not occupied by a distinct hydra, whereof the characteristics, though obscure and indistinct, may be recognised by acute observation.

In our present state of knowledge, the variety of hydræ brought under the description of British Zoophytes, even with the latitude assumed in these volumes, is extremely limited.

The Order of Zoophytes we have seen to be divided into four principal sections in scientific treatises. I. The Hydraoid, comprehending Tubularia and Sertularia. II. Helianthoid, comprehending the Actinia. III. The Asteroid, comprehending Virgularia and Pennatula. IV. The Ascidian, comprehending the Flustra and Cristatella.

The hydra of each of these bears a distinct character. There is some alliance between the animals of the first and second section.

At present only the first three sections are deemed real zoophytes.

The exact place of the *Coryna squamata*, and of the *Pedicellina*, is somewhat questionable: that of the *Coryna glandulosa* is much more obscure.

The anatomy of the *Hydra proper* is scarcely farther explained or understood than as discovered by simple inspection. Its nearest kindred are probably the hydra of the *Coryna squamata*, and that of the Sertularian Zoophytes: for it is scarcely logical to include an animal, though of intimate resemblance, while in an acknowledged state of transition, such as the *Hydra tuba* of the sea.

The nature and the functions of the simple hydra are apparently more obvious than those of the compound zoophyte. We discover the origin, food, and the increment of individuals of the former more readily than we see of the others.

We find no sensible medium whereby the benefit derived from the sustenance of the ascidian hydræ is transmitted to the polyparium, though their anatomy is more explicit. The like may be said of the pectinate hydræ, whose anatomy, on the other hand, is less explicit.

Were we to view the hydra comprehensively, we should find room for several important distinctions. Thus, there are noted characters derived from the tentacula, in being muricate and ciliated. Those of the Helianthoids, unlike the rest, are smooth.

Muricate tentacula belong to the naked hydra of the Tubularian and Sertularian zoophytes: Pectinate to the hydra of the Lobularia, Virgularia, and Pennatula; the Actiniæ have smooth tentacula; those of the Flustra, Alcyonium, Cristatella, and other lunate zoophytes, are ciliated; but the animals belonging to them are distinguished by features equally prominent, and by more complex organization than the rest.

The number of tentacula is rarely a positive feature. There is one row in the naked Hydra, commonly three in the Actinia; two in the Tubularia, one in the other fistulous zoophytes: and they are arranged in different stages in the *Coryna squamata*.

In the lunate ascidian hydræ, they are in a single encircling row, disposed in a horse-shoe or crescent form, though sometimes referred to as in a double row. But the row is truly single.

The number of tentacula is exceedingly variable in many zoophytes: as it is in the simple hydra. Eight belong to all the pectinate hydræ of the carnose genera, or asteroid zoophytes; but this number distinguishes only some species of the other genera; as the *Sertularia arcta* of the hydraoids. The ascidian hydræ, also, of the genus Valkeria, have eight tentacula. There is scarcely any other fixed number; for in the rest they are so irregular, that they will be found advancing from ten to above an hundred. These organs discharge the office of fingers or hands, seizing the prey of the animals, and conveying it to the mouth, where it is always devoured entire. Many tentacula, to be subsequently acquired, are deficient in most of the younger zoophytes. Their successive evolution is beautifully illustrated in the *Hydra tuba*, where, commencing with two, they may ultimately exceed thirty. This successive evolution continues very long, and to a great extent, in the Actinia. I know not when it ceases. Thus, the number of tentacula may be a very indefinite guide to systematic arrangement.

Except in the flexibility of the stem, I can discover scarcely any other feature in the analogy of the *Coryna glandulosa*, to the structure of the zoophytes known to us.

The animal functions of all are extremely obscure, nay, in most of them, they are utterly unknown. We have seen indications of circulation among some of the hydraoid zoophytes; but it ought to be witnessed again and again, that it may be understood, as it is certain that a multitude of specimens may be subjected unsuccessfully to our instruments for that purpose. We cannot say as much of the pectinate race. But it is different with the ascidian genera, for their circulation, or some process in immediate relation, plainly ensues.

In that fluid, which, in zoophytes, may be compared to the red blood of other animals, the globules are generally black, amidst a transparent matter, wherever I have been able to see them. But in the Botryllus, the globules are evidently yellow.

The food of all the zoophytes, unless the Hydra or Polypus, and the Actinia, is extremely obscure. These are evidently highly carnivorous, and the digestive faculty is strong. Thence also come assimilation and increment. They receive almost all fleshy substances, without exception, and in inordinate quantities. The stomach may be distended to any excess, and apparently with impunity. Indeed, nearly the entire animal seems to be only a stomach.

Thus the tentacula are, doubtless, adapted for their respective functions, by the difference of their structure. 1. They are smooth, susceptible of distension, possessed of an adhesive power, and with a terminal orifice in the helianthoids. 2. Ciliated, as in the ascidian zoophytes. 3. Muricate in the hydraoids. 4. Pectinate in the asteroids. Perhaps all are tubular. But this is not ascertained. From what we see, however, their structure is adapted for conveying the substances believed the source of aliment, within reach of the mouth.

Therefore, it is chiefly by means of the tentacula, and their appurtenances, that zoophytes are supplied with food. Their structure is adapted for their office.

As if the young animals could dispense with sustenance for a season, they have infinitely fewer than in maturer age, and this peculiarity characterizes the greater proportion. The Tubularia, with its double row at last, is scantily provided in the beginning. The nascent Actinia has seldom more than eight, twelve, or twenty, while the full complement is not under an hundred; nor are those of the Cristatella in greater proportion.

If we may be permitted to take such an example, the progress of the evolution of these important organs is best illustrated in the metamorphoses of the planula of the Medusa to a Hydra.

It is unnecessary to recur to the functions of the cilia, so profusely fringing the tentacula of the animals of the zoophytes, as long as their peculiar office is unknown. Naturalists of distinguished eminence, indeed, have assigned them a very important office, nor have they confined it to one exclusively. But we can affirm no more than that buoyant particles are directed towards the vicinity of the animal while they are in action.

Various parts of the animal frame of every creature, are void of any certain known functions. We assume that they are for one or for other purpose; and thence does opinion pass current. But I doubt whether we can speak of the service of the lobe of the ear; of the true object designed from the hair of the head or of the beard; or of the nails on the fingers and toes of mankind. It is the same with the parts of many animals. We forget the state of original man, that in which he truly comes from the hands of Nature. He is naked, forlorn, and, unless for the protection of a parent, who in a state of nature is a savage, and leads a savage life, nothing could preserve him. Every trace of civilization belongs to a later age and a better epoch. Strip him of civilization what is he?—a savage again!

Yet, in so far as we can penetrate the vast design, the Creator has done nothing in vain. So we may justly conclude, that all the parts of the animal frame have been intended for some specific purpose. Nevertheless, that by the progress of time and the change of circumstances, the exercise of their original functions may have now become less essential.

The external action of the cilia is notably excited by the visible presence of foreign matter, and by this the whole energies of the animal seem to be aroused.

A fine example is shewn by another creature, a thousand times larger than the inhabitant of any of the zoophytes. Elsewhere we shall perhaps have an opportunity of detailing the facts more at large.

I speak of the *Amphitrite ventilabrum*, which is not an ascidian hydra indeed, but is at present incorporated with another race, known by rather an indefinite name, the Annelides. The anterior extremity is decorated with a beautiful plume, consisting of many ciliated ribs, disposed in similar arrangement as tentacula. A row of cilia fringes each side of sixty or seventy ribs or tentacula in adult specimens, the central rib being two or three inches long. While the Amphitrite is quiescent below in its tubular dwelling, apparently regardless of every thing, let a few muddy drops fall amidst its element, over the orifice of the tube, it quickly ascends, displays the beautiful plume, and immediately thousands of cilia are in motion. Attracted to their sphere, the muddy particles are accumulated, received into the mouth, prepared as paste, and applied to the upper edge of the tube, where it is moulded into shape, and beaten down by two organs, bearing a rude resemblance to trowels, accomplishing, as it were, the work of human hands.

Here the functions of the cilia are definite.

Later naturalists finding cilia in many unexpected places, testify some earnestness to assign them a peculiar office, though their real use has probably to be postponed for future discovery.

The Hydra and the Actinia being carnivorous, it might be inferred that the hydraoid zoophytes, including the Tubularia, should be of the like nature. However, we cannot speak positively to that point. We only know that some of the race are voraciously and promiscuously carnivorous.

Admitting the probability of the hydræ of the zoophytes being so likewise, it should be recollected, that none of the Ascidiæ manifest any such propensity. Therefore it may be logically deduced, that the same principles should govern the nature of the ascidian hydra, as I have ventured to denominate it, when in this compound form of a zoophyte.

But now its necessity, or its desire for replenishment, is more conspicuously demonstrated than what is shewn by either the hydraoids or asteroids above described. This is so evident as to preclude the chance of error. Thousands eagerly absorb the muddy solutions prepared for them until they can contain no more.

As this is both artificially and forcibly done, it is easy to understand how living animalcula may be accidentally absorbed with other substances of the mixture. These may be retained, indeed, and possibly they may be digested, which is nevertheless more doubtful. Here, however, I apprehend, is the explanation of what is said by some naturalists in expressing their opinion that the ascidian hydræ are carnivorous.

Excepting with regard to those notoriously and voraciously carnivorous, my own observations on the food of zoophytes, farther than the ready and copious absorption of muddy matter, have not been decisive. Animals, it is well known, may be sometimes reconciled to food which seems unnatural. It is alike known that there are some, especially among the smaller tribes, which not even the pressure of hunger can induce to taste of substances unless of their own selection and preference.

I acknowledge that I have been often much perplexed to account for the rapid increment of zoophytes, when unable to detect the means of their sustenance; for it is not reasonable to admit that living bodies can be enlarged, while preserving health and vigour, under continued abstinence.

A certain waste seems to accompany the mere subsistence of life, which the Great Architect of Nature has wisely made a provision to compensate, by the desire of every perfect animated being for food, whence are cavities in the animal frame also provided for its reception.

A certain portion of the food must be, therefore, incorporated with the system.

6. *Senses.*—The senses of the whole race of zoophytes are apparently very few, and their operation, for the most part, very obtuse and confined in many.

This is a subject, indeed, whereon we would do well to speak cautiously, for we can judge of a sense in other beings than ourselves, only by its evident effects, and these rather positive than negative. Also, faculties wholly unknown, may belong to the humbler tenants of the universe.

It does not appear, however, that those animals deemed more perfect, from extraordinary acuteness of sight or smell: or that those whose fleetness can almost outstrip the wind, enjoy any higher place than their less gifted fellows.

Perhaps, from resemblance, position, or other reasons, we allot organs of sense to some of the zoophytes, which are not truly such, nor convey the impressions transmitted by the corresponding organs of other creatures.

Sounds do not seem to give zoophytes any disturbance. Light makes considerable impression on many: but the faculty of sight is equivocal, I believe I may say in all. The sense of feeling is acute, nor can there be any doubt of the faculty of taste from the evidence of selection. If some have the power of smelling, the subjects are generally very close, so that it may be questioned whether the escape of volatile particles of grosser description than mere emanations, does not stimulate an external sense.

Though most of the senses belonging to the more perfect animals are not recognised by us in this extensive tribe, the zoophytes, the animals composing it are always aware of the quality of the element wherein they are appointed to dwell. They are not insensible of a genial atmosphere, and some can apparently discriminate night from day.

When the fluid surrounding them is stale or impure, those having shelter, withdraw to pertinaceous retreat: some swell a little, as if to stretch beyond the deleterious influence: almost all simply contract to smaller bulk, without attempting any vigorous effort to escape by quitting their abode.

Zoophytes, independently of mere sensations, testify some consciousness of the circumstances wherein they are placed. The most unequivocal symptoms shew their enjoyment of the renovated element, it summons them into life and action from their longest retreat: they hasten forth with all their organs displayed in the amplest form, to reap the whole benefit, promoting invigoration. The simple effects of sensation may accomplish this: but an external shock, warning them of danger, they disappear with precipitation, and they lurk in concealment, until continued tranquility, renewing their confidence in security, they return to the enjoyments they had left.

The sensations of the ascidian zoophytes are infinitely keener, and their activity greater, than what is betrayed by any of the rest.

All the demonstrations and motions of the asteroids have appeared to me much feebler and slower.

The precise reciprocal relation of the hydræ of the compound zoophytes of the same specimen to each other, or the precise relation of any one to the whole community, involves an intricate question. A common benefit seems to be imparted to all, and all seem to be affected by common circumstances. This is viewing the product as a whole. Besides, in a specimen composed of an hundred or a thousand living beings, each of the individuals is so constituted as to receive the benefit adapted for the vital functions peculiar to itself. It seems to originate, to live, and to die, without affecting its nearest neighbour, or of impairing the safety of the community. Herein it appears to be an independent animal, and scarcely more than a solitary individual.

Notwithstanding, the whole inhabitants of the most luxuriant Sertularia, Flustra, or Tubularia, may testify their susceptibility, in as far as we can determine, of the same external impressions, the agency of a single hydra, or of several, neither has any evident influence on the rest, nor, *vice versa*, is the single hydra, or a group, affected by the rest.

In some genera, however, comprehending the Coryna, the Vorticella, or the Cristatella, it is difficult to understand how certain positions or inflections could be assumed without the common will of several parts of the specimen adopting them. The flexure of the Coryna, the collapse of the Vorticella, the progression of the Cristatella, tardy as it is, infinitely surpasses the power residing in single portions of the product : therefore, they can result only from some general combination of many, or from some occult quality.

Something like volition is displayed.

Yet this is a mysterious subject, whereon many profound speculations may be indulged to little purpose.

7. *Propagation: Reproduction.*—Had not the Great Creator provided for the permanence of animated nature, his original works would have long since perished, from decay of their component elements.

But the same ineffable wisdom which fashioned the universe has blunted the corrosion of time, and defeated the ravages of death, by decreeing the incessant renewal of the creatures of the earth.

Thus is the waste of life imperceptible, for the world is always full.

Under the undeviating laws preserving the harmonies of the universe, I repeat, that no solid basis can be found, whereon to rest the theory of spontaneous generation, or the origin of living beings from accidental combinations. I feel incapable of discovering any physical means whereby unknown indefinite atoms, molecules, or particles of inert matter, shall be attracted, associated, and incorporated as symmetrical forms, and lighted up with the spark of life.

Is it alike difficult to comprehend how one living being, the offspring, shall be derived from another living being—the parent,—inheriting all its parts, its faculties, and qualities?

Still, so long as numerous insoluble phenomena are daily presented before us, let us carefully refrain from presumptuously pretending our ability in interpretations;—we must be content to admire what we are unable to explain. It has not been the will of heaven yet to have so far enlarged our understanding.

Ignorance gives birth to conjecture, whence does each individual who would probe the mysteries of Nature, entertain that theory which seems to him the most consistent with reason.

Thus, many conclude that the origin of animals concentrates in a primordial germ involving others to infinity, of which each is prepared for evolution, as concurring conditions allow.

Others assume that such principles or elements are derived from one or from both parents, where two, as gradually consolidating and expanding, constitute the offspring, and carry on the race.

Many difficulties are concomitant on every theory. But it does not seem an extravagant conjecture, as long ago intimated, that the original animal, in its earlier intelligible stage, is a vascular speck, with the rudiments of its complete organization. I shall not embarrass the philosophic reader with a discussion of the reasons why it may be so. He will discover them by his own philosophical reflections.

A learned author, Dr Martin Barry, maintains the unity of the original germ, as universally present, whereby there is a general correspondence among those of all animals. No doubt, the elements of the parts may be of similar description and qualities, yet under such differences as shall, in maturity, determine the distinction of tribes.

(1.) *Germ, Ovum, Embryo.*—Very indistinct ideas must be entertained of the germ : it cannot be otherwise, when reasoning from conjecture only. Whether solid or vascular, we may assume that it is long invisible, that it is dormant, its existence maintained in passive life, and that its form is afterwards demonstrated, in a certain state of evolution, by active life.

In the course of that evolution, the matter of the ovum is formed as an auxiliary to the germ, now known as the germinal vesicle. Vigour and nutrition reciprocally promote the progress of the component parts. The whole elements reside in the ovum, which becomes a sensible object, undergoing a continual change, by an embryo beginning to occupy a portion of it.

Next, the irregular mass of vague and indistinct organization is rudely moulded, as the fœtus, composed of disproportioned and misshapen enlarging parts. These are refined in more advanced stages, and at length the young animal, which shall ultimately resemble the parent, is ushered into life.

The germ is thus an organism originally of unknown aspect, but which, by successive nutrition and evolution of what must be the rudiments of the future animal, is subsequently presented to view in a more advanced irregular, and at length in a perfect form.

Instead of an elementary germ, according to the preceding hypothesis, should there be such a secretion and depositation of matter, from an individual parent, and lodged in a peculiar cell, probably an analogous process ensues. After passing through different advancing phases, the offspring at last comes to light in whatever shape belongs to its nature.

It is with the *ovum* of animals that we are most familiar ; for this is that stage of the progeny wherein it can be commonly exposed without injury, and is most frequently presented to view.

The ovum is an organic formation, usually generated within the parent, as in all the larger and more perfect animals, and with few exceptions, it is produced externally. It seems originally an inert mass, which unless *rendered prolific*, shall ever remain barren and unproductive.

With the various theories of the effective process, whereby the latter may be averted, I purposely abstain from interfering, farther than to observe, that in my opinion, no arguments sufficiently relevant are yet offered, to establish that those mysterious invisible animals belonging to the stronger sex, are instrumental in perpetuating the race.

No subject, however, can be of equally curious and interesting investigation, than how living animals are derived from each other.

The ova of most creatures are generated internally, as if it were necessary for the security of their tender elements. But, in certain tribes of the zoophytes, they are generated externally, and sometimes in great profusion.

The ovum is then protected by an integument, often affording little resistance, as in the Tubularia: or greater, as in the Sertularia, when lodged in a pod or capsule. The progress of the former may be traced as advancing from lower stages to maturity. But the early state of the latter, in as far as I understand, has not been yet detected.

Whatever be the original form, substance, or nature, of that which becomes afterwards recognizable as an embryo, or fœtus, it is at length contained in an ovum, along with a quantity of matter serving as pabulum, to sustain it throughout its advances until exclusion.

Meantime many important changes are undergone.

If a germ or a speck from depositation of the parents be the nucleus of the ovum, which is merely enlarged and modified in the course of increment, the earliest sensible form seems to be spherical, in preparing it for receiving the institution of life.

If in this state the early ovum, with the germ, be soft and ductile, expansion in one direction more than in the other, may render it ovoidal.

Simple prolongation of the extremities may next produce a vermicular shape.

Thence the early appearance of embryonic animals may resemble worms.

These are hypotheses, indeed, to be sustained or overthrown by observation. But, in certain respects, they are undoubtedly not altogether unfounded.

I have already remarked the opinion of some learned authors on the irritability sometimes betrayed by ova, and if I rightly understand them, that the ova are endowed with spontaneous motion. I must be permitted to repeat, that this is only inaccuracy of expression, for it does not appear that any such faculty belongs to the ovum itself:—otherwise the power must reside in the integument, whether a calcareous shell or a membranaceous capsule, which is not a logical inference. Any irritability or motion should be, therefore, ascribed to the contents, as having attained a particular stage. But motion, that is spontaneous motion, belongs more properly to the nascent creature, having escaped those integuments binding its parts compactly together, until liberated by birth.

(2.) *Planula, Corpusculum, Spinula.*—The originating being having absorbed the pabulum provided for it by Nature, and having attained the requisite degree of maturity in quiescence within the ovum, escapes from it into active life, but still to undergo certain marvellous metamorphoses in progress to equal perfection with its parent.

Metamorphosis or transformation, of which we speak as familiarly as if it were perfectly understood, is nevertheless a most obscure operation in animal physiology.

Can we say more than that it consists of the decay or diminution of certain parts of a living organism, and the unequal or disproportionate evolution of others in comparison to the rest? Something, therefore,—a certain form will ensue, which has not hitherto been.

The earliest sensible alteration in the ovum of the hydraoid and of some other zoophytes, is its elongation into an entire animal, rudely resembling the general outline of a tadpole, which we have designated a planula. By anticipation I may here cite, for a much stronger resemblance, the spinula from the ovum of the ascidian race.

In doing so it is not to dip more deeply into the theory already glanced, which considers the source of the fertility of every ovum as derived from the union or incorporation of one of the mysterious animalcula above named with it.

Certainly it is very extraordinary to witness so remarkable a resemblance to the tadpole, in such a number of animals in an early stage.

But, to assume that the invisible animal—one of its ten thousand fellows, belonging to the male, imparts life by its incorporation with the ovum of the female, and that from thence subsequent enlargement, evolution, and metamorphosis, for maturing a perfect being, shall ensue, has no shadow of probability.

In the genera above named, the Sertularia and the Ascidia, the form of the ovum resolves into the resemblance of the tadpole, the former less definitely than the latter.

Thus, without presuming to controvert the opinion of those profound physiologists, maintaining that the microscopic tadpole is instrumental in so wonderful a part, I most humbly doubt, in infinite deference to them, whether the consequent is not substituted for the antecedent; whether the early course of metamorphosis does not resolve into the microscopic form, instead of that microscopic form preceding the commencement of metamorphosis.

It is difficult, indeed, to reason satisfactorily on either side, where experiment can offer so little aid, or rather none, and regarding which even the unassisted senses of mankind fail of imparting knowledge.

The ancient maxim, *Omne animal ex ovo*, "Every animal comes from an egg," is far from fallacious. It may be duly appreciated in numberless examples, from animals at a certain stage. Did the microscopic tadpole fertilize the otherwise sterile ovum, the maxim would be inverted. On the whole, it seems more natural to presume that the host of animalcula found in so peculiar a medium as their dwelling, originates as the *animalcula infusoria*; that they belong to a multitude of ova, so minute as to escape detection by the microscope: or that they may be dissipated after discharging their contents: and that these contents will appear when in a favourable medium.

Yet all this resolving only into conjecture, let us stimulate the energetic naturalist to farther researches, in expectation of finding the truth.

The *planula* has been already described, as contained in a pod or vesicle, borne principally by the hydraoid Sertulariæ. In some, the vesicles amount to several hundreds on a specimen, and according to the species of the product, each vesicle may contain from one to thirty planulæ. The planula is endowed with active motion when discharged from the vesicle; motion may continue several days, when it is arrested: its elongated leech-like form shortens; contracts to a spherical segment, from the vertex of which a stalk speedily rises, crowned by a cell and hydra; and this is the originating figure of the hydraoid zoophytes.

The process attending production of the planula by the *Hydra squamata*, may be somewhat different; also of an animal of corresponding formation from another parent, the pectinate hydra of the *Virgularia*. But this demands some farther investigation, for I have not yet succeeded in ascertaining that other carnose zoophytes originate through the planular form.

Many zoophytes are perpetuated by means of a small organic body denominated the corpusculum or gemmule, for which no name more characteristic is yet adopted.

By this is to be understood that certain beings are generated in the body of the parent, endowed with the external properties of active life; spontaneous motion, apparent volition, and the like, on birth.

But when viewing them at large, they are so different in form, and belong to tribes so far apart, besides being subject to such diversified processes in the course of conversion to perfect animals, that they cannot be brought under general definitions.

The gemmule is minute, consistent, soft, of variable shape, covered or begirt by cilia, serving as natatory organs, and endowed with vigorous locomotive faculties. Its activity is often very great, its movements rapid:

it traverses the liquid element in all directions, evidently selecting its course, and occasionally seeking repose of indefinite duration.

But motion is at length arrested as in the others; perfect quiescence ensues. By progressive metamorphosis the rudiments of the animal are unfolded as a hydra: then a leaf, as in the Flustra, cells; or a better shape, with developing tentacula, as in the Actinia.

Perpetuation of the race by means of gemmules is seen among animals which systematic naturalists separate by wide intervals among the zoophytes, such as the Flustra, the Alcyonium, and the Actinia.

Neither the precise form nor the peculiar properties of the gemmule are yet sufficiently ascertained: nor have I understood that, as elementary stages of the Actinia, though manifesting themselves in the tentacula, they have been detected in the body of the parent.

An investigation of the disparities to be discovered among gemmules would be very desirable, especially as some seem organised in such a manner as is seldom satisfactorily exposed.

The original ovum of the larger and more perfect animals at length presents the germ or contents in the advanced stages of the embryo, gradually refined by progressive developement, as the fœtus preparing to be ushered into separate existence.

The young thus generated and matured is contained in a matrix specially designed by nature for its use and protection until reaching maturity. Acute research might perhaps discover some analogous provision in the perpetuation of zoophytes, could observation remount to an early epoch.

It rather appears that the elements of the young are generally in the lower portion of certain zoophytes, perhaps amidst the polyparium, and that they have a tendency to rise upwards as they advance, and can at last escape when mature. But an organization bearing no imperfect comparison to a real matrix, is also presented under certain circumstances, containing the young, as belonging to the higher products of the creation.

An ovarium composed of clusters of cysts, is generated externally on the head or hydra of the *Tubularia indivisa.* Each cyst is a separate integument or capsule, containing an ovoidal, soft ovum, embryô, or fœtus.

which is discharged on maturity, without undergoing farther metamorphosis than ensues by developement of the parts in evolution of rudimental tentacula from one side, and the origin of a stem from the opposite side.

This cyst bears the narrowest general resemblance to a matrix, in its long retention of an individual being, gradually nurtured there and brought to maturity.

These cysts, however, may amount to 500 ; each seems independent of the rest, though pendulous in clusters like bunches of grapes.

Whatever be the earlier stages of metamorphosis here, they have taken place before expulsion of their subject from the cyst.

The vesicle of the Sertularia, so profusely distributed over specimens, is a matrix of another kind, wherein an animal *sui generis* originates, and is nurtured until expulsion, when it has still to undergo a complete metamorphosis in progress to perfection.

Perhaps the nearest approach to a real ovum with an indurated shell, is seen in the ovum of the *Cristatella mucedo*, together with the ova of the Alcyonella, and the Plumatella, all compound zoophytes, with lunate ascidian hydræ. In these we observe that the ovum consists of two shells, like watch-glasses, which sunder naturally, as the young gains sufficient strength to quit this its early abode.

The precise relation between the hydra and the ovum of the Cristatella, is not explicit ; and it is almost equally obscure in the Alcyonella. Others may have done so, but I could never ascertain that there is a specific ovarium common to the whole specimen, situated in the common substance, the polyparium, basis, or sole ; and whether ova, one or more, be generated in each hydra. They have never occurred in such numbers as to sanction belief of this latter as the fact.

None of the hydræ of either the hydraoid or ascidian zoophytes above mentioned, are sensibly endangered from the existence of originating progeny. But, with the lunate zoophytes, maturity of the ova is the prelude of decay.

One mode of perpetuation among the simple and the compound Ascidiæ demands particular and attentive notice, from its singularity. Although these animal products be not strictly incorporated with zoophytes, remarkable analogies are discovered between them. This may not appear so strange, on reflecting that many distinct analogies between the animal and the undoubted products of the vegetable creation, can be described, though infinitely farther apart.

Here, a capsule or integument containing the embryo, is generated in the fleshy portion of the compound ascidia, at least it is there that we first find the object. This object is discharged singly, somewhat as the contents of a single cyst of the *Tubularia indivisa*, being an integument covering a minute animal, intimately resembling a tadpole or common pin. Thence, for the facility of recognition, it is denominated *spinula*.

This minute creature quitting its capsule or integument, is active, wriggling its way like a tadpole through the water. Like the tadpole, also, its form consists of a head and a tail. Its motion is arrested, the head adheres to the surface of the glass below, while the tail, at first remaining upright, soon wastes away and disappears. Meantime eight originating radicles rivet the head to its position, and they also wasting away, the head of the spinula in adhesion, is in a short time metamorphosed to an Ascidia. But this does not exhaust the generative process, for with the compound Ascidiæ, a second young Ascidia developes beside the first that came from the original spinula: then a third; and next a fourth, and thus of others, to augment the specimen: All, however, without the intervention of a second or additional spinula.

The animated productions of Nature are wonderfully advanced through various successive stages, generally so different from each other, that unless by following their progress, the existence of the same being could not be identified. These changes are denominated metamorphoses; because they seem the transformation of one subject to another, though, let us repeat, their principles and their course are very insufficiently understood.

Metamorphosis, however, seems always for the purpose of advancing towards perfection. Nature pursues a uniform course, and as the Author of the universe seems, by his mighty *fiat*, to have determined the distinct existence of every separate race, that each shall remain in its own individuality for ever, or until becoming extinct by means preventing its continuance, assuredly it is not through the medium of metamorphosis that new generations,—those different from the parent stock, can ensue.

I apprehend that until final perfection, the living being, under whatever difference we behold it, is only in a state of transition, of longer or shorter duration.

If admitting, that, as is probable, all the organs subsequently displayed in maturity, exist in the germ or other elements of the animal frame, metamorphosis seems to consist in what we deem the irregular evolution of some parts, and the irregular contraction, decay, or disappearance of others, while induration and other processes are advancing.

Throughout the progress of metamorphosis, the animated being is adapted by its form for the precise condition wherein it is placed.

If the elements of the future product be a germ, this germ seems to include the rudiments of the whole future specimen, not the elements of the Hydra or Ascidia only, but of all their accessories.

These are successively evolved, as more conspicuously seen in the preceding example of the compound Ascidia: also in the *Flustra hispida*, the *Alcyonium gelatinosum*, and the *Cristatella*.

The evolution of a single primitive animal is the foundation of all, as in the Cristatella; others are speedily generated. and the basis at length serves as a common polyparium for the whole colony.

The conversion of the active elements of the zoophytes, after discharge from the matrix, to forms so different, succeeding their stationary state, cannot fail to be compared to metamorphosis. This is not unexampled, indeed, especially in the insect tribes, and in other animals. In the first stage, however, the zoophyte is free: in the last it is fixed. Among other creatures, some are free in the first stage, motionless in the second; and finally free again. Still a third race remains free, under great modifications, or a lower kind of transformation.

The metamorphosis of most zoophytes ensues within a short time after their production in the earliest stage, as *planula*, *gemmule*, or *spinula*. All these soon appear under their ultimate aspect, in only a few days. But a long time elapses in bringing the embryo of the lunate hydræ to maturity,—many months,—not fewer than 200 days intervening from production of the ovum of the Cristatella, until its sundering shells allow protrusion of the nascent hydra.

On the whole, it seems more consistent to conclude that the elements of the future specimen are lodged in the germ, than that each successive hydra is derived from the first or from any one preceding its own evolution.

The race of the Polypus, or *Hydra proper*, is perpetuated by gemmation, or budding of progeny from the parent, as buds burst from the tree. Various learned authors, of older date, and also those more modern, among whom a skilful physiologist, Professor Allen Thomson, recently discusses the question of propagation being carried on by ova likewise. The general confirmation of such an important fact would be interesting to naturalists.

Independently of this, however, propagation is incessantly advancing by the developement of young hydræ from the body of the parent, which, without undergoing any sensible external metamorphosis, are perfected merely by evolution of the parts.

The fresh-water hydræ, yet believed to be in a final and perfect state as such, are minute subjects; but in the *Hydra tuba*, though in a state of transition, this process is beautifully displayed to great advantage from its infinitely superior dimensions, conjoined with its long and easy preservation.

A kind of twofold generation is carried on by some zoophytes, one augmenting the parent, the other perpetuating the race. A gemmule is discharged, founding a new colony, as by the foliaceous Flustræ, while the developement of new hydræ multiplies the original colony of the specimen.

A process not dissimilar may be ascribed, though less explicitly, to the Sertularian Zoophytes. A planula discharged from a vesicle founds a new specimen, while the old is augmented by developement of new shoots, bearing cells with their hydræ.

Generation by enlargement, or evolution of new parts augmenting the specimen, becomes very clear from the nature and formation of the *Alcyonidium mytili*. Here the cellular margin of the old subject is enlarged by a parallel row of growing cells, originally empty to appearance, but each subsequently occupied by an embryo hydra, which gains maturity as the cell is perfected. Several rows may be in progress at once.

Now, the first row thus newly generated, is thin and transparent, the sides of the cells indistinctly defined, while the centre is vacant. A second marginal row is generated from the first; and a third from the second, all proceeding outwards, and which, in their early origin, are precisely as here described. As these are advancing, a fourth perhaps appears, which is at that time the outermost, and alike transparent and empty.

The hydræ of the old marginal row may be still vigorous, or they may have disappeared by decay. The hydræ of the first new row adjoining it are yet only in embryo, while the cells of the fourth new row, daily becoming more conspicuous, are still empty: no rudiments of the future tenants are visible.

Shall it be concluded that the fourth, or external new row, is derived from either the first, the second, or the third?

The question here involved depends on similar principles, involving the source of increment, augmenting the *Flustra hispida* and others.

It is one of much interest.

The propagation of zoophytes is not so rigidly limited to certain seasons of the year as that of a multitude of other animals, terrestrial and aquatic. It advances apparently, at most times, vigorously and uninterruptedly.

But the lower tribes are not susceptible of organic evolution during the prevalence of rigorous cold. For this peculiar process, a certain temperature is always indispensable. The waters, however, are less readily affected than the air by refrigeration: And, in fact, I have observed the rate of multiplication during winter almost equivalent to what it is in zoophytes during spring or summer.

Nevertheless, Nature seems, by one of her paramount ordinances, to have appointed the more evident preparations for preserving the continuance of the animal and vegetable world, during March, April, and May, which is the principal season of the multiplication of zoophytes.

Possibly, in respect to the terrestrial tribes, it is that the young may be strengthened by approaching summer.

We may be assured, that although we cannot discover the purpose, none of Nature's provisions are vain.

8. *Life.*—The increment, the perfection, and symmetry of animals, is not the necessary concomitant, or the inevitable consequence of the mere formation of an ovum in the parent.

Concurring circumstances,—the institution of the vital spark, nutrition also, and progressive evolution, are indispensable.

Previous to birth there must be preparations for discharge of the vital functions after it, otherwise the nascent animal, liberated from its prison, would quickly perish.

We know not how these are carried on. But, it is evident that there are either different kinds of life, or gradations of the same kind of life. Thus there is the dormant or passive life of the ovum, until impregnation; and active life after it. We discover the dispersion of life throughout an animal, by the evolution into entire forms of its sundered parts: and we behold the unnatural growth of diseased portions, by some new vital energy, destructive of mankind as well as of all other beings.

Perhaps no important distinctions subsist between the life of zoophytes and that diffused throughout the rest of the animated world. But the most important functions, seen and explicable in the higher orders, such as digestion, circulation, and respiration, are extremely obscure.

In certain respects, the humbler products are more privileged than the chosen works of the Creation. Life often seems less destructible. Many can endure wounds and lacerations which would be fatal to the others; and important parts of their frame may be removed, not only preserving life, but the integrity of the original being may be restored.

Animals so endowed, enjoy indemnity, from a kind of *vis insita*, awakening the energies of active life for the restoration of lost organs. But how this shall be accomplished, how the new organization shall resemble the old in its evolution, must rank among the profoundest mysteries.

How does Nature guard against excess or defect?

Can we avail ourselves of the theory of germs? Can we presume that germs of the new elements are universally dispersed throughout the animated being enjoying such distinguished privileges, ever prepared for evolution if opportunity be granted?

Few intelligible examples are afforded to the physiologist. If a group of flourishing Tubulariæ is bisected, new hydræ soon crown the stumps. If the stumps be again bisected, the like will be repeated, and new hydræ will crown the remaining portions. This may be even repeated for the third time, or more, without exhausting the vital elements, regenerating perfect animals. At length it fails, nor does farther reproduction ensue.

Are all these renovations from new elements secreted and deposited in consequence of the successive mutilations exciting the energy of the parts; or are the new hydræ successively developed from the dispersion of pre-existing germs?

No known or definite principles guide us to the arrival of maturity in zoophytes, to the period when multiplication commences, when their increment ceases; or to the duration of their life.

Pregnant reasons inculcate belief of a longer existence being assigned to the tenants of the waters, than observers are generally disposed to concede.

But, how few of the inhabitants of the universe are reserved to die from age,—to cease to live, because the vital organs fail in decay to perform their office. How infinite are the means of destruction! Disease and accident are never idle: they are the grand destroyers of life: and so incessant is their operation, so constantly their activity before our eyes, that we become doubtful whether any special term of existence is assigned to animated beings.

Whatever precautions be taken in the order of things for preserving the race, and these are certainly great, it is obviously the will of Nature, that the former generation shall be overwhelmed and annihilated by the later, where increment is indispensably effected by the superposition of the successive strata of zoophytes. Thence does the last generation only enjoy that existence which it has thus obtained, and of which the course of time will bereave it.

Therefore, this fact is certain, that there are examples of the birth of the progeny being necessarily fatal to the parent; that the cotemporary survivance of both is incompatible with the ordinances governing their race.

Some among the zoophytes may be privileged by an existence of uncommon duration; but, like the fairest flowers, the vigorous luxuriance of the most beautiful is so transient, that they seem to live,—only to wither and die.

What profound subjects for meditation are the origin, the subsistence, the distribution, the extinction, and renewal of the vital principle throughout the universe!

It is an etherial essence, ever veiled from mortal eye, diffused amidst the whole. Its presence can be recognized solely when combined with that inanimate matter susceptible of its reception. Its fountain is inconceivable: it is unknown: the spark is struck; it glows—the breath is infused at a moment which none can tell.

Important changes follow the elicitation of life, which, from that moment, are advancing and maturing for the benefit of the being which is to enjoy them, as the medium of enabling it to replenish the world, by succeeding generations. Such is the grand device of Omnipotence. By the Deity having reserved the creative power for the exercise of his own authority, no more than the faculty of promoting evolution is granted to his creatures.

Thus, no subject whatever possessing the privilege of forming itself:—and all living animals being derived from each other: nor any tendency betrayed by matter, to frame subjects symmetrically constituted, that ever either testify or are adapted for the reception or demonstrations of life, we cannot allow that the universe has originated otherwise than by actual creation.

It signifies not whether the origin of each separate tribe be conjectured from a primordial germ, or the origin of each living being, from a secretion and depositation by the parent, comprising the elements of future evolution, when concurring circumstances shall stimulate or admit, it is only when the result is ripening, that the presence of life can be known.

It darkens early transparency, and hastens increment by its effects: it promotes the vigour of organic matter, and enables it to resist decay.

The presence of life arouses the consciousness of existence; imparts an anxiety for its preservation, and excites the expanding soul of man to lofty contemplations.

Let it cease;—the tenement which it occupied: the matter which as a medium, it endowed with activity and resolution, is speedily dissolved, and disappears amidst the surrounding elements.

ANALYTICAL INDEX.

CHAPTER I.—*continued.*

CHAPTER IV.—*continued.*

CHAPTER VI.—*continued.*

CHAPTER VI.—*continued.*

CHAPTER VI.—*continued.*

CHAPTER IX.—*continued.*

CHAPTER X.—*continued.*

CHAPTER XII.—*continued.*

END OF VOL. II.

TO THE BINDER.

The Binder will place the Plates thus :—