

RARE AND REMARKABLE ANIMALS

OF

SCOTLAND,

REPRESENTED FROM LIVING SUBJECTS:

WITH

PRACTICAL OBSERVATIONS ON THEIR NATURE.

BY

SIR JOHN GRAHAM DALYELL,
BARONET.

VOLUME FIRST,

CONTAINING

FIFTY-THREE COLOURED PLATES.



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ERRATUM.

Page 72, line 5, for *duodecilia* read *sexdecilia* (*cilis sexdecem*).

PREFACE.

THE substance of the following Treatise has been derived from a series of observations, protracted during many years.

Its scope is limited, being restricted entirely to the natural productions of Scotland, which I feel desirous of rendering somewhat more familiar to my countrymen, as those who must be the most interested in them.

The subjects introduced are comparatively few, from my entertaining less solicitude for multiplying numbers, than for illustrating qualities.

We are prone, in general, to condemn the lower animated tribes, as unworthy of notice and investigation.

But is it not arrogant to despise any portion of that stupendous CREATION, whereof we ourselves form only a single section? Is it right, that, dwelling amidst creatures occupying the same world, enjoying the same Divine protection, alike provided with subsistence, and privileged to prolong their race, we should remain in utter ignorance regarding them?

The true philosopher beholds the hand of the *Omnipotent* imprinted on every living being around him; he finds nothing too humble whereon to exercise those faculties benignantly bestowed on himself for enlarging his mind by acquiring knowledge. Thence he will discover that to each of the countless legions replenishing the world, along with his own existence, is appointed the fulfilment of a special part.

If the florist enjoys the bloom of those resplendent gems, which, void of evident sensation and motion, yet stud the verdant fields, or decorate

his gardens, and fill the air with fragrance, so much the higher should we prize those living tenants of the deep, withdrawn to testify the action and volition diffused throughout their beautiful and luxuriant flourish.

But this is only one of a thousand subjects adapted to invite our admiration of the works of Providence.

Let us examine the marvellous structure of animated beings framed for the maintenance of life; the organs allotted for the prehension, the reception, the internal preparation and distribution of the food for nutriment, and the benefit which it imparts. Let us contemplate the other animal functions, all relative, co-operative, and effective towards producing a common end, we are astounded alike at the contrivance and the execution. "How could this originate!" we exclaim. "How could such an edifice be reared, but by some *Supreme Architect!*"

Still, is this glorious edifice doomed to perish? Every year, every hour, nay, each moment, is advancing it to decay. Why should it be so? Death is the necessary consequence of life. Were not multiplication balanced by destruction, the earth would be soon overrun—incapable of sustaining its tenants: Nor can the human imagination figure that space sufficient to receive them to eternity. But while the lesser structure perishes, the foundation remains. To living nature is committed the means of replenishing the waste.

In endeavouring to ascertain the history of the animated tribes, it must be prosecuted from their origin to the close. We should behold them under the nearest possible circumstances to their mode of life in their natural abode. This, indeed, may be difficult. But spite of that tenuity of many humbler beings which almost eludes the observer's gaze, of that delicacy and fragility almost precluding his touch, their retreat from the light of day, and feeling the gentlest treatment too rude, patience and perseverance will infallibly reward his diligence.

The more important features to be considered, are form, feeding, breeding, and the habits of animals. The form cannot be otherwise demonstrated than by the living subject. The food being seldom present with the creature, is often to be found only by accident; the breeding may be seen from opportunity, though long sought in vain; and the exhibition

of habits is dependent on so many contingencies, as to require the careful preservation of life under the best conditions.

From such indispensable requisites for a Treatise on Natural History, it is obvious that the taste and qualifications of the historians of each must be diversified in their respective departments, that their opportunities shall be favourable, and their labours protracted.

The operations of Nature undisturbed, are those which demand our confidence. The real organization and habits of the inferior tribes are never displayed unless in a tranquil, vigorous, and healthy state. When under constraint, placed in an unsuitable medium, or enfeebled by disease, the finest specimens languish : they alter and contract, the relative position of their parts is disturbed, their functions are impaired : the organs most conspicuous or most important during life, often disappear entirely, or they are changed by death, beyond the hope of recognition. Thence can we do otherwise than reprehend and distrust the cruel operations and assumed results whereon too many modern anatomists have founded theories, from living animals—rather from animals in the agonies of death !

It is vain for one individual to claim the concentration of so many qualities as are necessary for the illustration of the natural history of even a single subject of the animal world ; whence, conscious of the superiority of my more distinguished fellows in the science, I confine myself to a narrow sphere.

My principal aim has been to render the external aspect and the habits of certain species of the lower orders more familiar to others, and especially to those who may not have had equal opportunities of personal observation.

In doing so, I have endeavoured to select the most vigorous living specimens of their kind ; and along with a general description, to present their resemblance from delineations by the most skilful artists. Nothing is described, nor scarcely alluded to, unless represented ; for it is irksome to read of what cannot be otherwise understood.

By suitable precautions, I have been enabled to preserve individual subjects, one, two, nay, even ten or twenty years, and, by this long acquaintance, to gain some information of their character.

The suitable mode of preservation depends on the nature of the race. But, after supplying their native element, first, the observer must guard against those destructive propensities of many of the lower animals, prompting them to wage war on each other. The *Crustacea* and the *Actinia* are fell devourers of whatever they can overpower. The *Asterias*, and the *Echinus*, and some of the leeches, are ravenous of prey. But the *Holothuria*, the *Amphitrite*, *Terebella*, and the whole ascidian tribes, seem perfectly harmless.

The element wherein the captives are kept should be always recent, generally pure, the vessels clean, and free of tainted matter. Some fall immediate victims to putrescence; others can resist it wonderfully, either endeavouring to escape by ascent, or by descent, according to their peculiar nature, or closing themselves up as if to avoid its deadly influence. The water for most of the *Crustacea* should be free of mud, and contain eminences whereon they may rest at will, above the surface. But muddy solutions are essential to most of the bivalve *Testacea*, and to all the ascidian tribes, unless belonging to some of the foliaceous or other zoophytes. Such solutions are grateful to certain *Amphitrite*, to many *Vermes*, as sand is to various species of the *Nereis*. Capacious vessels are commonly beneficial, and within them should be shells or stones for retreat and shelter. The presence of the common *Lepas* of the shore, is useful as an infallible guide, by its display, to the purity of the water.

The naturalist's earliest care ought to be obtaining an accurate delineation of his subject—always selecting the finest specimen—and taking it in motion, or when the parts are best unfolded. Herein it is preferable to employ another's talent than the naturalist himself, though a skilful artist. Many delusions are ever ready to mislead, but of two observers, each may correct the other. After delineation, the subject can be studied at leisure.

Respecting the representation itself, where indispensable to have figures larger than life, that is, as shewn by lenses and microscopes, nothing more is requisite than what will favour distinct inspection. There, the author and the artist should stop. We are now less removed from the reality. Preserving distinct vision, perhaps diminution will be preferable to

enlargement, just as a miniature of the human visage is more agreeable than one of colossal size. Besides, certain subjects become indefinite in proportion to the magnifying powers; where these are very high, unequal surfaces cannot be brought within a common focus. In general, the lower the power the better.

All specimens ought to be healthy, vigorous, and entire. A portion is seldom a satisfactory type for the whole. As the truth and accuracy of observation depend greatly on the number and quality of specimens, one only should not content the naturalist, nor should he dispense with many. Delineation ought to be the inseparable companion of description.

I have endeavoured to practice this rule throughout, from conviction of its utility.

Among many accomplished artists to whom this work is indebted, I cannot omit the late Mr Peter Syme, an eminent flower painter, who last superintended the academical department of his particular pursuits at Dollar,—also the late Mr Alexander Macaulay, an amateur who devoted much of his time to similar studies,—Mr John Welch, an excellent miniature painter, whose exquisite productions from the microscope are entitled to the highest admiration,—likewise Mr Andrew Thom, presently occupied in paintings for the Stained Glass Windows of the House of Lords, whose accuracy and patient diligence exceed all commendation.

It is not without diffidence that I venture to offer the following fragments to the public, seeing that there are numbers of the scientific world so much better qualified for the task. My purpose is repeatedly explained, as designing them to be viewed only as some detached Memoirs, composed from an accumulation of facts.

I profess no more than to speak of the living subjects I myself have beheld, and such as belong to Scotland. I disclaim all pretensions to discovery. I think, indeed, it would be difficult to name the first observer of Nature's offspring, whose race has existed since the beginning of time. If speaking personally of subjects occurring to me, it is by no means to disparage other naturalists, to whom I shall always render the homage due: if omitting quotation of the works of celebrity, it is from my inabi-

lity to procure them, nor will their candid authors impute it to disrespect. Men gain nothing by depreciating their fellows.

A treatise such as the present must be necessarily impaired by many inequalities. Lists of synonyms, so copiously introduced in the valuable writings of Lamarck and Dr George Johnston, become less important here, where every subject described is represented. Likewise, as the structure of the skeleton of zoophytes is very obscure during life, little is said of it, from being so copiously illustrated by this last named author, by M. de Blainville, an eminent French naturalist; and nearly a century ago by Ellis.

There may be numerous deficiencies in nomenclature: Nor do I entertain so great a reverence for new names, as immediately to abandon the old. Most of the arts and sciences, it is true, have a jargon peculiar to themselves, tending too much to obstruct the facility of their acquisition, though useful when conquered. But nothing can be more appalling to the eager student, in quest of knowledge, than a repulsive array of unintelligible phrases, intercepting the objects of curiosity from his understanding. Those familiar with names never think of enquiring after roots, nor would the greater part be easily comprehended if found. The language of social intercourse remaining unchanged, proves it sufficiently explicit without recurrence to roots for its derivation.

Neither have I hurried after the multiplication of genera, which now so freely adopted, will probably lead to such embarrassment, that an epoch may not be distant, when the more enlarged views of succeeding naturalists shall concentrate their number, by restoring the disjointed members to their previous position.

The sciences benefit little from the mere enumeration of a multitude of species by name, which must be held as a meagre substitute for the shortest commentary on their nature: Neither can the most copious description of living creatures convey an adequate knowledge of their form without representation.

The progress of science is very slow. New observations are seldom diffused in less than seven or ten years, unless those hasty and sometimes

inaccurate contributions to periodical publications. Dr Samuel Johnson, the lexicographer, remarks of the singularities of a cavern in the Hebrides, that he there saw what he had never seen before, “limpets and mussels in their natural state,”—an example of how little the most familiar objects are known!

If the naturalist expects ready confirmation of his discoveries or observations, he must occupy himself with subjects of easy acquisition,—with those which are not rarities. The common store of knowledge might be also enlarged by bestowing more attention on the productions of our own immediate districts, instead of seeking after those at a distance. Things common to us, may be to others very rare.

Some of the most desirable animals are frequently of the most difficult attainment. But the majority of living creatures are local: Food, soil, and climate, have spread them over the earth, and lodged them amidst the waters. A modern French author expresses his surprise, that the scarcity of a certain zoophyte, plentiful in his own country, should have embarrassed an English naturalist. If I mistake not, Professor Delle Chiaie, a learned Italian, affirms, that, from the Bay of Naples, he had obtained 2000 *Holothuriæ*,—an animal so rare in most of the British seas, that very few of our naturalists can say they have ever seen it alive. Though having myself been more fortunate, for at least 150 of different species have fallen into my possession, some of them surviving for years, it will be seen in the course of these Memoirs, how little information I can offer on the subject beyond those faithful representations after Nature, which I can find nowhere else:—Or how meagre my narratives of the *Lobularia*, *Terebella*, *Amphitrite*, and many others, though year after year was anxiously devoted to enquiries regarding them.

Of various other animals, I can do scarcely more, if so much, as skilful authors have left nothing important, besides, to illustrate their history. It is by uniting fragments that regular narratives are completed.

The sedulous naturalist must advance with a steady pace; he is not to be deterred from description, because unable to compose a dissertation: nor abandon his dissertation, from wanting illustrative views at the moment to confirm it. He must often renew his task, though often inter-

rupted: Nor easily discouraged, ought he ever to forsake his pursuit as hopeless. If it be difficult to determine truth, from the time and trouble of ages, how should we be guarded from error by negligence and precipitation?

Those who are animated by the love of science, who are endowed with liberality and learning—and, above all, the pious, who bow in veneration of the mighty Power of the Creator, will justly appreciate the true import of this Treatise, though impaired by the numerous defects inseparable from the works of mankind.

RARE AND REMARKABLE ANIMALS.

ZOOPHYTES, OR ANIMALS RESEMBLING PLANTS.

CHAPTER I.

THE waters of the world teem with organic life: the depths of the ocean harbour the most beautiful, rare, and remarkable productions; marshes, rivers, lakes, and fountains swarm with an host of animated beings, whose varied forms and isolated habits unfold another universe, pregnant with inexhaustible sources of enjoyment to the contemplative mind.

On surveying the legions thus dispersed, we are absorbed in admiration of the profound, the grand and uniform design which obviously regulates their existence. Each has its appointed time and place. No deficiencies restrain the action of those, but so many simple atoms to our imperfect senses, void of external or subordinate parts. No embarrassments confuse the exercise of what to us seem useless, unmanageable, or redundant organs: nothing precludes the operation of such functions as are essential for self-preservation, and the continuance of their race. Each has that perfection which is necessary for it individually, while

forming a portion of that harmonious whole wherein all are comprehended.

Entire tribes, as yet unnamed,—and many yet unseen,—incessantly originate, and flourish, and decay, where most remote from notice, or most inaccessible to mankind. When casually withdrawn from their recesses, it is as if in derision of our vaunted knowledge, and to prove our ignorance of the wonderful works of creation. Now the entire aspect of animated nature changes before us.

1. TUBULARIA INDIVISA.—*The Simple Tubularia, or Oaten Pipe Coralline.**—PLATES I., II., III., IV.—An animal product, which the superficial observer might conclude a flourishing vegetable, dwells at the depth of thirty or forty feet from the surface of the sea. This, a yellow fistulous stem, full of mucilaginous pith, is rooted on a solid substance below, and crowned by a living head, resembling a fine scarlet blossom, with a double row of tentacula, and often with pendent clusters like grapes, embellished by various hues, wherein red and yellow predominate.

Though perfect as a single stem, this production seldom appears in a solitary state,—two, three, fifty, or even an hundred and fifty stalks crowded together,—their heads of diverse figures, shades and dimensions, constitute a brilliant animated group, too rich in nature to be effectively portrayed by art. Plate I.†

The stalks of a numerous colony are frequently intertwined towards the root, which runs as a mere prolongation of the stem, on the subjacent substance, or descends over its side, in a tortuous form, in strong adhesion; but always destitute of radicles like those rivetting vegetable products to the earth. Many of the stalks deviate from perpendicularity by

* This may be defined, “Hydra sustained on a fistulous stem, wherein it is not retractile. Tentacula in two rows: ovarium interposed between them.”

† All the subjects described here, being represented from living specimens, renders a list of synonyms superfluous. The reader will find great assistance from the works of ELLIS, the Rev. Professor Dr JOHN FLEMING, Dr GEORGE JOHNSTON, LAMOROUX, LAMARCK, and other learned authors.



Entalium Indicum

From the collection of the British Museum

great incurvatures as they rise, bending at right angles, waving in serpentine forms, or quitting and resuming their original direction. All enlarge slightly upwards.

The head is a hydra or polypus, the general nature of which extraordinary race shall be afterwards illustrated. It consists of a central pouch or stomach, amidst a row of tentacular organs, which may be conveniently denominated *palpi*, nearly as numerous as another external marginal circle of from 15 to 35 larger *tentacula* or feelers, the number varying according to the specimen.—Plate III. fig. 1, *a, b*. The orifice of the stomach, rarely shown, when dilated exposes an internal dark red ring. Interposed between these two rows of larger and lesser feelers, and apparently originating from the external lower part of the stomach, are seen the ovaria, resembling minute protuberances in the beginning, and pendent clusters on reaching maturity. Their peculiar position in the vicinity of the stomach is a fact of much interest, when the analogies connecting the different species of hydra are investigated.

But, notwithstanding the ornamental aspect of the product, and the strict resemblance of the whole to a bouquet of vivid flowers from the hand of nature, there is no uniformity in the quality or proportion of its various parts; nor are any definite principles affecting either its luxuriance or its meagreness sufficiently understood.—Plate II. figs. 1, 2, 3, 4; Plate III. fig. 1.

The tallest specimens rise thirteen inches high, by about a line where thickest,—the height of the stalk being thus equal to 156 times its diameter; and the head expands 14 or 15 lines between the opposite tips of the tentacula.* But the height and diameter, the general luxuriance and the fertility of the product, have no reciprocal dependence on each other. The largest head is commonly borne by the largest stalk. Some of the finest appear, nevertheless, on stems only two or three inches high, very slender, and with scanty pith, the abundance of which substance is for the most part essential to vigour. Recurvature of the tentacula

* The finest specimens are always to be understood, when describing the dimensions of animals. I speak only of those occurring to myself.

denotes salubrity: their ruddy hue then descends a portion of the stalk, which is often longitudinally striated above, and of a rich orpiment colour, fading downwards.

The organs of prehension, nutrition, and propagation belong to the *hydra*, or *head* of the *Tubularia*. Here also is vitality demonstrated, by its turning from side to side, by the various tentacular motions, the action of the oral palpi, distension of the stomach, and discharges of half-digested food from its orifice, which may be held as the animal's mouth,—an incident seldom witnessed. But, excepting in its own immediate vicinity, the head exercises no sensible influence over the stalk; neither has the latter any vacant cavity for its reception, as some have been led to believe, from inaccurate description of the parts, nor can it be retracted.

This *Tubularia* commonly occurs in society, resulting perhaps from its mode of propagation, where the oldest and the youngest are approximated in the same group. As every separate stem enlarges insensibly upwards, the intertwining roots are concentrated within a limited spot below. A colony composed of 55 stalks, diverging five inches above, was rooted within the diameter of an inch. None rose above six inches; 32 were fine flourishing heads; 23 stalks were vacant. Another colony, occurring in 1843, consisting of 140 stalks, might have been received in a vessel seven inches high, of a quadrangular form, four inches wide, and under two across. The concentrated roots were limited to an area of an inch and a half by an inch. Great inequality prevailed among these specimens, nor were any luxuriant.

Specimens are generally founded on shells, entire or decayed, empty or tenanted. The latter seldom appear. A brilliant group once occurred on a shell which was carried along in its course by the crawling inhabitant. As few vegetate on stones, the calcareous matter of shells may be more favourable to evolution.

Reproduction of the head.—Though some later naturalists object to the application of the name of this portion of the animal frame, in describing the lower orders, it is a distinction too convenient, brief, and explicit, to be precipitately abandoned.

When the head of the *Tubularia* has attained complete maturity from

age, or increment, the tentacula become much recurved, their wonted regularity is impaired, and their extremities exhibit approaching decay. The pendent ovarian clusters spread luxuriantly over them; the central pouch, as if its faculties were exhausted, is empty and contracted, the whole betrays a languishing, sickly aspect. Next, a point of intersection may be discovered amidst the ruddy pith near the summit of the stalk; and the head soon separating there, falls amidst the surrounding element, but not to perish immediately: demonstrations of life continue during many hours; nay, they are protracted for eight days or longer in vigorous specimens.

Some analogy with the form of the simple hydra may be now recognised in this separated portion; and we shall afterwards find a correspondence between its condition and that of the nascent product in its earlier stages. But neither has the short stump, under the head, which is drawn from the stalk by separation any adhesive faculty; nor are the feelers of that extensile nature or prehensile power belonging to those of the hydra proper. Indeed, in their best and most vigorous state, their property is rather adhesive than prehensile, in regard to other objects.

Meantime, the florid summit of the vacant stalk is fading; a kind of cicatrix closes the wound. But on the lapse of a certain interval, it darkens again; an internal bud is advancing, which speedily ascending, bursts a transparent involucre, and flourishes as a new head, precisely from the same point whence its precursor had fallen, and of equally vivid hue.

Singular, to be told, the regenerative faculty is not exhausted here; for, after subsisting an indefinite time, this second head droops and dies, and is dissolved on its fall. Then it is replaced by a third, and the third by a successor. How often the like may be repeated—how many successive heads may be generated anew, throughout the whole life of the zoophyte, cannot be readily ascertained, and that for various reasons.

All marine productions dislodged from considerable depths are liable to the greatest injury. Though casually obtained clean and entire, most of them are profusely invested by parasites, which, fatally and invisibly wounded, speedily corrupt the circumambient fluid in their decay. Even

under the best conditions, no trivial embarrassments impede the artificial conservation of delicate creatures abounding in the sea. The water, also, sometimes contracts a noxious principle, from causes eluding conjecture and observation, But it may be fit to warn the naturalist against employing tall vessels, with copious vacuities above the water, on all occasions; for, if the air, vitiated by respiration, escaping from the surface, be re-absorbed, it cannot be otherwise than deleterious. This is well illustrated by attempting to keep fishes in deep vessels, with a scanty proportion of water, to prevent their leaping over the side. They generally perish in a short time; and hence shallower vessels nearly full are preferable.

Five successive heads have vegetated from the same stem of a specimen of this *Tubularia* in captivity, without computing those necessarily borne, as the medium of its previous prolongation. But it is not to be inferred that the reproductive power was then exhausted, for one so prolific, in the brief period devoted to observation, may regenerate ten or twelve times during the course of its existence.

Some remarkable facts attend renewal of the head; and first, the prolongation of the stem seems absolutely dependent upon it. Having lost its head, the stem to all appearance remains stationary, unless in the wound closing; but from the moment that the rising internal bud reaches the vacant extremity, in its integument, the neck, or that portion sustaining this young hydra, visibly lengthens, and so continues, until further prolongation is arrested, by the separation and fall of the regenerated parts. The wound cicatrizes again. If reproduction follow, by another embryo rising within to issue from the summit, a new prolongation ensues also; and so on with a third, a fourth, or more. Thus are formed as many nodes or articulations of the stem.

Prolongation of the stalk seems combined with the evolution of the hydra by one of the few invariable laws ascertained. But the irregular duration of the successive hydræ or heads, produces an irregularity in the accessions to the length of the stalk. One shoot extending six or eight lines may be followed by another of only two or three; and the prolongation seems scarcely sensible where the head flourishes merely to decay.

The utmost dimensions of this product are therefore as uncertain as the number of regenerated hydræ whereby they are attained. Let it be always remembered, that the prolongation of the hydra's neck is the sole medium of extension of the stem.

The tallest of a group in confinement had reached five inches in five months, after regenerating five heads; whence it must have borne at least six, including the first or original head. Instead of one, however, there might have been more. With greater care, this specimen might have proved more prolific. Others of the same group continued flourishing during a whole year by hydræ regenerating.

Where no articulation or node indicates the origin of a shoot throughout two or three inches, either the head has never fallen, or, on reproduction, the neck has been incorporated so intimately with the stalk, as to render the place from whence it issues imperceptible. The head has never been so permanent in confinement as to show that such remarkable elongation can result from the existence of a single regeneration.

The renovated shoot is flexible, especially towards the head. Greater rigidity ensues, as also of the lower portion of it, and the colour fades with time.

The reproduced hydra certainly originates below, as shall be afterwards illustrated; and sometimes the transparency of the stem exposes the ascending embryo while yet at a distance from the summit. Defective vigour may render its ultimate evolution abortive.

Regeneration of the head is an important process in the arrangements of nature, from its being the site of not only the organs essential for nutrition of the individual, but of those instrumental in the conservation of the race.

Propagation.—Several florid clusters, resembling minute bunches of grapes, with three, seven, twelve, or more berries in each, weigh down the most luxuriant heads. These constitute the ovarium, composed of so many capsules or cysts, each in an advanced stage, containing a single embryo or fœtus. The greatest disparity of size and number prevails among the cysts and the clusters, nor are they of uniform figure. Cysts, as mere protuberances, are associated in some bunches with those whose

contents approach maturity. Generally, they are somewhat lanceolate, or resembling an inverted pear. Each cluster is suspended by a hollow stalk from the lower part of the stomach in its vicinity; and each cyst hangs by a pedicle from this stalk.—Plate II. figs. 2, 3, 4, 5; Plate III. fig. 1. Clusters 2–4, 6–8, natural size: Magnified, 3, 5, 7, 9; also fig. 16.

The internal ovum seems connected with the stalk suspending the bunch through the medium of its pedicle, which penetrates the cyst. Perhaps this connection may be such as of the embryo in the vesicles of the Sertularia, with what later naturalists denominate the placental column.

The integument of the cyst is rather of a fleshy consistence, either opaque, or so thin and semi-transparent as to expose its contents.—Pl. III. fig. 9.*

Each contains a single embryo or fœtus, which on maturity is expelled slowly and gradually, as a minute, white, solid substance, from a dilateable orifice at the extremity.—Pl. III. figs. 10, 11, 12, 13.

I was long doubtful whether two were not included in a single cyst, especially as a dark septum seems to divide it. But one only in a spherical or ellipsoidal form belongs to each. Some are not half as large as others.—Pl. III. figs. 14, 15.

Soon after expulsion an irregular zone or waving line may be recognized on the circumference of the embryo, which, within a day, denotes originating tentacula. In earlier stages the animal resembles a star with obtuse rays, or the spokes of a wheel; figs. 20, 23. The centre is next prolonged in opposite directions: on the one side as extending oral palpi, on the other as the neck or stalk of the hydra.

But these are of slower progress; and meanwhile the discoidal or circumferential tentacula exhibit enlarged extremities in their elongation, whereon the nascent animal sustaining itself, reversed from the ultimate natural position, can voluntarily change its place. Now, the central portion forming the stomach augments in length, and decreases in thickness;

* Considerable latitude must be allowed to the signification of fleshy, membranaceous, gelatinous, and the like.

as prominences indicate originating palpi, the swelling extremities of the tentacula refine into points: the animal, still a simple hydra, endowed with locomotive faculties, reverses its position, and becomes permanently rooted on the plane supporting it.

Such is the issue of the process generally followed by Nature, and that sometimes within twenty-four hours of expulsion of the embryo from the ovarian cyst.—Pl. III. figs. 20–26.

But sometimes, also, the embryo is retained in the cyst until development is discovered by partial protrusion of the tentacula from its orifice.—Figs. 16, 17, 18. *a*.

As most naturalists deny that the inferior animals are truly viviparous, they may ask, Whether an ovum, an embryo, or a fœtus, has been thus expelled, particularly as the use of these characters is often too indiscriminate. By an *ovum* may be understood a certain organic formation, derived from the parent, involving the elements of a germ susceptible of the institution of life:—by an *embryo*, that evolution of the germ into such definite form as may be recognised by the beholder;—and by a *fœtus* that approach to maturity by the development of those essential organs which shall admit protracted existence, and the means of maintaining it after separation from the parent.

But nothing can be more obscure than the precise nature of what we denominate the germ: whether it be a recent organic atom, derived immediately from the parent, by some secretory process, and lodged in an invisible cyst or cell; whether of primordial origin it has subsisted as an atom, until the successive maturity or decay of preceding atoms wherein it was involved has set it free, that now, from concurring circumstances and conditions its own evolution may ensue. Neither is the commencement of the embryonic state to be sufficiently defined, farther than signifying the sensible formation of parts to be modelled for their respective functions in final perfection.

Nevertheless, we may conjecture that the germ is a vascular speck, originally eluding the observer's view, which becomes susceptible of the institution of life on attaining some certain stage or condition of its existence; that the presence of life admits the evolution of the various

parts, by the incorporation of matter derived from the parent, and that through the medium of what constitutes the other substance of the ovum. But how the spark is kindled, and especially how life is instituted in what is derived from androgynous beings,—as well as where Nature has determined different sexes, is wrapped in impenetrable mystery.*

The transparence incident to originating beings, denoting extreme tenuity, gradually diminishes as their rudimentary organization expands and consolidates. Whence, an embryo next recognised in advance to a foetus is seen under definite form, and the foetus is at length ushered into independent life.

But were it not for other conditions, apparently more depending on chance than arrangement, life shall never glow, nor can maturity follow; and these affect the largest, the most valuable, and most important products of Nature equally with those deemed utterly insignificant by the mass of mankind.

Though the elementary germ be susceptible of impregnation, or although by germination it may unfold as a bud bursting from the parent, unless for a certain degree of temperature evolution cannot ensue. Heat is a positive condition: it is indispensable for its organization acquiring sufficient capacity for nutrition, and the consequent benefit.

Should the progeny be considered an ovum on expulsion, instead of an embryo or foetus, that state is very transient, for it resolves almost immediately into another form by the evolution of other parts. If casually retained in the cyst, its expulsion as a foetus quickly follows.

All regenerated portions of the adult are at first invested by a transparent spath; nor is it improbable that some delicate amnios surrounds the organic substance expelled from the cyst, whose presence is disguised by excessive tenuity.

Nothing can be more remarkable to the spectator than finding the progeny free, while the parent is immoveably rooted—sufficient evidence that there is nothing of vegetable nature in such zoophytes. It is as strictly

* I am not ignorant of what is a modified theory of older date, much insisted in of late,—that a minute creature, whose parts elude human observation, finds a nidus in the ovum, and thence becomes the real source of future increment and organic vitality,—also that a being reputed androgynous may fructify itself.

an animal product as an *alcyonium* or an *ascidia*, whose original *corpusculum*, *planula*, *spinula*, *larva*, or by whatever name may be given, which by nature becomes rivetted to some solid sustaining foundation.

The nascent tubularia thus free, and capable of selecting its position, loses that faculty never to be regained and is rooted at an indefinite period—sometimes in the course of one day, sometimes on the lapse of two. But quiescence is essential here. Should frequent disturbance alter its place, the adhesive power seems to be impaired, or the creature rendered incapable of its exercise. The increment of those which are rooted in early age is commonly much more rapid than that of others. Specimens discharged from the cyst on the 1st of January, and affixing speedily, were about four lines high in seven days. Those whose adhesion had not ensued were infinitely smaller. With the latter, it is not improbable that, instead of the softer extremity vegetating downwards and remaining susceptible of adhesion, it becomes invested on exposure by an intercepting epidermis.

At the stage of early adhesion, the tentacula, which are 14 or 16 in number, appear alternately set as in a higher and a lower circle; and the stem is somewhat of variable figure—both probably indicating the softness of the parts or the result of it.

All nascent Tubulariæ are of the palest grey; and for the first fortnight, the length of the tentacula and general dimensions of the hydra are proportionally greater than in adults. But the stem is seldom straight; sometimes also, irregularities are seen near the root, which, as already remarked, has no radicles.—Plate III. fig. 28: The same enlarged, fig. 35.

The head of the nascent tubularia falls after an indefinite period, just as with the adult. But life is so feeble here, that the first is rarely replaced by a successor. That of a specimen bred from the ovum in April 1825, fell eleven days from its evolution; but one bred in January 1841, subsisted thirty-seven days, being longer than any other.

A nascent tubularia, with a flourishing head of fourteen or fifteen tentacula, regenerated one with only seven, which fell on the third day, and was not replaced.—Plate III. fig. 39. Another, bred from an ample ovarium, was so firmly rooted in two days that its vessel might be safely emptied. It had fifteen tentacula, which extended a line a week later;

the whole product being white and very vigorous: the head fell in twenty-one days from the first, leaving the stalk nearly four lines high. In seven days it was succeeded by a second, also pure white, but with only eight tentacula. This subsisted eleven days, without acquiring the vigour of its precursor:—Plate III. fig. 40; enlarged, fig. 41, distinctly shewing the ascent of the neck from within. In a recent instance the second head of a nascent specimen was developed with six tentacula.

Considerable difference is presented by the aspect of different nascent animals from the cyst, and especially in the curvature of the stem, so seldom straight, which may be influenced by the hardness and smoothness of the glass, whereon in this artificial state it was founded throughout the course of my observations.—Figs. 20–41.

There are also considerable disparities in the comparative dimensions of the head with the rest of the product;—as well as in the comparative rates of increment of those which are fixed or free,—all resulting, perhaps, from the pabulum afforded by their respective site. Of four nascent tubulariæ, produced in April, two had seventeen tentacula, one fifteen, and the other fourteen. The last never adhered, but it grew more rapidly, and on losing its head, had extended half an inch,—exceeding the others, though the head of one subsisted at least thirty days.

Thus no undeviating rule is prevalent in determining the circumstances incident to the existence of the tubularia, although the necessary conditions under which the race shall be preserved are governed by general laws.

Vigour is indicated by the number and size of the tentacula; but the delicacy of the product seems to preclude its preservation until the ruddy tinge of maturity darkens the original white of the nascent tubularia.

It may be questioned whether, according to the common course of nature, the fall of the head should precede the expulsion of the fœtus from the cyst. From the evident accessions received by the stalk, indicating renovation of the head, we may certainly conclude that this incident constantly occurs to the product in its proper abode previous to removal from it.

We collect from the preceding detail, that an external ovarium is situated among the other parts composing the hydra or head of the *Tubularia indivisa*;—that the unusual recurvature of the tentacula, their irre-

gularity and symptoms of approaching decay, augment in proportion to its advancing maturity, while the aspect of the stomach also indicates that its functions are required no more. It is impossible to overlook the correspondence of these conspicuous facts with that uniform principle of Nature, obviously testifying a warmer solicitude for perpetuation of the progeny than for the permanence of the parent. How few are the effectual provisions for warding off a mortal blow from the strongest or the weakest of animated beings? How numerous the cares and precautions that others shall exist? How infinite are the means of destroying life! The elements themselves seem to conspire against it. Myriads which have lived perish in a moment; while the lapse of time is demanded for their evolution and maturity,—yet Nature forbids extirpation of their race. Whence is utter destruction counteracted, and inevitable fate compensated by multiplication.

The cyst expels its contents as a sphere or an ellipsoid, from which external organs are about to unfold;—or their evolution may ensue while still retained within it. But, the head carrying along with it the whole ovarium, is likewise observed to separate; and in falling to dissolve amidst the circumambient fluid. As all our observations here are restricted of necessity to the artificial state of the product from confinement, it may be demanded, which of these alternatives is the natural process?—Probably expulsion of the fœtus from the ovarium only. There are reasons for believing it so.

Concomitant decay of the parts being conjoined with progressive maturity of the embryo, did the fall of the head bring down the whole ovarium along with it, supervening putrescence might contaminate and consume the contents in whatever stage. This ensues, indeed, very often in confinement;—the fallen head, together with the ovarium, become a common mass of corruption. Therefore, expulsion of the nascent being from the cyst, should precede the fall of the head;—which seems to be required by the laws providing for conservation of the race. Whether a second progeny may be then generated in the vacant cyst is unknown. The permanence and vigour of the head, however, are perhaps exhausted by the discharge of the first.

Yet a new ovarium develops from a regenerated head, if it be sufficiently vigorous ; whence the fall of an old prolific head does not seem to be accidental but a provision of nature.

Probably the evolution of an ovarium from a regenerated head is restrained by the famine suffered in confinement impairing the general vigour of the subject ; thence it is not common. Nevertheless, examples do occur, though always on a limited scale.—Plate II. fig. 5. enlarged. None have ever appeared as ample clusters, or have hung in luxuriance.

The clustering ovaria are generally confined to the largest heads, and for the most part, March and April may be held the chief season of propagation, though, as common to various other zoophytes, it is not absolutely excluded from any period of the year. Let the influence of temperature on organic evolution be kept in view, we shall see that the bottom of the sea not being subject to the same alternation as the surface of the earth, nor exposed to similar refrigeration, may account for that incessant generation and reproduction which seems to suffer little interruption.

The finest ovarium ever occurring to me was in February 1826. On gross computation, between 200 and 300 cysts were distributed among ten or eleven clusters, composing it. The head laid on a flat surface spread like a star, the opposite points of the rays about nine lines asunder. But the multitude of parts in such limited compass, precluded distinct inspection of the division and subdivision of the clusters, and the peculiar appropriation of the cysts to each ; likewise satisfactory delineation of the whole was impracticable. In March 1841 and September 1842, clusters of ovaria were seen depressing the heads of tubulariæ by their weight. Some heads bore nine clusters, and some clusters had thirty cysts.

Throughout animated nature, there is not a subject better adapted for profound contemplation, or which can excite greater admiration of mankind than the enclosure of a germ susceptible of life and evolution as a perfect being in an egg. What device alike suitable could have been contrived as adapting a point—that which *has no parts and no magnitude*—to carry on successive generations, accompanying the infinite course of time ? Let the mind wander over the boundless extent of the animal kingdom ;—let our sight behold the varied—the endless, the indescribable forms com-

prising life—as if exhausting every combination of matter ; astonishment bewilders our conceptions of the transcendant Power which could fashion them into definite shapes. It seems as if some ancient world were shivered, that breath might be infused into every fragment.

Some may ask, indeed,—Could not the attraction, the approximation, and concurrence of inert particles display the form of living animals by intimate or reciprocal incorporation ? Could not the vital spark be elicited by some very simple process, though veiled from mortal eyes ? Life, we know, is dormant in the originating being ;—matter, we know, is susceptible of its institution there ;—nay, that we can be instrumental in awakening it at will ;—that resolving that it shall never glow, the matter wherein it might have been unfolded perishes irretrievably, or it must sleep in eternal night.

Yet, what unless design could appropriate the respective parts of the animal frame, what could guide the vital stream, expand the muscles, lubricate the joints, or appoint the organs to do their office, such as Nature requires to be done ?

How many theories vanish, how much illusion is refuted and dispelled, in contemplating the perpetuation of the creatures filling the universe ? A definite plan is betrayed, and a regular arrangement for its execution, which cannot have sprung of simple casualties. The living world contains in itself the means of replenishing the void of futurity.

Thus the propagation of this humble zoophyte—a subject which of all others might be presumed the most inexplicable, as the farthest withdrawn from human notice—is not altogether beyond elucidation. Along with its birth there was a provision for its permanence.

Let us now resume a few general observations on the reproduction of defective organs, such as shall replace those necessarily perishing by the fall and dissolution of the head.

It might be naturally assumed that the summit of a vacant stalk contains in itself the elements of regenerating parts. But none are truly there : they reside elsewhere, as we shall easily demonstrate.

In the nascent animal, the stalk vegetates downwards from the disc : no inferior parts are yet present from which the disc could vegetate up-

wards. If, in this first instance, the stem descends from the elements of the disc, or perhaps, in more correctness, from the vicinity of the stomach, it is probably from the elements of the like originating parts in all subsequent regenerations. This, indeed, is not to be readily understood or explained, for we always presume the disc as at the highest point, where it actually appears as sustained on the regenerated neck. But we must conceive what is the earlier stage; and it will be allowed that the process is advancing within the tubular stem. The rudiments of the essential organs are in preparation to unfold before the regenerated mass has rose so high as to present itself to view. Thence it may be concluded that the whole evolution is developed from the head as reproductions from the simple hydra or polypus. This would sanction the presumption that the elementary organization of all the subsidiary parts resides in what we denominate the head of the tubularia.

Overpassing the point, however, for the present, we shall devote a paragraph to the occurrence, the frequency, the intervals, and the concomitants of so wonderful a property as the renewal of defective parts, one which seems to retard the stroke of death, and almost to defy mortality.

But the finest, most luxuriant, picturesque, and interesting specimens are less adapted for protracted observation than those which are meagre and solitary; for the latter are neither so ready to spread corruption from their exuberance, nor do destructive parasites find a hidden asylum there.

A group of thirteen obtained on March 29, had had three vacant stalks; the rest bore heads in various stages.—(Pl. II. fig. 1, half size.) All had fallen on the 31st; but the ruddy tinge of the three vacant stalks now announcing speedy reproduction, a head with 22 tentacula issued from one of them, on the 6th of April, though to enjoy only short existence, as it fell on the 9th. It was replaced on the 21st, by one with 18 tentacula, which fell on the 26th. (Fig. 1, *g*.) The head *b*, originally with 20 tentacula, flourished April 9, and decaying on the 15th, was replaced by another with 20 tentacula also, which fell on the 30th. The heads *c* and *d* flourished April 10. The former, on its fall, was replaced on May 4 by a new head, which fell on the 9th. On the 7th of April *e* flourished, and it decayed on the 11th. On the 5th, the head *f* flourished, and it still subsisted

on the 11th. The finest of all flourished on the 7th, and fell on the 15th of April. This group afforded no farther reproductions.

Omitting various subordinate facts, the preceding abstract shows the absence of all the heads on March 31st ; that six were regenerated against the 9th of April ; that two were produced in succession, on *b, c, g* ; farther, that the intervals of their presence and absence were irregular.

Another, a different specimen, flourished on November 21, and the head fell on December 8. It was succeeded on the 19th by one with 21 tentacula, which fell on the 30th, and was replaced on January 4. by a head with 20 tentacula, which fell on the 11th. Another head, the fourth, with 17 tentacula, had regenerated on February 4, and fell on the 8th. Still a fifth head, with 21 tentacula followed on March 5, proving but evanescent, for next day it had faded and fallen.

Thus, independently of the heads preceding the first above specified, which had been indispensable for raising the stem, at that time to the height of five inches, other five, we see, had flourished in succession, from the 21st of November until the 6th of March.

The reproduction of six successive heads, from November to April, on the tallest stalk of a fine specimen was proved in another instance, though the subject had been much neglected during the interval.

The regenerative faculty of this animal product is very great ; the latent germ seems ever ready for evolution while the vigour of the stalk remains.

None of my observations have been sufficiently protracted to determine its utmost extent.

But is there any vegetable product to rival it in these climates ? Any one which blossoms and fructifies so often ? We admire their exuberance if they flourish twice within a year. How infinitely more fertile must this be deemed, if its most essential organization be renewed repeatedly within a month ! Should comparison with vegetables fail, let us inquire whether the lower animals afford a parallel ? I am not aware that any has been hitherto named.

The germinating powers, however, seem gradually exhausted by reproduction ; for the energies required for each evolution are feebler and

feebler, so that frequency represses luxuriance. The succeeding head never inherits the exuberance of parts and the ample dimensions of its precursor. The swelling clusters of the ovarium are never regenerated, nor are they followed by other than simple rudiments, unless in the rarest instances. Scarcely more than mere ovarian protuberances are reproduced in confinement. The extremity of a stalk having been injured about the 9th of January, after losing its head, subsequent enlargement of long continuance there was remarkable. At last, a fine new head protruded on the 9th of March, surpassing the vigour of any regeneration previously observed. Besides 34 or 35 tentacula, regenerated clusters were indicated in three days, by three rows of protuberances, some of them developing into bunches of five cysts, before the fall of this new head, which subsisted nine days. Here the pouch or stomach, guarded by numerous oral palpi, was much distended.—Pl. II. fig. 11.

There seems, on the whole, a progressive diminution of the reproductive energies amidst great irregularity in their exhibition.

Although the earliest animated condition of the tubularia is recognised under considerable analogy to the hydra proper, its race is not perpetuated after a similar mode, namely, by external germination; nor do I know any of the zoophytes where the polypus or hydra is combined with other parts—where multiplication by the young issuing immediately from the parent's body, though often very near it, augments the species.

Pith, or Medullary Matter.—The casual observer may be prone to conclude that vitality resides throughout every portion of the stem of the tubularia, because experiment can produce superabundant organization, that a greater number of essential living parts shall result from artificial interference than are allotted by nature amidst her undisturbed operations.

The stalk of fine and florid specimens is replete with a yellowish tenacious mucous matter, completely occupying the whole, or accumulated in irregular ruddy masses, separated by transparent intervals denoting vacuity. Sometimes a surprising discharge issues from the headless summit above, or from the ruptured root below, when torn off its foundation; and sometimes continuing to flow for several days from either. We know nothing farther of this substance than that its presence shows the healthy state of

the product, and that its absence indicates or prognosticates decay. Though not putrescent in itself at first, the water is so speedily tainted by it that the subsequent preservation of specimens needs to be scarcely attempted.

This peculiar substance appears to have an important influence over life and organization.

If, admitting the evolution of living animals, from an elementary principle comprising the rudiments of their organs, we find a profound and difficult question,—Where is the site of the germ?

This elementary principle may be conjectured as either of primordial nature, existing an atom, involved by a series of other atoms, each developing into sensible form as opportunity admits; or it may be conjectured to result from a deposition of matter, secreted from the mature living product into some cellular receptacle, whence it shall be subsequently evolved when in such a state as to be susceptible of attaining an independent condition.

If the germ be lodged amidst the pith, there seems no point throughout the whole length of the stalk from which it may not be developed, and that far below the summit, should the portion above be sundered. Nevertheless, we must guard ourselves from that delusion, where, of a subject to be so imperfectly discovered, there may be a bud in progress, which we believe is yet only a germ.

Wherever the germ or the bud be repositied, the presence of the pith is indispensable for the reproductive process; and whether the elements of this process be displayed as internal germination, resulting from secretion and deposition, on springs of a primordial germ, the principle appears to be lodged below. That this may be presumed is, first from the new heads of *natural* reproduction being observed to rise in the tubular stalk; secondly, from the numerous reproductions obtained by artificial sections.

After attaining a certain age and consistence, the elementary principle is present of definite size and form in the course of its ascent; yet, while still insensible to view, and in some early stage it is susceptible of injury, of laceration, and partition by an edged instrument, as is proved by its future evolution, with distorted, multiplied, or superabundant parts.

Supposing the summit of three or four stalks amidst a group to be

vacant, a head in various stages of advancement in each respectively, will be seen a little within the orifice. One which thus presented the tip of the tentacula at noon, protruded part of the disc a few hours later.

The ascent is sometimes speedy, sometimes slow and gradual. The bud, when near maturity, sometimes appears rather in a spiral form, bursting a transparent delicate spath, as it protrudes from the summit of the stem. An internal bud of this description, noted as three lines below the extremity, reached it in three or four days. A nascent tubularia, bred from the cyst, having lost its head, a new bud was some time afterwards discovered, at a third of the length of the stalk from the summit. It flourished through the course of the day following that of observation.

When the continuity of the pith is interrupted, the vacant part of the stalk becomes of a fine transparent horn colour, which allows the formation of a regenerating head, preparing from the upper portion of the internal mass of pith below, to be discerned. This aspect being presented at the distance of an inch from the summit of a stalk, it was sundered near the place, to facilitate the exit of the reproduction, which could not have ascended the original vacuity in vigour. Not only did the bud rise half a line within to the point of this artificial section, but it projected half a line farther. Nevertheless, it went to decay though florid.

The progressive ascent of the head is demonstrated both by experiment and from exposure by the transparency of the stalk. But it can be hardly maintained that the germinating principle is universally diffused amidst the pith, or that the ascent of each regenerating head commences from the lowest part of the root immediately on privation of the original organization.

However, several regenerations in different early stages may be advancing at once.

A new shoot in flourish was deeply wounded, almost to separation of the parts. Restored to its element, the head had turned round and the point of adhesion was nearly ruptured. Yet the lacerated parts recovered their natural position, and their edges having applied together, they seemed to have united in forty-eight hours. The head which had previously flourished nine days, fell seventy-two hours after the experiment. The

new shoot had elongated nine lines, and the wound had been inflicted six lines below the disc. Now a slight enlargement became sensible below the site of the wound. In twenty days a new head, still invested by its spath or involucre, though three lines high, was unexpectedly issuing from the stalk, and burst next day with twenty-two tentacula, its precursor had only twenty, and it proved a fine specimen.

This regeneration had suffered nothing from the previous wounding of the stem, either because the minuteness of the germ had eluded the edge of the instrument, or, which was more probable, because the early bud had not rose high enough to be injured.

Root.—Little is to be explained regarding the root of the Tubularia. Its origin seems subordinate to that of the head: it advances downwards, and extends superficially. But the vegetative principle here, so conspicuous and so vigorous in plants, is apparently much more feeble in this animal product. Zoophytes, it must be remembered, have no proper penetrating or spreading root, comparable to that which is reinforced by accessories in the other kingdom. The root of the *Tubularia indivisa* runs in a kind of irregular cylindrical form, somewhat distorted, insomuch, that Ellis describes the subject as arising “from small worm-like figures, many of which interwoven together, look like the guts of small animals.” He alludes hereby to the congeries descending from a group, for the root of an individual specimen is single, appearing simply an opaque yellowish, more solid and compact prolongation of the stem. Such prolongation is seldom seen in an artificial state, nor, when it does ensue, is the adhesion alike firm as in the natural state, where it is very strong. Extension of the stalk above depends exclusively on the evolution, together with the duration of the head, for the increment of the one is regulated by the subsistence of the others. But, as far as can be ascertained, its prolongation downwards is independent of either; nor is it ever so rapid and evident. Both the extension and the diameter of the root augment with age as demonstrated in older specimens: its course is always superficial, sometimes descending over the edge of what may sustain it, but scarcely sinking the least into the surface of shells of softer substance. There is no diffusion of parts here as with the root of some nascent *Sertulariæ*.

Circulation.—A subject of much interest might admit of some discussion,—namely, does any vital fluid, resembling the blood which circulates throughout the system in the higher order of animals, perform a corresponding function in this race of Zoophytes?

Here I acknowledge my observations have not been conclusive. Some authors affirm that they have witnessed currents ascending and descending the stem of the *Tubularia indivisa*. On no occasion have I been alike fortunate. I have subjected all different specimens, ages, and parts to the microscope;—all different views and positions have been chosen; yet I was uniformly unsuccessful. Nascent specimens, still of the palest grey, almost white, which were more manageable than adults, never afforded any evidence of the fact.

Nevertheless, let not these remarks be held as an imputation on the accuracy or on the veracity of other naturalists, though I have no reason to believe their vision more acute, or their instruments more perfect than mine.

Extraordinary embarrassment always accompanies the diminution of light, from the use of such powerful magnifiers as are necessary to bring very minute objects into view. Thence, although present, they may be concealed amidst the supervening obscuration.

All that I can say, therefore, concentrates in my inability to discover circulation in the *Tubularia indivisa*—reminding the reader that some observers of no mean note have denied facts advanced by naturalists from the same cause, which later authorities confirm. One example may be given in the cilia fringing the tentacula of certain zoophytes.

Having thus briefly disposed of the course of the natural functions uninterrupted, our attention may be now directed to the results of a few experiments regarding the nature of this zoophyte, from which physiologists may possibly draw some deductions subsequently, although presently appearing matters more of curiosity than use. From these we shall discover, in the first place, that superabundant organization may be probably promoted artificially.

Should an animal be seen slumbering in apparent death from privation of the heart, and if life, motion, and activity were to follow the resto-

ration of that important organ, surely it would be a most interesting question—"Did the heart decay by nature, or was it violently reft from the carcass?" The hydra of the zoophyte is to its existence as the heart in the quadruped.

Effect of Wounds and Lacerations.—A blood-red spot generally remains below the point of separation in the pith, from whence a head has naturally fallen. But this is not an internal embryo rising to displace the head; it seems only a residue of that obtuse prolongation of the disc descending into the stalk, or of the pith itself which had joined the head. This descending stump, which is inserted for about a line into the stalk, is sometimes withdrawn entire from the tube as a part of the hydra, then quitting that sheath as an independent substance. The pith under its greatest consolidation is very tenacious. A perfect portion extending nine lines, fell out of a section of the stem after it was sundered; likewise, portions entire may be blown out of short sections by the mouth. The former of vivid red was nearly as solid as flesh; at least, much more consistent and more tenacious than jelly. Part of the pith seems always to separate along with the deciduous head.

The regeneration of the ovum in the cyst being void of probability, and as the fall of the head in our cabinets, without violence, produces the same nodes or articulations of the stem as are found on specimens withdrawn from the deep, the elements of a new head to replace the old one should be preparing on purpose, that perpetuation of the race shall continue.

Experiment seems to confirm the fact. In the natural state only a single head can subsist on a stalk. More than one at a time is the result of monstrous conformation; nor does this appear once among five hundred specimens. Indeed, I have never witnessed it above twice or thrice through a very long series of observations. In the first instance, a much smaller head issued from the side of a stalk than that crowning the summit, and about half an inch lower. Another specimen afforded an example of two stalks, about half an inch long, issuing from a common aperture still lower in the side of the main stem, and diverging as they rose.—Pl. IV. fig. 25. A third consisted of a stalk, five or six inches high, forking

into three limbs, all in flourish. The head of the main portion, evidently the fourth in succession, had 25 tentacula, that of the lowest 22, and the intermediate head, borne on the shortest stalk, interposed between them, had 18. These heads, being deciduous, and new heads replacing them, proved the participation of the whole specimen in the identical nature of the Tubularia.—Pl. IV. fig. 26.

In such cases, the observer must beware of assuming a nascent Tubularia, which evolved from an ovum falling on some neighbouring stalk of a group, and affixing itself there, thus presents apparent monstrosity. Here, however, a generating root would betray the truth.

A luxuriant head having fallen from a specimen, the stem, previously detached from its original site, was now portioned into three sections, the lowest two inches long, each of those above it one. When entire, the higher was thrice the diameter of the lower extremity, for it will be recollected that the stem is smallest at the root. Nothing resulted from the highest section, where it might have been most expected, although it was not in decay, and five months afterwards contained fluid matter, originally the pith. But in ten days a head burst from the lowest section, where it might have been least expected; and in fourteen one from the top of the middle section. Both were flourishing sixteen days from the date of the experiment, and so continued during a fortnight, meantime generating as usual a light carnation striated neck, half an inch long. Thus was superabundant organization obtained, because two heads cannot naturally subsist at once on the same stalk, nor in the same perpendicular line. The lower extremity of these sections adhered to the side of the vessel, which rarely happens, and both ascended in diagonal elongation during absence of the heads. Some expectations were indulged of a head germinating from the lower extremities reddening and becoming very obtuse, which would have been opposite its natural place. But nothing followed. We shall afterwards find examples of such a generation among the hydraoid zoophytes.

The preceding experiment proved that the evolution of an elementary hydra—a germ or embryo two inches down the stalk was promoted by an artificial section.

It does not appear that the embryo ultimately constituting a new head displaces its precursor, that its rise and developement are so immediate as to bring the two in contact.

The distortion and monstrosity consequent on wounds indicate that the injury is received while the embryo is below ; but the variable and irregular evolution of the parts embarrass our investigation of the original site of the germinating principle.

In a comparative experiment to ascertain the concomitants of postponed evolution, two congeries of intertwisted stalks were cut over. The one was founded on a stone, the other on a shell. More vigorous reproduction ensued from the latter, where the section had been twenty-one lines above the root, than with the former, where within six lines of it. Conical projections arose from all the stumps, and in thirteen days a minute head sprouted from one of each congeries. Eight sprung and flourished ultimately from that on the shell, but the last not until 63 days after the first, by which time, the stump advancing fastest had regenerated three heads, and was reddening again—the wonted prognostic of subsequent evolution. This congeries is represented as appearing 20 days after the date of the sections, Pl. II. fig. 6, and 67 days later than this figure, by fig. 10. Its intermediate stages are seen in figs. 7, 8, 9.* The heads had 12 or 14 tentacula ; they were generally of short duration, the stalks frequently abortive ; and in about three months from the date of the experiment they ceased to flourish, though again reddening. In eight months observation was finally abandoned. I now speak of the group upon the shell remaining after separation of the upper portion of the congeries.

The sundered or upper portion of this same group was found flourishing sixteen days after separation.

As to the congeries on the stone, which consisted of four stalks, after four vigorous new heads had been generated for the second time, the group was cut over again three lines lower than the previous section, when, in

* Date of fig. 6, December 22. 1824 ; of figs. 7, 8, 9, January 17, 18, 19, 1825 ; of fig. 10, February 27. 1825. This last view is from the side opposite to the view of the preceding figures.

four weeks, other four renovated heads flourished from the mutilated extremities of the stalks. Vegetation proving languid, the section was repeated in a few days, for the third time, and at about the same distance from the summit, which becomes always higher from prolongation of the stem by the regenerating heads. The reproduction of four more which now followed, was accompanied by a fifth very minute, from some stem previously unobserved, all unfolding successively. Conical projections ensued ten weeks after still another section, but the regenerating principle of farther living organization was exhausted.

By the preceding experiment the prolific elements were found in the stem descending still lower and lower, and their evolution, though under great irregularities, was undoubtedly promoted. Low conical projections rise from sections when placed in an inverted position, as if prognosticating generation, opposite to the natural direction, from the under extremity, now uppermost, but evolution does not follow.

Excision.—If deep and unsightly wounds fail to injure the germinating principle, we say it may be so subtle as to elude the edge of the instrument, or so remote as to be unattainable.

Excisions of the stalk are generally more pernicious than other lacerations to the reproduction. After them a new head has sometimes issued from the summit, if vacant. Sometimes, though very seldom, it issues through the artificial orifice, while all the higher portion has decayed.

It rather appears that the excision being low, the absent head is replaced in natural course from the summit; where high, it may issue through the aperture.

Five days after an excision three lines below the summit, a small globular projection issued through the wound, which in two days longer I discovered, with some surprise, to be a regenerated head bursting its integument, and it attained sufficient dimensions. The original head had fallen previous to the excision. In another experiment, a new head issuing from an excision made also about three lines from the summit, rent the stalk by its enlargement. This head fell seven or eight days after protrusion, leaving a shoot half an inch long. In 13 days another flourished

in its place for about the same period, but the shoot left by it did not exceed a line in length. Here the principle, the germ or bud of each, had been evidently lower than the place of excision.

Of many specimens wounded by excision, two generated monstrosities in a fortnight, consisting of a double neck, with a head of preternatural conformation. In one, the reproduction, very florid, never extended three lines; the other was of similar character, Pl. IV. figs. 16, 17. Both stalks were slender and transparent, thence unfavourable for reproduction; nor did these reproductions subsist above three days. One aperture was less, the other more than half an inch from the top of its stalk.

Six weeks subsequent to the excision of a portion of another stalk, on March 22, a distorted mass protruded, never developing completely, and proving on decay, on the 16th of May, to be two papillæ terminating a monstrous shoot. From one of these papillæ a small head, somewhat distorted, with about 20 tentacula, burst on November 10.—Pl. IV. fig. 18. Being gradually rounded into shape, it subsisted five or six days: but it had no successor.

Symmetry restored.—It is no mean presumption that the works of Nature have been modelled after a given plan, if we behold organic energies always tending to produce that symmetry which is peculiar to the being whereon they operate. From the activity of this principle, an original or an accidental malformation may ultimately attain, or recover its suitable figure and proportions. A very learned author, *Dana*, has recently shown that the form of organized bodies, however complicated, depends on the vital energies operating on the evolution of the constituent parts.

An incision having penetrated the top of a florid stalk lately vacant, regeneration in three weeks exhibited a recurved florid neck covered by a widely distended globular pouch. A few short distorted tentacula environed the base, and the summit bore oral palpi of a similar description. This swelling organ, of variable shape according to its nature, was of a beautiful red colour. Its form subsequently improved by elongation of the tentacula and diminution of the sphere, but still remaining monstrous, it decayed in three days.—Pl. II. fig. 11.

The first head which is generated from a cleft or incision always rises

in a monstrous form, or manifesting peculiarities, if it has not been too remote, or if its elements have not been too remote to be affected. A section an inch and a half long, comprehending the summit of a vacant stalk that had borne a prolific head, was cleft at both ends on the 11th of January. A monstrous head was regenerated on the 26th from the upper end, appearing as in Pl. II. fig. 12, on the last of that month. It fell on February 9th or 10th.

From another stalk, also cleft on January 11, a symmetrical head had regenerated on February 11th or 12th. But from a third stalk, cleft at the same time into unequal parts, two unequal heads were generated on February 19. The one was sustained on a distorted neck; the other, not a fourth or a fifth of its size, had only eight tentacula. The latter outlived its companion nearly a week.—Pl. II. fig. 13. Here I concluded that an internal bud had been within reach of the instrument.

No definite rules or principles can anticipate the precise course of reproduction.

On November 22, a specimen four or five inches long, with a fine ovarium, was cut over near the root: and after the head fell the summit was deeply cleft on the 25th. In 60 days a small head regenerated from one division of the cleft, and flourished at right angles to the stem.—Pl. IV. fig. 7. It decayed on the fifth day. After a farther interval of 90 days, a florid head with 24 somewhat irregular tentacula regenerated, and, like the former, at right angles to the stem; but it rose straighter in a few days, and on its decay in seven or eight, this was still more obvious. Now an interval of no less than 143 days elapsed, when a third regeneration was discovered rising within the stalk in an ovoidal form. It burst as a head, less obliquely than the two preceding, and it nearly gained perpendicularity, though subsisting but transiently, nor were the tentacula perfect. At this time the injury from the cleaving was nearly repaired, for notwithstanding the previous extraordinary intervals, a fine and flourishing head, the fourth, burst fourteen days after the decay of its precursor. A thick neck sustained it, but several of its tentacula seemed to be mutilated: and on the sixth day it was in a decaying state, much earlier than its aspect promised.—Pl. IV. fig. 8. In ten days, however, the embryo of

a fifth head, well defined, was visible within the stalk : the tentacula were folded longitudinally together ; and the disc denoted by a convex outline, all the parts being very conspicuous through the delicate integument investing them. Next evening the head was displayed with 19 tentacula. It became fine and vigorous ; none of equal dimensions had been regenerated ; its shape was quite symmetrical, it rose perpendicularly, and in every thing it proved perfect. The rudiments of an ovarium could be recognised on the fifth day ; but on the seventh this promising reproduction separated from the stalk and fell. A very short interval then elapsed, as on the following evening a new head was bursting from the stalk, which became fine, and like the last, exhibited 19 tentacula.—Pl. IV. fig. 9. But it flourished only two or three days ; yet the reproductive energies were not totally exhausted, for the vacant summit reddening again exposed an embryo rising within, which was displayed as a head with 20 tentacula on the 12th of December, and it subsisted ten days. This was the last organization matured, for although the indications of an embryo appeared a fortnight later, it proved abortive. On supervening transparence the specimen was abandoned, after remaining the subject of observation for fifteen months.

It is to be deduced from the preceding experiment,—1. In the course of 395 days seven successive heads had been borne by the same specimen of the tubularia, subsequent to its having attained a high stage of maturity. 2. The interval between the earlier reproductions infinitely exceeded the ordinary natural period, which is about fourteen days. The first regenerated head required 60 days, the second 90 ; and 143 elapsed between the second and the third. 3. But great irregularity followed, as the fourth and fifth head required only 14 days each ; the sixth only 9, and the seventh 31. 4. The first and second reproductions were distorted : the fifth was perfect. 5. The tendency to symmetry was progressive, and at last very nearly attained.

The extraordinary intervals requisite for bringing the germ or embryo to perfection cannot escape notice, no less than 60 days from the date of the experiment being essential for maturity of the first regenerated head ; 150 for that of the second, and 293 for that of the third. It is alike sin-

gular that the intervals then became so much abbreviated, that while 60 days elapsed from the cleaving of the stalk to the evolution of the first regenerated head, 90 between the fall of the latter and evolution of the second, and 143 from the fall of the second and evolution of the third, no more than 14 days were occupied in the regeneration of the fourth.

The embryo is often invisibly sundered in cleaving the stem. Two vacant stalks, *a* and *b*, were cleft down six and nine lines respectively. What followed? In 16 days a head slightly distorted was issuing from *a*, the former, and one quite entire in 21 days from *b*, the latter. Neither rose from the centre of the stalk; but they originated individually from one of the halves of the cleft, about three lines from the extremity. Each regeneration became free of its half as it grew, and both proved symmetrical ultimately. The head from *a* had 13 tentacula, that from *b* had 12. Each head fell in eleven days. These heads, though on different stalks, corresponded in position. The first regenerated head of *a*, adhering to one side of the cleft, having fallen, another head, somewhat distorted, with 12 tentacula, issued from the opposite side of the cleft, 41 days subsequent to the original cleaving. It will be recollected that each head first regenerated had subsisted eleven days. Here the embryo had been undoubtedly sundered by the edge of the instrument. One half of the cleft of *a* had exhibited a head with 13 tentacula in 16 days; but the evolution of what we may conjecture the other half of the sundered embryo was postponed during 41 days.

The summit of a stalk having been cleft, on the 14th of February, two perfect heads were produced on the 3d of March. But the embryo had not eluded the edge of the instrument; for, only 12 tentacula being on one, and 10 on the other, the whole did not exceed the complement belonging to a single hydra.

The same may be said of the specimen above described, and represented Pl. II. fig. 13.

Monstrosities.—If the wound be such as absolutely to preclude the reintegration of the parts by the sanative energies of Nature, a real monstrosity may ensue, and this may appear either in excess or defect. The subject of monstrosity is deeply interesting to physiologists; they will ge-

nerally find it difficult to understand the cause of supernatural enlargement, diminution, multiplication, and distortion. Symmetry itself seems to result from an original harmonious arrangement of the constituent parts of the elementary organs, and their regular developement following the institution of life:—deformity from some disturbance received during the progress of their evolution. But if symmetry be not altogether an artificial character, expressed by an arbitrary term, there is, in truth, for the most part, throughout the universe, only an approximation towards it. Regardless of minutiae, when these approximations are close, we hastily pronounce on identity. Still, how seldom is any pair of human organs or any subordinates of these organs alike? Amidst a thousand leaves or flowers we cannot mistake one of any two for the other, on the due exercise of our perceptive faculties. Therefore it would be remarkable, after the violent divulsion of organic structures, to find its effects totally obliterated by reunion of the parts. Wounds may be inflicted which cannot heal, spite of the wonderful energies of living matter.

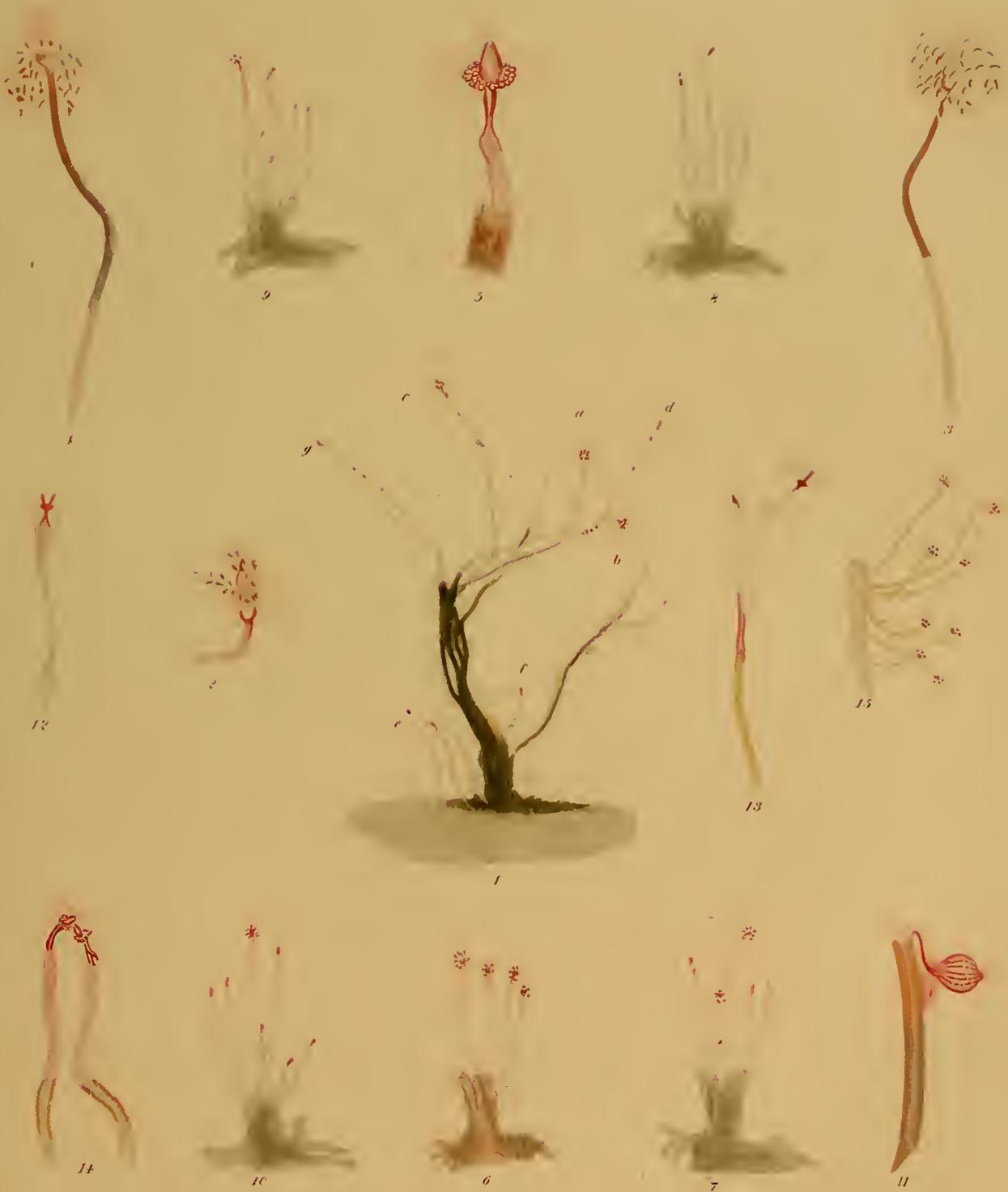
The stalk of a specimen having been cleft down from the summit, nothing followed. Afterwards it broke over, but without separating at the point of fracture, and the cloven summit hung lowest by the side of the upright stem. There were now two summits, one originally the under part of the cloven portion, which portion was there inverted, the other the upper part of the fractured stalk. A hydra issued from each. The summits were unconnected, but the two hydræ were conjoined by the union of the oral palpi of the one to the pouch of the other.—Pl. II. fig. 14. As both parts of the ruptured stem were previously upright, the hydra now issuing from the point opposite to the cleft was opposite to what would have been its direction by regular and undisturbed reproduction. The larger and more perfect hydra developed from the main stem in its natural direction; the other was inverted. On the 1st of January the rudiments of reproduction were visible from the cleft of a specimen which had been made a month previously; and a head with 14 tentacula, but without oral palpi, burst on the 7th. The latter developed, however, and the head become symmetrical, decayed on the 15th. A second head regenerated from *a*, the same half of the cleft, on May 3, which fell on the 6th.—Pl. IV.

fig. 19. An enlargement from the other half of the same cleft *b*, had appeared also on the 1st of January, which burst as a head on the 16th; fig. 20, *b*. But from being invested with some mucous matter it scarcely expanded. No more flourish came of the former cleft *a*; however, the latter, *b*, generated a symmetrical head, with 14 tentacula, about the 13th of February; and this was succeeded by another with 19, on the 13th of March. But an interval of 167 days now followed its decay, when a very small head, with parts imperfectly developed, replaced it.

Probably the number, the size, and the distribution of regenerated organs will depend on the laceration or impunity of the foetus or latent embryo, or on the obstacles and facilities presented for their evolution. The peculiar condition of the early subject must expose it more or less to injury. But it is remarkable that the originating organization of animals invisible to mankind, and in such a stage of existence should be thus impaired, as proved by later increment. Where the head is much smaller, and only half the wonted number of tentacula belonging to a perfect hydra border the disc of one or of two regenerated, it is not unreasonable to conclude that the embryonic product was cleft asunder; that if the numbers be nearly equal it was bisected.

A fine and florid stalk which had borne a prolific hydra was cleft half an inch down on October 24. Much of the wound healed up as usual; but on November 6, a distorted disc, with 30 tentacula, of sufficient dimensions, bearing a double pouch, each having its peculiar palpi unfolded, though imperfectly. Next evening, the neck, originally very stout, had refined along with the rest into better proportion; but the heads were more distorted.—Pl. IV. figs. 21, 22, 23, 24. This reproduction subsisted only another day; but, in a week, a single head, with 30 short stunted tentacula, a pouch unusually distended, and very short palpi, rose from the vacant stalk. Having burst its spath, it decayed without complete evolution on the day following. In nearly three months it was succeeded by a new head, somewhat distorted, with about 25 irregular tentacula, which decayed in three days.

The reproduction, Pl. II. fig. 12, was of similar character to the preceding figures, as above described.



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From the result of these and other experiments, it is evident that the elements of the future hydra, regenerated on a stalk, do not belong to the hydra which has come to maturity, but that they reside at some distance from that summit destined to bear them in their perfect state. Farther, it is undoubted that their evolution and maturity depend on the presence of a certain portion of the pith.

I doubt not that skilful physiologists may rear some interesting theories on the result of experiments proving that reproductions, exceeding the number apparently allotted by nature in her usual course, can be obtained artificially. Neither will the consequence of protracted intervals be overlooked.

From previous observations it is shown, that seven complete and one abortive hydra were borne successively in 395 days by a single specimen, which let us now denominate A, selected originally on November 22.—Pl. IV. figs. 7, 8, 9.

The lower half which is to be denominated B, becoming very foul, was cut off on the 17th of March following. In 50 days an abortive bulbous reproduction rose from the summit of this half. After 131 days more a head burst on September 11. from the summit, which had reddened for a long time; but it decayed next day without complete evolution, though the neck extended three lines and the tentacula were unfolding. This last generation from the summit of B had occupied 297 days in attaining that degree of maturity, so long having elapsed from the time when the original stem A, then comprehending B, was cut over near the root on November 22. of the preceding year. This same last evolution was succeeded in 40 days by another head, with about 22 tentacula somewhat distorted and decaying on the second day, from a larger neck than its precursor. The next, issuing in seven or eight days from the vacant summit, though subsisting but a single day, was sufficiently symmetrical with 25 tentacula. Its successor, also with 25 tentacula, several of their extremities being mutilated, unfolded on the 11th day, and decayed in four, after affording a satisfactory delineation.—Pl. IV. fig. 10. This was followed by one in three weeks, still more evanescent, bursting with 25 tentacula on the 5th of November, and decaying on the 6th. The last proved

of remarkable permanence. It flourished with 17 tentacula on the 7th of December, and was delineated on the 10th.—Fig. 11. On the 25th its approaching fall was indicated by separation of the neck from the internal pith of the stalk, after which, vacuities and transparency proving the exhaustion of the reproductive principle, farther observation on this section B was abandoned on January 15. or in very nearly one year and two months from the 22d of November.

The heads obtained by this experiment from the section B, originally the lower half of the stalk A, were seven.

As the energies above of the section B had ceased, an inch and a half, C was sundered from its lower extremity.

Thus the original stem, first sundered on November 22. had been now sundered into three portions, A, B, C, of which the intervals follow. A was sundered 22d November; B cut off it in 84 days, and C cut off B 333 days afterwards. Therefore the separation of C was 417 days after the portion B B had been originally removed.

This last section, C, being laid horizontally at the bottom of a narrow cylindrical vessel, a head with 19 tentacula rose at right angles from it in the subsequent February, within a month of the division.—Pl. IV. fig. 14. It fell on the 25th of the same month, when an embryo next ascending the stalk decayed on March 13. without evolution. Howsoever, a head with 25 tentacula developed on the 9th of April, and subsisted three days. Now, the new shoot extending an inch and a half, produced a vigorous head with 20 tentacula on May 24. which fell on the 3d of June.—Pl. IV. fig. 15. Supervening transparence induced me to abandon this section C on the first of October, after having generated three heads and one embryo, as above specified.

But a remarkable incident had followed the separation of C, fig. 14, from B, figs. 10, 11, of which figures it was the lower portion. The summit of B, fig. 12, was vacant at *a*, when C, fig. 14, was separated from it; and the headless portion consisted of *a b* only. Nearly three weeks afterwards a shoot bearing a hydra, *c*, was generated from *b*, the lower extremity of B, and on February 11. was rising upwards by a very regular curvature. B had been suspended by a silk thread in a jar of sea-water.

This reproduction, *c*, subsisted until February 25. Another head, with 20 tentacula, replaced it on March 5. and decayed in three days. A third, also with 20 tentacula, was reproduced on March 20. and decayed within the same period ; and a fourth, lasting as long, burst with 19 tentacula on the 12th of May. The shoot now extended an inch and three quarters, its ruddy tinge gradually faded, when its regeneration ceased.—Pl. IV. fig. 13.

Relative to the latter experiment, it is worthy of observation, that sundering C from B had generated two heads at what was the point of intersection of fig. 11, which figure represents B C entire, as composed of figs. 12, 14 ; for, one head vegetated naturally from the higher extremity of C, fig. 14, while another vegetated unnaturally, fig. 12 *c*, from the point *b*, whence it had been sundered. These two heads vegetating by ascent and descent, from what had been the same point, flourished at the same time, February 16. and fell at the same time, on the 25th. Both had attained sufficient dimensions ; the rudiments of an ovarium became perceptible in one, which was, besides, very tenacious of life, as it survived its fall eleven days. But that from ascent having 19, and that from descent 18 tentacula, it may be conjectured, that although so very remote from the natural site of evolution, the summit of both had originally constituted a single embryo, which, by partition, developed into two, becoming progressively symmetrical in maturity.

Thus, while A had naturally afforded seven perfect hydræ, besides an embryo, B had generated seven by ascent, and four by descent, and from C, three together with an embryo had ascended.

Therefore, in the course of 550 days, the single specimen rendered in this manner the subject of experiment, had borne 22 heads, including that subsisting when it was withdrawn from the sea.

By cleaving a fine stalk D, on November 25, some farther illustrations were obtained of the preceding facts. From this, the head, with an ovarium, had already fallen. The wound healed, and in 56 days, a head for some time standing awry, but afterwards gaining symmetry, burst with 25 tentacula.—Pl. IV. fig. 1. It fell in eight days. Another flourished and decayed. Then a third with 21 tentacula, not inferior to the first. It now rose vertically.

A portion E, being the lower part of D, was severed from it on the 17th of March following. The summit of this portion E, though affording symptoms of reproduction, generated no symmetrical head, until one with 21 tentacula appeared on the 12th of October, and decayed in three days.—Pl. IV. fig. 2. Another head, being the third, quite symmetrical, vigorous, and florid, with the same number of tentacula, succeeded it. But the fourth was slightly distorted. A fifth was generated on the 8th of December, and subsisted until the 17th.—Pl. IV. fig. 4.

Symptoms of internal decay at this time interrupting reproduction, it was seen as represented, fig. 4.

About 18 lines, F, were severed from the lower part of E, and consigned to a narrow glass cylinder, on January 4. after the preceding December. On February 11. a vigorous hydra, with 19 tentacula, had developed, and was then some days old. But, cramped for room, it had turned upwards, as the section itself lay horizontally, fig. 5. Having subsisted above a fortnight, it was succeeded by another with an equal number of tentacula, which burst on March 6. and fell in three days. The section being now suspended in a more capacious vessel, its increment unrestrained, made rapid advances with a third hydra, which subsisted fourteen days from April 12. At this time the length of the new shoot equalled the length of the original section, and it had become nearly vertical.—Pl. IV. fig. 6.

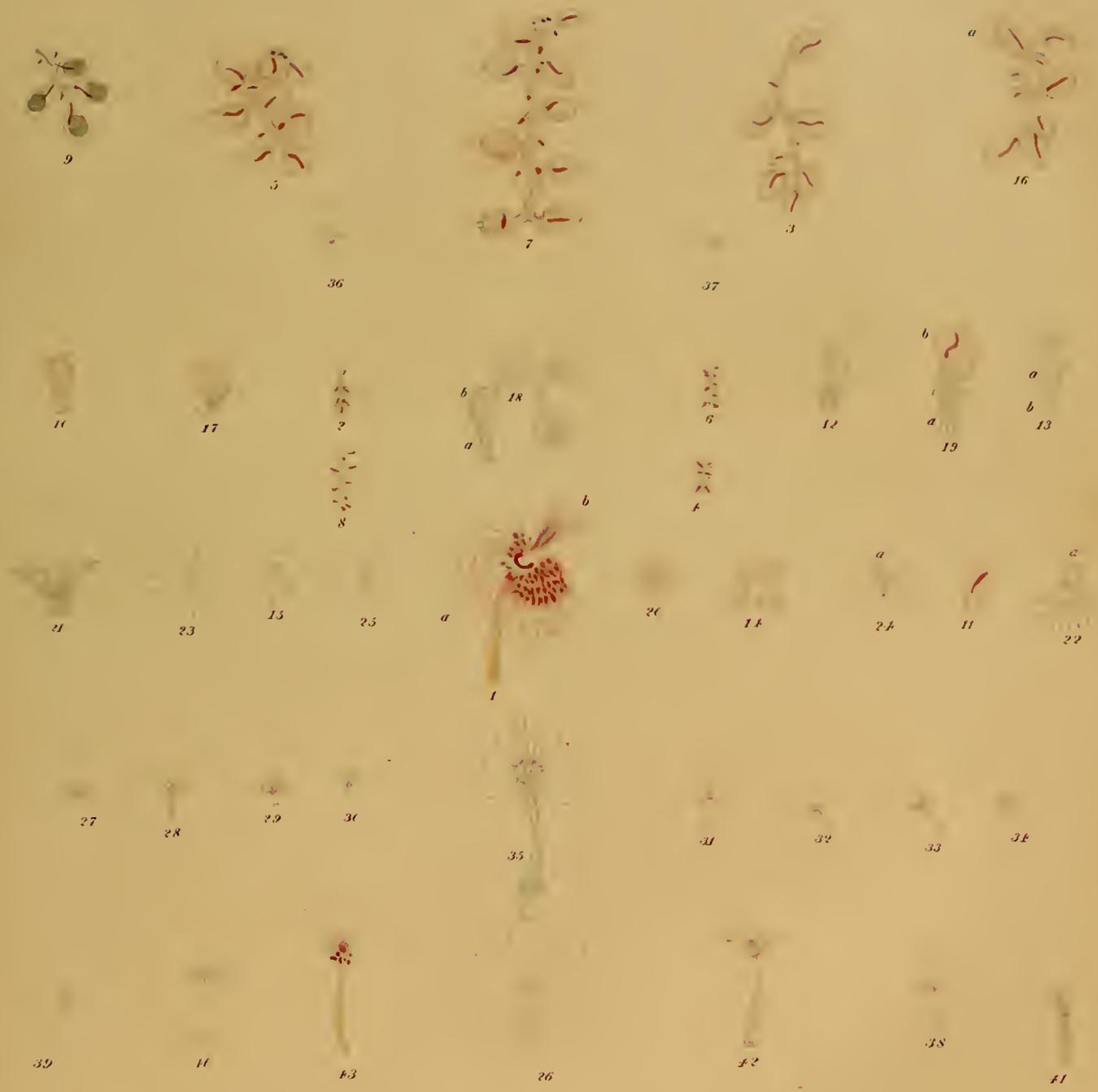
Supervening transparence in June rendered farther observations unnecessary. The total hydræ regenerated by this stalk and its sections in 506 days amounted to twelve in number.

The following conclusions may be deduced from the preceding narrative :—

I.—The *Tubularia Indivisa* consists of a single living hydra, sustained on a fistulous stem, rooted irreversibly to a solid foundation.

II.—The stem is occupied by a tenacious matter or pith, essential to the permanent life and the animal functions of the product.

III.—An external ovarium, composed of several clusters, is borne by the hydra, each cluster consisting of several cysts, and each cyst containing an ovum or embryo.



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IV.—On expulsion of the ovum from the cyst a hydra is unfolded, which enjoys the faculty of locomotion, and in its earlier stages evinces animal nature exclusively.

V.—After a brief display of the locomotive faculty, the hydra becomes rooted permanently, and thus it flourishes, enlarges, multiplies, and dies.

VI.—The original hydra reared on the first elongated stem falls from its summit, after a certain but indefinite interval from its evolution, and perishes below.

VII.—One or more hydræ, according to the vigour of the specimen, replace in succession that which has first fallen.

VIII.—If the luxuriance of the hydra be great when the subject is originally recovered from the sea, that of its successor is generally inferior.

IX.—No correspondence appears between the dimensions and the number of regenerated organs of the successor, and those of its immediate precursor.

X.—No uniform length of interval prevails between the regeneration of the successive hydræ, some being evolved much more speedily than others.

XI.—No uniform duration prevails among the regenerated hydræ.

XII.—Prolongation of the stem is absolutely dependent on the existence of the hydra, and the rate of increment generally corresponds to its duration.

XIII.—Six successive hydræ may be generated from the summit of the same stem in six months.

XIV.—The germ or elements of each hydra probably reside at some distance from the summit of the stem.

XV.—A greater number of hydræ than apparently allotted by nature to a single stem, may be obtained by artificial sections or subdivisions of it.

XVI.—By such subdivisions, 22 hydræ have been generated in 550 days from three sections of a single stem.

XVII.—Monstrosities from external injury to succeeding hydræ before evolution are gradually effaced in each successor; and symmetry, to which there appears a constant tendency, is restored, in remote regenerations.

Contemplating this humble and defenceless production of Nature, how many admirable properties does it not disclose? It blossoms as a beautiful plant in the dark abysses of the deep. The offspring generated in the head of the parent drops from its place, to unfold its organs, and to enjoy an independent existence. Though endowed with the privilege of moving around to select its site, no sooner does it show its choice, than there it is appointed to rest for ever. The fruit of its prolific womb discharged, the head which bears it is sundered, and the extinction menaced of its reproductive powers. But Nature interposes for their preservation. Another head is generated. Another ovarium may be borne. The means of providing for posterity ensure conservation of the race. Dwelling amidst the ravenous tenants of the deep, the delicate organs of this defenceless being are offered for immediate prey. What if torn asunder, mutilated, or severed into many parts? It may arise as yet unhurt. Wounds and lacerations—such as are mortal to the strongest inhabitants of the earth—have not impaired its vital principle; and that important portion bearing the source of distant generations, is renovated, to flourish in all its pristine symmetry.

PLATE I.—General view of a group of the *Tubularia Indivisa*, founded on a mussel shell, a large portion being invested by parasite matter.

PLATE II.—Renovation and propagation of the *Tubularia Indivisa*.

FIG. 1. Group illustrating the deciduous nature of the hydra, reduced to half the size of life.

2. Prolific hydra.
3. Prolific hydra, front.
4. The same viewed from behind.
5. Regenerated hydra, with incipient ovarium.
6. Group of regenerating hydræ, after separation of the upper portion, as appearing December 22.
7. The same as appearing subsequently, January 14.
8. The same, January 17.
9. The same, January 18.

- FIG. 10. The same as appearing subsequently, February 27.
11. Monstrous reproduction of a head, afterwards becoming symmetrical.
 12. Monstrous reproduction from a cleft stalk.
 13. Monstrous reproduction from a cleft.
 14. Monstrous reproduction from a stalk fractured.
 15. Group of uncertain species—supposed the *Tubularia Larynx*.

PLATE III.—Propagation of the *Tubularia Indivisa*.

FIG. 1. Prolific hydra, being one of the group Plate I., with an ovarium consisting of several clusters of cysts, each containing an ovum or an embryo.—Tentacula, *a*, oral palpi, *b*. Slightly larger than life.

2. Cluster of cysts.
3. The same enlarged.
4. Cluster of cysts.
5. The same enlarged.
6. Cluster of cysts in different stages, *b*.
7. The same enlarged.
8. Cluster of cysts less mature.
9. Cluster of cysts, where the embryo is exposed through the semi-transparent sac, enlarged.
10. Cyst expelling its ovum or embryo, enlarged.
11. Another.
12. Another.
13. The same,—the embryo, *b*, having been expelled from the cyst, *a*, enlarged.
14. Ova or embryos after expulsion, enlarged.
15. Ova or embryos, of irregular size and shape, enlarged.
16. Cluster of cysts wherein the contents are unequally advanced.—The tentaculum, *a*, of an embryo protruding from a cyst, *b*, enlarged.
17. Tentacula of an embryo farther advanced, protruding from a cyst, enlarged.
18. Cluster of cysts unequally advanced, several tentacula, *a*, protruding from their cyst, *b*, enlarged.
19. Tentacula, *a*, from an embryo still farther advanced in the cyst, *b*, before expulsion, enlarged.

- FIG. 20. Hydra in an early stage, developing in a stellate form from its embryo state; enlarged.
21. Nascent Tubularia,—tentacula still clavate, enlarged.
 22. Nascent Tubularia farther advanced,—oral palpi, *a*, originating, enlarged.
 23. Nascent Tubularia,—the tentacula nearly symmetrical, front, enlarged.
 24. Nascent Tubularia, sustained on the tentacula,—oral palpi unfolding, enlarged.
 25. Nascent Tubularia, still free,—organs almost symmetrical.
 26. The same enlarged.
 - 27–34. The figures inclusive represent young Tubulariæ bred from the cyst, in January 1841, in various positions, all rooted.
 35. Young Tubularia (fig. 28 enlarged), with irregularities near the root.
 36. Young Tubularia bred from the cyst.
 37. Another.
 38. Young Tubularia bred from a cyst of fig. 18.
 39. Young Tubularia bred with 15 tentacula from the cyst. The tentacula of the regenerated hydra succeeding it were only 7.
 40. Young Tubularia bred from the cyst in 1832. The hydra subsisted 21 days.
 41. Upper portion of a young Tubularia, with a renovated hydra, which is rising from the stem.
 42. Young Tubularia bred from the cyst, enlarged.
 43. Prolific Tubularia—natural size.

PLATE IV.—Redintegrations of the *Tubularia Indivisa*.

- FIG. 1. A hydra or head generated from an artificial cleft.
2. The original stalk of fig. 1, having been previously cut asunder, the hydra of this fig. 2, was generated from the summit of the lower half.
 3. Head generated from the same lower half, after fig. 2 fell.
 4. Summit of the regenerated neck in decay.
 5. The lower half of fig. 2 having been sundered, a hydra was generated from the summit of this section.
 6. Another hydra, generated from the same summit of fig. 5, in succession to the former, the shoot having prolonged.



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- FIG. 7. A hydra, generated at right angles to the stem, from an artificial cleft of a different specimen—none of the preceding.
8. Another hydra, generated from the same cleft, after the former fell.
 9. A third hydra, generated from the same cleft, the parts originally distorted, having now become symmetrical.
 10. Hydra, generated from the lower half of fig. 7, which had been sundered.
 11. Hydra, generated in succession to fig. 10, from the summit of the same lower section.
 12. This figure, originally the lower section of fig. 7, remained the upper part of fig. 10, after this fig. 10. lost its own lower half. The vacant summit *a* had borne the hydra of fig. 11, and now when that hydra had fallen, a hydra *c* sprung from the opposite or lower extremity, contrary to the course of nature, and then gradually rose upwards.
 13. Ultimate appearance of fig. 12, in decay, after losing the hydra from *c*.
 14. Hydra, generated in the natural direction, from the lower half of fig. 10.
 15. Second hydra, succeeding fig. 14.
 16. Monstrous hydra, issuing through an excision of a part of a stalk.
 17. Monstrous hydra, issuing through an excision of the stalk of another specimen.
 18. Monstrous hydra, issuing from an excision of a third stalk.
 19. Reproduction from a cleft stalk—hydra displayed—hydra in embryo *b*.
 20. The same, *a*, having decayed, and *b* having unfolded.
 21. A stalk cleft, October 24.
 22. The same, with an obscure embryonic formation, November 4.
 23. The same, with the preceding formation developed as a monstrous hydra, November 6.
 24. The same, as appearing November 7.
 25. A stalk, apparently monstrous by nature.
 26. Another stalk, apparently monstrous by nature.

2. TUBULARIA LARYNX.*—PLATE V.—The preceding disquisition, prolix, no doubt, to those impatient for conclusions, will enable us to abbreviate the history of this singular genus, for all participate of a common nature, though exhibited under conspicuous modifications.

The larger organic bodies afford the observer many enviable facilities, compared with the series of those animated beings, vanishing by progressive diminution from his view.

The simplicity distinguishing the preceding product recommends it as a suitable introduction to the knowledge of its more complex and more diminutive kindred. Its external parts are few: the root a mere prolongation of the stem, which latter, never dividing, is always single; its dimensions are readily exposed to the naked eye, or they may be compassed by moderate magnifiers. Farther, it is not of difficult preservation. But others, most minute, are of obscure and intricate formation, whether collectively, when dwelling in society, or individually, if existing in a solitary state. Thence they require separation, division, and a kind of analysis in pursuing the investigation of their nature.

Like the former, the *Tubularia larynx* is found either in a social or a solitary state.

In the month of December a group was recovered from the sea, resembling a copious handful of white, crisp, baked horse hair, which rose two inches high, and occupied a vessel of four inches diameter.

Closer inspection discovered this to be a vast congeries;—one of not fewer than five hundred snowy tubes, crowned by scarlet animated blossoms of various hue. In the aggregate, it may be compared to a fine and beautiful tuft of pinks decorating a flower-garden.—Plate V. fig. 1.

Viewed externally, it seemed doubtful whether this luxuriant assemblage sprung from a single root or from many, the whole being somewhat contracted by convergence below. But one alike numerous is of rare

* This name has been applied from the whirls or prominent rings sometimes on parts of the stalks as resembling the windpipe. It is not warranted by such being a distinct and invariable character. The whirls or convexities are the converse of the hollow circumference of pulleys.

occurrence; the product commonly appears as a parasite on other zoophytes, seldom on shells, rocks, or stones.

The *Tubularia larynx* rises three inches high; it consists of a stem, subdividing into several irregular ramifications, each crowned by a hydra, narrowly resembling that of the *Tubularia indivisa* in structure and appearance. All the tubular parts are white, the hydra red. The former, that is the tube, occurs from the diameter of a horse's hair to the third or fourth of a line; and the latter from a mere speck to three lines in expansion between the opposite tips of the tentacula. About 21 tentacula border the disc of the finest specimens; the mouth is fringed by about 16 palpi, rough, rounder, and more obtuse than those of the *Tubularia indivisa*. Faint whirls indent the neck of some specimens, and two of the ramifications are sometimes united by a cross bar.

Much irregularity subsists in aspect and proportions. Specimens occur of all inferior dimensions to the largest instanced above, and of great discrepancy in the proportion and number of parts. Specks scarcely discernible by the naked eye are nearly white; and others of very minute dimensions which have only nine, or even but six tentacula. A stalk an inch long frequently bears a head no larger than a branch extending three lines from its side. Thus no definite rules seem applicable to the size, proportions and appearance of this product. The lower parts are also always so much interwoven, that, until cut out from among the rest, it is impossible to determine the formation of a single specimen: Nor is it easy to discover that only a single root is extricated. But the general aspect and structure of the *Tubularia* may be seen in figs. 2, 3, 4.

The polypus or hydra is not retractile within the stem, as there is no vacuity in the summit for its reception. It is of a more lively nature than the former, turning freely from side to side, closing and unfolding itself repeatedly, and apparently enjoying a moderate degree of light. But both are of that languid inactive disposition which constitutes a prominent feature of most zoophytes void of a receptacle for retreat and protection of the head on the occurrence of danger.—Figs. 5, 6, enlarged.

The propagation of this *Tubularia* resembles that of the *indivisa* in as far as it can be ascertained. But the precise process is very rarely wit-

nessed. Like the former, clusters of minute cysts are borne on the head, from which embryos have been obtained in the month of June. The nascent animal is originally white, or of the palest grey—figs. 7, 8. It is so difficult to be obtained, however, that eleven years from the commencement of my original observations elapsed before I could procure prolific specimens. The naturalist is compelled to rely on accident as much as on design for the success of his objects.

The evolution, decay, and disappearance of the head form another illustration of the vigorous reproductive faculty residing in the genus. Here the progressive renewal is more conspicuous than in the preceding, from the readier exposure of the rising embryo, and its stronger contrast with the thin sides of the tubular stem.

The hydra is deciduous. It survives its fall entire during a certain time, and the summit of the stalk remains vacant. But a florid internal bud is soon discovered ascending towards the extremity of its snowy cylinder, whence it speedily bursts; and sometimes the progress is so rapid that on one occasion it issued forth and spread, during the course of a single protracted observation.

In this respect, the *Tubularia larynx* probably exceeds the regenerations of the *indivisa*. The limits confining the renovation of these, the parts most essential to life and the perpetuation of its race, cannot be defined.

On April 14, two single specimens were selected for observation—one with eight hydræ, besides several vacant stalks, fig. 2; the other with five hydræ and two vacant stalks, or seven summits in all, fig. 3.

The vacant stalks had flourished recently. Vigorous reproduction now ensued, but attended with much irregularity, both in respect to maturity and to its duration, as well as in the number of regenerated organs.

The specimen, fig. 2, had eight hydræ on the 14th of April, at which time *a* was vacant. Here a hydra was regenerated on the 20th, which had fallen on the 25th. This hydra was reproduced. I should rather more correctly say, it was succeeded by another next day, the 26th. The last had fallen May 1; it was regenerated on the 7th, by one which had fallen on the 12th. Another, regenerated on the 18th, had fallen on the 25th;

it was regenerated on the 28th, and decayed on the 30th, but still a new hydra, on June 8th, replaced it, which fell on the 10th. Thus six hydræ regenerated from the same stalk in 51 or 52 days.

The hydra, fig. 2, *b*, was displayed April 14. It had fallen May 7, and was regenerated on the 12th. But no reproduction followed this successor.

The hydra, fig. 2, *c*, was also displayed on 14th April, and fell on the 20th, without farther reproduction. Therefore, the former, *b*, regenerated only two heads, and the latter but one.

Although the whole stalks of this specimen, fig. 2, were prolific, it never bore above eight hydræ at once, subsequent to the commencement of their fall.

On May 2. all the stalks were vacant: in five days the specimen had seven heads.

The specimen fig. 3, was totally vacant on May 2; and after various reproductions, it was totally vacant again on May 14. The number of contemporary hydræ after they began to fall never exceeded three. The hydra *c*, of this specimen, flourishing April 19. fell and was regenerated for the fifth time, including preceding regenerations, on May 31; that is, in 42 days. Progressive reduction of the number of reproduced organs is proportional to the frequency of regeneration here, as in the *Tubularia indivisa*.

The hydra *c* had 14 tentacula on the third regeneration; on the fifth it had only 12.

The same peculiarity has been evinced still more conspicuously in other examples. Thus, the hydra fig. 2, *i*, falling April 20, was replaced on the 23d, by a fine head with 16 tentacula. This falling on the 28th, was succeeded by one with 12 tentacula, on May 3. The latter had fallen on the 9th of May, and it was renewed with 10 tentacula on the 12th. Having fallen, it was regenerated with 9 tentacula on the 28th. This having fallen, a new hydra appeared next day, June 4. with only seven; which, on its fall, was replaced by yet another hydra, with no more than six tentacula. The successive heads actually seen and enumerated amounted to seven, all being in existence and inheriting the summit of a

single stalk after each other, within 66 days. The complement of tentacula crowning the first was accidentally overlooked. Probably it exceeded that of the second, which was regenerated with 16; while the seventh head had only six. The meagreness of its aspect was extraordinary.

The hydra fig. 2, *d*, having fallen April 18. another with 18 tentacula was generated on the 22d. Its successor, on May 13. had only 10; this was replaced on the 30th; it fell, and was succeeded on June 10. by one having 8. But the next and last, which was scarcely visible, had only 7.—Pl. V. fig. 9.

Thus, in the *Tubularia larynx*, degeneration of the hydra is concomitant on reproduction.

In general this portion of the organization subsists five or six days. The intervals of reproduction are quite indefinite; sometimes, though very seldom, a day or two intervenes between the disappearance of the old hydra and the evolution of the new one; sometimes from three to eight. For the most part the stalk remains vacant for about five days.

The finest regeneration commonly issues from the largest stalk.

At first the new head is very minute: the heads of shorter stalks are particularly so, and they are very pale: several have been scarcely perceptible, and the neck is extremely slender. Like the parts of the *Tubularia indivisa*, both enlarge in time. The neck is prolonged also during subsistence of its head, whence, by the accession of no more than the third of a line at once, a specimen reproducing profusely, gains considerable comparative altitude by the aggregate accessions.

This, however, is ultimately productive of much inconvenience to the observer, for the longer parts above and the shorter below, preserving no regular or definite direction, they are respectively intercepted from the eye, or interrupt the view of earlier reproductions. Thus, in the course of June, the specimens figs. 2, 3, had become so intricate, by prolongations and curvatures of the stalks; and the hydræ had become so minute in repeated regeneration, that farther observations on them could not be satisfactorily continued.

The regenerative qualities of this product are very powerful, as it is

seen from the preceding detail, that seven hydræ subsisted in 66 days ; that their average duration, including the interval of their absence, scarcely exceeded nine days ;—that a new head might even unfold and occupy the place of one which had been in existence the preceding day.

The progressive degeneration of external organs, whether in size or number, is no less remarkable,—as if evincing the gradual exhaustion of the resources or energies of nature. Contrasting the fine, florid, and luxuriant hydra with 22 tentacula, and some remote successor, pale and diminutive, with only 6 or 7, proves the difference between feeble and vigorous evolution.

In probing the embryonic sources, a subject of such profound interest to the philosopher, arguments might be reared against the infinite evolution of germs, from the nature of the reproductions of the two species of Tubularia now described. Some might certainly maintain that were such the primitive order, all the germs would unfold the true complement of organs, distinguishing its peculiar kind, though of diminished size. But if the germ be generated immediately in the parent, it might be said that the production of animals in such rapid succession impairs the *quantum* of elementary matter to be derived for each, which shall suffice for the nucleus of the offspring,—whence the organization of the successive hydræ degenerates. Likewise, some may conclude that the primitive or successive germs are not all repositied in a magazine of vitality, seated amidst the pith or elsewhere deep in the stem, but that the embryo may be generated from the internal surface of the fistulous tube below, or formed in some invisible cell, by the organic energies of the parent.

If we admit the universal vascular structure of the elementary parts of animal matter, the theory of primitive germs is supported, because the dilatibility and increment of the parts, resulting from the institution of life and consequent nutrition, may adapt them for the benefit of the perfect being.

Perhaps there are varieties of this and the subject of the next chapter, which perplex the observer in determining on rejecting identity. The want of absolute uniformity which pervades all animated objects, and of which we become sensible as we are more or less acquainted with them, can-

not but excite doubts and difficulties: Nor can we tell what tests are authoritative. Degeneration itself alters the appearance of specimens so much, that it is scarcely possible to class them with the more vigorous of the race. Yet degeneration does not merely result from that exhaustion of the elements of evolution which seems concomitant on successive reproduction. But, as an unsuitable soil and climate reduce gigantic vegetable products to dwarfs, or absolutely preclude their germination, so is the growth of all zoophytes repressed by an unfavourable position. Some of the more prominent features distinguishing certain species may be thus obliterated. Without a profusion of specimens, our doubts cannot be resolved, and such specimens must be of that description, besides, as to advance from greater imperfection to superior quality.

A group of about 20 specimens vegetated through some spongy matter wherein the roots were involved. No whirls distinguished any portion of the stalk; but the course of reproduction was infinitely quicker than in the *Tubularia indivisa*, and the hydræ had all the characters of the *larynx*. None of the stalks were connected by bars. Unless for the speedy reproduction, these might have been thought dwarf *indivisa*. —Pl. II. fig. 15.

The *Tubularia larynx* is infested by dangerous enemies. During the frequent regenerations of the fine and ample specimen first described, a very numerous colony of a certain kind of Doris, which shall come under cognizance in its proper place, menaced its destruction. These little creatures, also consuming the epidermis of the *Tubularia indivisa*, now nestled among the most intricate recesses of the mass, whence they could not be otherwise dislodged than by a slight putrescence imparted to the water, compelling them to forsake their haunts below in quest of a purer medium. Thus were 68 diminutive parasites captured and removed. Repeated lotions cleansed and purified the tuft, so that regeneration continued. But the ravages of the Doris had been great, and clusters of its spawn remained inaccessible.

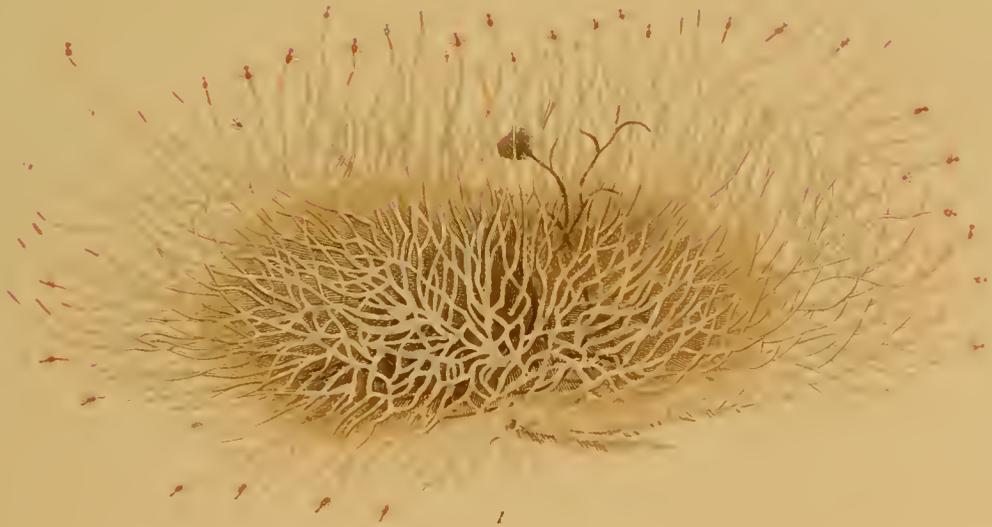
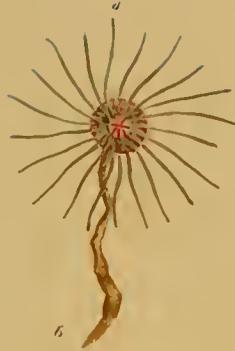


PLATE V. FIG. 1. *Tubularia Larynx*—Compound or many headed Tubularia ;
Group.

2. Specimen selected for illustrating the course of reproduction.
 3. Another, selected for the same purpose. The peculiar aspect of the product is shewn by both.
 4. Skeleton of fig. 2, shewing the structure of the inorganic parts.
 5. Hydra and Stalk, tentacula *a*.
 6. Hydra and Stalk.
 7. Nascent Tubularia from the ovum.
 8. Another.
 9. Regenerated hydra, shewing the progressive diminution of the organs.
- All the preceding, except fig. 1, enlarged.

CHAPTER II.

TUBULARIA (SERTULARIA) RAMEA.—PLATES VI. VII. VIII. IX. X.

§ 1. The Tubularia proper is distinguished by two prominent characteristics; *first*, In the hydra having a double row of tentacula; *second*, In an ovarium of pendent clusters, near the stomach, being interposed between them. I have found none in Scotland, unless the two preceding species, with similar organs thus disposed. As neither of these features, palpi or clusters, is presented by the subject of this paragraph, it ought certainly to be incorporated with the *Sertulariæ*, or perhaps assigned to an intermediate place.

Some recent authorities, indeed, propose to denominate it *Eudendrium*, which is rather more adapted for a specific than a generic distinction, especially from being inappropriate to nine-tenths of the specimens occurring, and in applying with equal force to many other zoophytes.

The hydra seems precisely of the same structure and habits as that of the *Sertularia*. It propagates, with exception of some peculiarities, precisely after an analogous fashion, through the medium of a prolific pod or vesicle; the progeny issuing from this most narrowly resembles the planula, which we shall see is discharged by the other, insomuch that for facility of indication they may pass by the same name.

Here, however, no cavity terminates the extremities of the product, adapted for reception of the numerous hydræ; there are neither the cylinders, sheaths, nor bells of most *Sertulariæ*; and they can only contract, instead of enjoying the privilege of retreating. But this important safeguard is not only incomplete in various species of the Sertularian tribes, but, when naturalists have even founded the systematic name and arrangement on its

presence in others, it is transient, and in some perishing with the tenant, though regenerated along with a successor.

The subject of this paragraph is therefore more nearly allied to the *Sertularia* than to the *Tubularia*, or to any other established genus. But while retaining the name, to avoid the perplexities involved by injudicious changes, I shall leave it to the skilful framer of the Systema to settle its true position.

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

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

But from its appearing in infinite variety, and as it is shown from the different synonyms bestowed that they cannot be uniformly applicable to any one subject as a type of the rest, and as many doubts may remain when they are concentrated under review, it is necessary to enter into a more special detail. Nothing is readier to delude the naturalist than beholding the earliest and the latest stages of such products, if deprived of intermediate specimens to explain their progress and transition.

A very fine specimen of the *Tubularia Ramea* was recovered from among the rocks of a cavity in the bottom of the Firth of Forth, at about 150 feet from the surface. It had vegetated in such a direction, that it was detached quite entire.

Being transferred to a capacious vessel of sea-water, I found this *Tubularia* rising seven inches and a half in height, by a stem about nine lines

in diameter near the root, then subdividing into several massy boughs, besides many lesser branches.

Numberless twigs, terminated by thousands of minute hydræ of the palest carnation, clothed the extremities which were ten inches apart.

The root itself diffused irregularly by a multitude of mossy-like fibres, which might be circumscribed by a circle of two inches diameter. It is to be observed that the stem and the higher rigid portions consisted of irregular bundles of tubes; but about two inches of the highest were in verticillate arrangement, that is, composed of twigs, set around the leading part, and not in simple divergence to right and left from it.* Though composed of bundles of tubes below, the absolute extremities bearing the hydræ resolve into single tubes, each with its animal.

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

A fine and accurate representation of the specimen was speedily executed by a masterly artist, Mr John Welch, miniature-painter. Yet, such was the extraordinary luxuriance of this product, that an infinity of subordinate parts were delightful to the eye in nature, which, intercepted by others, could not be shown on a mere surface.—Plate VI.

So great an accumulation of parasite matter, however, combined with animal life, hastened the decay of this splendid subject, by tainting the purity of the surrounding fluid.

Other specimens have occurred of similar aspect and conformation, chiefly from four to six inches high, but none above nine. From these and the former it appears that the higher portion surmounting the main stem may be confined by an elliptical outline. That is the fashion of its growth. Thus, one most beautiful and luxuriant, four inches high and diverging four inches, might have been circumscribed by an ellipse two inches and a quarter across. By gross computation, 1200 hydræ, deeper

* The proper definition of verticillate might be, a regular form, like the spokes issuing from the nave of a wheel at first horizontally, and then turning upwards.

Salix humilis



coloured than peach blossom, decorated this latter specimen. All had fallen on the third day—none whatever remained.

Such specimens are dark and bushy, the hydræ commonly pale, sometimes almost white. Except in colour, I have been unable to discern any difference between those ornamenting the larger specimens of this *Tubularia* in thousands, and those of fine and florid red and yellow on small specimens, where there are very few. But it must be kept in view, that, as a hydra naturally belongs to every extremity, where the hydræ are numerous there must be many parts; where they are scanty, the specimen being vigorous, the parts are few.

Perhaps the dimensions of the *Tubularia ramca* in a salubrious situation much depends on age. Those specimens less mature have fewer boughs, branches, and twigs, but the last always terminated by a hydra. Though void of that surprising luxuriance above described, many are extremely beautiful to behold. All the parts and proportions are of admirable symmetry; the length of each twig being about double the expansion of the hydra.—Plate X. The stem of such specimens is of dark umber colour; the hydra red and yellow. This, the hydra, which is the organic part of the product, considered externally, consists of a single row of 24 obtuse muricate tentacula, bordering the disc and around the stomach, which rises as a central prominence of variable form.* This pouch or stomach is sometimes flattened almost down to the disc on discharging its contents. The hydra expands about a line between the opposite tips of the tentacula; therefore, it is smaller than that of either of the preceding *Tubulariæ*, but its dimensions surpass those of any of the Scottish *Sertulariæ* with which I am acquainted.—Plate VIII. figs. 1, 2, enlarged. The tentacula are endowed with sensible action; and the head always expands and turns towards the direction whereby light is introduced; but it has no influence whatever over the twig or the stem by which it is borne. Therefore the naturalist who is told of *flexible* zoophytes must beware of believing in their voluntary motions—that they bend sponta-

* Muricate, resembling an assemblage of low pyramids, with slight intermediate impressions.

neously. Very few enjoy that faculty; some only to the slightest extent. All the *Tubulariæ* and *Sertulariæ* are in this sense inflexible, in as far as I am aware. Many zoophytes, indeed, including these genera in earlier, and some in the latest stages, though growing upright, are incapable of sustaining themselves when deprived of their native element, which is not rendered sufficiently explicit by those characterising them as flexible.

But there are, in fact, several which are completely so. Single *Vorticellæ*, for example, can bend and turn and twist in all directions; they can almost cast a knot on their tender and delicate stems. Microscopic shrubs composed of similar animals, hundreds of campanulate hydræ terminating their extremities, while at their highest enjoyment of full expansion in some favourable position, will suddenly collapse on a momentary alarm, crouching close down to the root in absolute quiescence. Then, as if relieved from the apprehension of danger, they rise again to display their beautiful proportions.—Plates XII. XXI.

The younger and smaller *Tubulariæ* and *Sertulariæ* consist of a single hydra, sustained on a fistulous stem, a character unalterable with either the age or dimensions of the *indivisa*. In some others it remains, while flourishing twigs issue from the sides: but this is true only with respect to the earlier specimens of many; for in those which are older, such as the *Tubularia (Sertularia) ramea*, and the *Sertularia (Nemertesia) ramosa*, the stem having attained considerable diameter, will be found to consist of numerous parallel *tubuli*; and, in both it is quite inflexible, remaining upright, though the smaller parts yield when unsupported by the water.

Different portions of the branches of the *Tubularia ramea* are indented by whorls, and especially the extremities.—Pl. VIII. fig. 3. But for the most part they are faint or altogether obliterated: nor do these seem one of the constant characters.

The head or hydra of this product is deciduous, like the hydræ of the two preceding species; also like them, it enjoys the remarkable prerogative of regeneration,—though perhaps for another purpose, because it is not there that the elements of posterity reside as in the former.

The duration of this most important part of its organization is indefinite. Of 80 vigorous hydræ which embellished the specimen, Plate VII.,



Gumou

when withdrawn from the sea, only 40 subsisted on the second day ; 30 on the third ; 12 on the sixth ; 4 on the seventh ; 2 on the eighth ; on the tenth there were none : the whole had fallen. This was a beautiful specimen. It might have been circumscribed by a circle the size of a shilling. The dimensions of another, alike beautiful, and more luxuriant, with the colours finely contrasted, were no larger.—Pl. X.

The head survives its fall for a short time. It generally wastes away suddenly, without falling. Likewise its decomposition is rapid. Though many have wasted or fallen in the course of a night, none are to be discovered at the bottom of the vessel next morning.

From the transparent cylinder now remaining, the summit appears to have been penetrated by a prolongation from below the disc : but the point of union with any internal pith or medullary matter is imperceptible during the hydra's life : Nor is this same hydra retractile, as already observed, there being no vacuity for its reception.

The nascent bud rises within the hollow tube, to replace the fallen hydra, precisely in the same manner as that of the *Tubularia indivisa*. Those of largest size after protruding from the extremity, but before bursting their involucre, are twice the diameter of the stalk. The new tube sustaining the regenerated hydra, though often much smaller than the stalk to which it is united, speedily expands as the head advances. Its delicate and pellucid red is finely contrasted with the dark umber of the older parts.

Much of the colour, size, and general aspect of specimens, depend on age ; but as the new hydræ do not exceed the size of their precursors, the proportion of the organic to the inorganic part is certainly diminishing, because every addition to the latter is permanent ; and every regeneration of the former is transient : Neither is the evolution of additional hydræ to be compared with the multitude of the other parts.

The generation and display of the embryo may be governed by the same rules which predominate in the preceding species.

A beautiful group of six or seven specimens, chiefly two inches and a half high, bore numerous hydræ on the 12th of February. All had fallen in three days. But in other twelve, many new heads were

flourishing; and many buds in different stages appeared among them. The least mature had a slight enlargement at the end of their respective twigs; and the most mature a dark ovular or ovoidal formation sustained on a short neck—the generating tube. The distribution, proportional increment, and perfection of the renovating parts, rendered the aspect of this group very interesting. Alike so were the subsequent changes. After all the heads had fallen, no germination was perceptible on the 22d of February. But fifty or sixty buds and hydræ appeared in forty hours, and in another day that number had doubled. Almost all the twigs were flourishing vigorously on the 2d of March. Above three-fourths of the heads had fallen on the 8th; and on the 10th, only one remained, which went to speedy decay. In the next place, a few buds again protruded from the extremities, on April 29: several flourished from the tallest stem on the 4th of May. Many irregularities ensued, but reproduction was general on the 13th of June.

The more minute the objects, the greater the difficulty of following the progress of reproduction, whence fewer illustrations can be obtained.

A branch, not exceeding three lines in length, had borne heads on three twigs, *x*, *y*, *z*. The head *x* fell March 3, leaving the tube it had generated an eighth of an inch long and lighter coloured than the rest. A bud now rose visibly, within the cylinder, and burst on the 29th; thus requiring 26 days for maturity,—the head preceding it had required 23. Having flourished 8 days, it fell April 2. Another head burst on May 3; thence the reproduction occupied about 29 days. Its subsistence was now more transient, for it fell in 6 days. A new bud, visible on the 11th of June, burst with 24 tentacula on the 12th, or in 33 days from the decay of its precursor, and it subsisted during 7. The twig flourished again in 16 days, and the renovated hydra remained 10. But the neck by this time becoming foul, no farther regeneration could be followed. So much for the extremity *x*. The twig *z*, being vacant, alike, on March 3, did not flourish until the 3d of May, that is, for 60 days, when the head then regenerated subsisted 7. But now falling, it had no successor. The twig *y* generated a head 29th March, which head subsisted 7 days, but it produced no more.



Tubularia Racemosa.



The preceding observations prove:—1. The same twig bore at least six successive hydræ. 2. The subsistence of the hydra was from 6 to 10 days. 3. The interval required for reproduction required from 16 days to 60. These irregularities are extraordinary.

The ascent of the bud is gradual; and it is visible within the tube for two or three days before its evolution.

Thus certain analogies are found between this product and the two preceding in the structure of the inorganic parts, and in the regeneration of successive hydræ, from the same portion of the same specimen; nor are the predominant irregularities in less correspondence.

Propagation.—Regarding the propagation of the zoophyte, which must certainly influence its position in the Systema, many years elapsed before my observations established the peculiar mode whereby it is effected.

A splendid group of above fifteen specimens occurred on a live mussel shell. One of these, not 18 lines high, bore 83 hydræ; and another somewhat taller above 100. At least a thousand animated beings decorated the group—a wonderful assemblage of variety and beauty on such a scale. Numerous clusters like yellow ova were interspersed among the hydræ, not within the circuit of the tentacula, as with the Tubulariæ of the preceding chapter, but generally around the exterior of the under surface or base of the disc, though disjoined from it; and sometimes as if compressing the hydræ by their number and position. But they were neither confined to any particular place, nor peculiar to the finest of the specimens. Subjected to the microscope, these substances proved of a smooth uniform surface, exactly resembling a minute ovoidal plum, attached by a short pedicle to some part of the stem, but never within the hydra. All in one specimen were ovoidal, those of another irregular, spherical, or ovoidal. They were single, in pairs, or in clusters of seven or eight together.—Pl. VIII. figs. 5, 6.

The whole were preserved most carefully for a long time, but I was disappointed of ascertaining their nature, nor was I more successful in respect to some other specimens of the same product.

Eleven years afterwards, however, several specimens having occurred,

which bore fine florid hydræ, like those of the *Tubularia* represented Plate VII., I found minute yellow objects like plums, as before, on different parts; two on some, and on others five or six. Many of the hydræ exhibited symptoms of decay, when these were in their immediate vicinity.

All were preserved with equal care as previously.

The yellow plums proved at length to be so many ovaria, analogous to the clustering cysts already described in detail, though differing somewhat in various particulars; for they neither corresponded in position or consistence, nor in the connection of a number by a pedicle affixing them to a common stalk, nor in their contents. In fact, they may be almost identified with the vesicles or pods borne by the *Sertulariæ*, which remain for ample discussion in their proper place.

Each of these minute yellow plums is a separate and independent pod or vesicle, wherein, no doubt, an ovum is originally generated, but discharging an animal intimately resembling a *Planaria*, and which, for the purpose of ready and familiar recognition, I shall venture to designate *planula*. The conventional name of *larva*, which there is at present so strong a disposition to incorporate in the vocabulary of natural history, seems scarcely enough expressive of its character.

Only a single large bright yellow planula is contained in the vesicle, whence it is discharged on maturity from an orifice towards one side near the summit. But the vesicle itself is of such extreme transparence, that it is hardly visible, after losing its contents.

This animal, the planula, is taper, roundish, or somewhat flattened, not half a line in length, of smooth, uniform, fleshy aspect, void of external organs. It crawls with considerable activity below; and on ascending by the side of its vessel to the surface of the water, it either descends again, or pursues a course at the edge; or committing itself to the element it swims supine. It changes its situation freely, testifying evident preferences, and it is of infinitely greater activity than the nascent hydra after being discharged, and during its evolution from the cyst of the *Tubularia indivisa*.—Pl. VIII. fig. 7.

Certain learned naturalists, whose opinion I highly respect, have expressed their doubts of the animation of this being, without having seen



Tubularia Hamca.

it, on my endeavouring to describe its properties. But it seems to me conclusive, that if a moving body, meeting an obstacle in its course, passes around instead of remaining still, or if it retraces a given track, and changes its direction according to circumstances, sufficient evidence is afforded both of animation and of volition.

The planula is soft and of variable form; and it continues crawling about for an indefinite time. Then its motion relaxes, it shortens and thickens, and appears as if composed of two portions, a larger and smaller, both very obtuse, and next it is found affixed to some solid substance.—Fig. 8.

In four days after this active creature has been discharged as a minute Planaria from the vesicle of the beautiful shrub, studded with numberless animated flowers, it becomes altogether metamorphosed—for now a living hydra is borne on a fistulous stem with a diffusing root below.—Fig. 9.

In the middle of November, an aged specimen, clinging to the tube of an Amphitrite, bore white hydræ. All the branches were invested by hundreds of clusters, composed of a number of prolific pure white vesicles crowded together and resembling minute eggs.

Another fine specimen of the product obtained towards the end of September, five inches high, and apparently very old, was remarkable for the profusion of pure white vesicles on the branches, which were disposed in clusters of five, six, or seven together.—Plate IX. fig. 1.—The same enlarged, fig. 2.

The hydræ of this specimen were not numerous; they were small, nearly white, some of the faintest carnation.

Within a few days, many planulæ, all pure white, had been discharged by the vesicles. They were of corresponding figure with the former; an obtuse rounded head,* thick and fleshy body, tapering towards the tail or lower extremity, which was also obtuse.—Plate IX. fig. 3.

The number of planulæ continued augmenting; but, in a short time, their motion relaxed. They became stationary and quiescent, and the alteration of their shape announced approaching metamorphosis.—Fig. 4.

* By this word rounded is to be understood, not simply obtuse, but something tending to a circular arc.

Here, as before, they seemed forming into two portions. Meantime a root was diffusing below, and a stomach forming above, fig. 5; and the higher portion by the gradual refining and improvement of the parts was developed as a perfect *Tubularia*.—Fig. 6.

The progress of this zoophyte is rapid; sometimes the nascent hydra flourishes in six days after the discharge of the planula from the vesicle. It is now furnished with from 12 to 18 very muricate tentacula, for the number is variable in individuals. Indeed, there is almost a common and singular irregularity of the subordinate parts, not only in the nascent, but in the mature hydra of many zoophytes. From such extraordinary irregularity or variety of aspect, it is less surprising that considerable differences are seen in the figures presented by authors, besides which there may be some difference in the aspect of the same species of animals found in various countries. Yet it is not to be denied that many imperfections originate, first, from neglect in selecting the finest specimens, secondly, from inability to obtain the service of competent artists. Let it be remembered that an alteration of the position of a subject will often bring a whole series of organs into view which were previously unnoticed.

The formation of the root of the *Tubularia ramea* is definite and conspicuous—generally forking from the centre into four radicles, full of pith like the stem, which extend far, and occasionally exhibit a subdivided extremity. Four radicles seem the regular complement. Herein is a great distinction from the *Tubularia* proper, and a strong analogy with the *Sertularia*. I mean in the formation of the root.

I am not aware that there is any essential difference between the nascent animal from the yellow vesicle and that from the white vesicle. The root of the former seemed diffusing amidst a transparent matter, which from colour might be inconspicuous in the latter. We shall afterwards find some correspondence in these points with the *Sertularia*.

Both nascent products from the yellow and the white planula regenerate the hydra. That of a nascent specimen from a yellow vesicle subsisted 23 days; in 10 days from its fall, it was replaced by one which subsisted 4 or 5.

The position and aspect of the vesicles are represented Plate VIII.

figs. 5, 6, 11, 12, 13, 14, and Plate IX. fig. 1, 2. The planulæ from the vesicles are seen Plate VIII. fig. 7, and Plate IX. figs. 3, 12; the commencement of their metamorphosis Plate VIII. fig. 8, Plate IX. fig. 13, and the progress of the nascent Tubularia from an early stage to perfection, Plate IX. figs. 5, 6, 7, 8, 9, 14, 15, 16, 17, 18, 19, and Plate VIII. fig. 9.

A monstrous hydra crowned the stem of a specimen bred from a planula, Plate IX. fig. 10; and two stems, *a*, *b*, issued from the same root of another, fig. 11—three roots from fig. 14—five from fig. 15.

Clusters of corpuscula of uncertain nature are seen, though rarely, at the summit of such stalks as have borne hydræ. They bear some resemblance to a compound vesicle, consisting of a spherule, sustained on a pediment. From 10 to 20 compose the cluster.—Plate VIII. fig. 10.

The various aspects under which almost all zoophytes occur occasion great embarrassment to the observer. There is scarcely any naturalist who fails to assign a series of whirls, or whorls, to different parts of the stalk of these Tubulariæ, as I conclude. Yet there are many of those now described wherein no such feature can be recognized. The stalk or twig remains smooth and even—quite plain from its origin up to the head. Others exhibit 8, 12, or 16 whirls, like prominent annulations; but they are frequently very faint and indistinct: nor have I ever seen the deep indentations, like a coil of ropes, represented by authors. A specimen, very old, though not taller than two inches, bearing hydræ, had none. Probably whirls of the neck are exposed through a transparent membrane in their early growth, while they may be subsequently disguised or at last obliterated by supervening age and opacity. Naturalists are very prone to represent microscopical objects or those, simply viewed by a lens, with features infinitely stronger and more definite than the truth. But many allowances must be made for the difficulty of obtaining the finest specimens, or a suitable view of them, and, above, all a competent artist. No one but he who would practically study the science for a protracted series of time, and wishes the world to profit by his labours, can appreciate the embarrassments opposing his representation of the identical subject and its parts.

The *Tubularia ramea* grows either as a very bushy shrub, upright,

and free, with a grey or a brown stem, and hydræ of vivid red and yellow, faint carmine, or almost white: Or it runs as a thread in adhesion to sub-jacent substances, merely shooting up twigs, and sometimes branches at intervals. Then the twig is crowned by one, and the branch may be terminated by ten florid hydræ. Adhesion of the stem, whenever contact with a foreign substance ensues, is a peculiarity incident to most Sertulariæ; and then it appears that the vegetation, which should naturally issue from the sides, if free, originates from the upper side only, the others adhering to the substance.

The difference between a luxuriant and a stunted specimen is incredible.

None of the zoophytes can be compared in luxuriance and beauty to the *Tubularia ramea*; or can excite greater interest in beholding such an animal product with its thousands of living parts growing from the same spot, affixed like a vegetable to the earth.

Its nature is prolific, for the vesicles of some amount to thousands. Yet it is not more—if equally prolific with others; as the vesicle contains only a single embryo, whereas the vesicles of some Sertulariæ contain above twenty. I cannot say whether any positive determination of genus or species is to be founded on the paucity or the profusion. The question merits investigation.

I have not seen any specimen higher than nine inches, or more than ten in divergence. Such are large zoophytes. The stem is then composed of numerous *tubuli*. I do not well comprehend how the accessions are gained to the single tube peculiar to early age. In their multiplied condition, the tubuli appear as free and independent or united in clusters, which may be seen from the section, Pl. VIII. fig. 15. Similar specimens are always imprinted with the marks of venerable antiquity.

PLATE VI. *Tubularia (Sertularia) ramea*; aged specimen.

VII. *Tubularia (Sertularia) ramea*; adult enlarged.

PLATE VIII. FIG. 1. Hydra of Plate VII., enlarged.

2. Hydra of Plate VII., enlarged.



Tubularia Eranca

- FIG. 3. Stem, branches, and hydræ of another specimen, shewing the arrangement of the parts, enlarged.
4. Branch of a specimen, illustrating the regeneration of its hydræ from *x, y, z*.
 5. Vesicles compressing the hydra, enlarged.
 6. Vesicles, partly dispersed on a branch, partly compressing the hydra whereby the variety of their form is illustrated, enlarged.
 7. Planulæ from yellow vesicles.
 8. Planula metamorphosing.
 9. Nascent hydra, previously a planula.
 10. Vascular substances of uncertain character.
 11. Branch bearing hydra and vesicles.
 12. Branch bearing hydra and vesicles.
 13. Part of a specimen with hydræ and vesicles, enlarged.
 14. Vesicles variously distributed, and hydræ.
 15. Transverse section of the stem of the aged specimen, Plate VI.

All the figures of this Plate, except fig. 4 and fig. 13, are enlarged.

PLATE IX. *Tubularia (Sertularia) ramea*. Propagation.

- FIG. 1. Branch with white vesicles.
2. The same, enlarged.
 3. Planulæ from white vesicles.
 4. Planulæ in different stages of metamorphosis.
 5. Nascent tubularia; root forming below; and stomach above.
 6. Nascent specimen.
 7. Nascent specimen.
 8. Nascent specimen.
 9. Nascent specimen.—The cruciform root is not distinctly exposed, in figs. 6, 7, 8, 9, from interception of the view.
 10. Nascent specimen, apparently monstrous, from the position or form of the hydra.
 11. Nascent specimen, considerably advanced.
 - 12-19. White planulæ and their metamorphosis, in November.
- All the figures, except the first, of this Plate, enlarged.

PLATE X. *Tubularia (Sertularia) ramea*, enlarged.—The original might have been circumscribed by a circle an inch in diameter.

§ 2. TUBULARIA (SERTULARIA) RAMOSA.—PLATE XI.

The preceding observations apply to those animal products resembling plants, whereof the hydra, head, or flourish, crowning the extremity of the tubular extremity of the stem sustaining it, remains permanently in its place during life, because there is no lower cavity adapted for its reception. The cylinder, though hollow, is occupied by a peculiar substance. It is otherwise with the subject of the present paragraph; whence observers, on becoming better acquainted with its nature, may remove it from this intermediate position, to be incorporated with the Sertulariæ, which, from the structure only, are apparently of nearer kindred. Mean-time certain peculiarities of extreme interest, concomitant on the few specimens falling into my possession, will perhaps atone for any deficiencies of description, classification, or nomenclature, more especially as these can be readily corrected by those learned authors devoting themselves to systematic arrangement. The multiplication of facts may facilitate their useful labours.

While occupied, early in June, with the *Pennatula mirabilis*, or *Virgularia*, as it is now denominated, I found the lower extremity of three different specimens invested by the zoophyte, under discussion. Many others also subjected to observation at the same time, were quite free of it. This lower extremity is usually a naked bone, protruding beyond the flesh of the *Virgularia*, or it is covered with a dark skin, being perhaps the fleshy part of the lobes, which shall be afterwards described, in a contracted state.

A colony of 20 or 30 of what I judged to be the *Tubularia ramosa* invested the lower part of the largest of the *Virgulariæ*, radiating as it were from around it.—Plate XI. fig. 1. It will be seen that they issue from the circumference of the bone.

Here the stem of the *Tubularia*, about an inch high, was surrounded by branches in somewhat of an alternate arrangement, shortening as they rose upwards; a few were subdivided into twigs: all the extremities were tubular, without any enlargement, and each was terminated by a hydra. The formation is in no respect dichotomous, that is, each larger portion subdividing into two lesser ones, and these undergoing a similar partition.

Faint whirls, almost inconspicuous in the living product, indent the *origin* of the branch and the *extremity* of the twigs. Chestnut brown or umber is the predominant colour of the inorganic parts ; the hydra, very minute, is reddish.—Plate XI. fig. 2, enlarged.

As the extremities of this product consist of hollow cylinders, without any cellular enlargement, the hydra retreats simply within for protection. When rising, it is protruded by a very long flexible body or neck, capable of great recurvature, which is bordered by from 6 to 14 muricate tentacula, environing an obtuse central cone—the stomach. The tentacula are susceptible of much elongation, when they become almost of cylindrical form. The stomach is indicated by a rough dark line descending far within the body.—Fig. 3.

Although the hydra protruded from the extremity of a cylinder, some issued immediately from the side of the stalks, without the obvious intervention of a tubular twig.

The great flexibility of the neck induced me to consider this product as allied to the *Coryna*, on obtaining a smaller specimeu many years antecedent to those now described ; nor even now do I speak positively of the name and species. It is susceptible of complete recurvature, or of looking behind, as we should express of other animals.

Naturalists have affirmed that a circulating fluid subsists in the *Tubularia indivisa*, a zoophyte of considerable magnitude, and of which the organic portion exceeds the dimensions of the corresponding part of any of the other corallines. My inability to discover it, though resorting to numerous specimens of every size and age, has been already explained. But I have witnessed it very satisfactorily in the present subject, under peculiar circumstances, not by one, but by repeated observations.

When the hydra is brought into a horizontal position, dark particles are seen ascending one side of the neck and descending by the other, as if conveyed by the current of a fluid. But the sides of the channels containing them are invisible, perhaps, from tenuity ; nor is it undoubted that the currents absolutely flow on the opposite sides of the animal, for the channels may be separated by a smaller interval. Relative position in objects so minute is extremely delusive. The current is chiefly visible at the

lower part of the head. A prominence on the neck of a hydra, Plate XI. fig. 4, exhibited similar currents, though less distinct.

The rate of such currents is not altogether uniform. This, indeed, is seen in the *Ascidia*, and various kinds of the lower animals; and in many, their acceleration or retardation must result from the mutable form of the subject. Sometimes the particles are carried along with considerable velocity in the hydra now described.

This hydra has no power over the skeleton, which, in comparison with it, must be considered rigid.

The same vegetative faculty distinguishes the present species as many *Sertulariæ*, for, having cut two portions from a specimen, I found them rooted to the glass whereon they lay in the course of a night.

Medusa ocilia.—Practical naturalists must be well aware that numerous colonies of minute *Medusæ*, and even successive generations of them, sometimes appear in vessels containing various marine collections. But it is extremely difficult to pursue the history and progress of such transparent, unmanageable, and too often evanescent beings. Their sudden existence has surprised me again and again. I was unable to ascertain their origin; they have remained some days in activity, then vanishing without leaving the slightest traces behind. No species could be preserved with facility, though for only a short period; they did not seem referable to any particular time or subject. Every thing regarding them was wrapped in mystery.

The smaller the objects, indeed, and the less conspicuous their aspect, independent of the delicacy of their perishable nature, the more restricted the scope for permanent observation. Yet there are some so hardy, and so readily beheld, not a tenth part of the dimensions of their fellow-tenants of the waters, which may remain so long as to disclose their own history.

While a number of vigorous hydræ still terminated the extremities of the zoophyte above described as the *Tubularia ramosa*, I suspended various specimens by silk threads, in vessels of sea-water. This is a method to be particularly recommended for convenience and security; the subject

is better preserved, the parts more accessible, and by immediate transference, it can be always kept in the purest medium.

Several white specks among the twigs issuing from the branches then became perceptible by the naked eye, which, under the microscope, proved to be small solid pear-like substances of bluish-grey colour. Thence I proposed to denominate them *pyrula*.

Thinking little more of the matter at the moment, I concluded they might be regenerating hydra, as not unusual with different zoophytes. But my attention was soon arrested by the position of some as if seated on the long neck of the living hydra. I could not doubt that one neck sustained three, and that elsewhere a cluster of four appeared at the extremity of a twig then vacant of a hydra. Further investigation ascertained the following facts.

Minute pyriform bodies, as above specified, are dispersed on the stalk of different parts of the Tubularia, at considerable intervals; sometimes three are together, sometimes two opposite to each other; or only one terminates a twig, where it might be readily supposed a regenerating hydra.—Plate XI. figs. 5, 6, 7. Each *pyrulum* is affixed by its own distinct pedicle, at first of some length, but gradually shortening as the remainder becomes more globular, or flattens. In a few days, the whole may be compared to the opening bud of a white rose.—Fig. 8.

Now the dilatation and collapse of the subject commence; convulsive struggles ensue; four pair of long rough muricate organs resembling tentacula, or ciliary processes, are gradually unfolded; and after what seems repeated severe and protracted exertions, a perfect animal of great transparency is liberated as a Medusa, suspended amidst the waters.—Figs. 9, 10.

This Medusa resembles a large transverse section of an ovoid, not half a line in diameter, the sides of excessive tenuity, the tentacula, or ciliary organs, four or five times as long as the diameter of the ovoid, and quite flexible. I conjectured there might be an orifice in the upper surface, and that some stump or particular organization by which it was penetrated, and remaining behind, the animal amidst its struggles was kept in its place. It is the upper surface which is that in application or adhesion,

as may be seen of others, the lower portion whence the cilia originate is meantime free. Here, as we know, the mouth or proboscis of the Medusarian race is situated. In the under surface four cruciform organs were apparent. But the difficulty of ascertaining relative position is never to be forgot; and, in fact, organs apparently below in such creatures may be in the middle, or actually above.

As in some other Medusæ, the ciliary, or tentacular organs, resemble knotted cords. Each pair originates from a prominent knob or button on the margin of the cavity in the under part; and a black speck, like an eye, is conspicuous at the root of each tentaculum: there are, therefore, eight in all. The transparent convex surface of the animal is crossed by two darker lines at right angles, as if dividing it into quarters, and terminating in the four buttons or knobs on the margin.

The opacity of this creature during its earlier stages is not such as entirely to intercept the light, though its transparence refines in proportion to the evolution of its organization. Thus, the cross lines running from what was conjectured an orifice is discovered to be four vessels, wherein a fluid carries a number of black particles down to the marginal knobs below. It rather appears also, though I could not satisfy myself of the fact, that the current may pass in another course around the margin.

We should be much deluded, as well as our fellows, in believing that sufficient opportunities are afforded for similar observations by the Medusa, free of the zoophyte, and swimming at large. On the contrary, they can be effected only while immaturity yet restrains the animal to its pristine site; and where, during progressive evolution, the microscopical focus can be accurately adjusted for distinct vision. The motion of so restless a being, when liberated, renders correct observation incompatible with that condition.

One of the *pyrula* seemed to be united to a hydra, just at the orifice of the twig from which it issued. Circulation manifestly advanced in both. Black particles were carried up as well as down the neck of the former—the *pyrulum*; and during their descent, a current was obviously conveying black particles up the body of the hydra; something similar seemed to be going on in an isolated *pyrulum*, where there was no hydra.

All this appeared to me very singular ; because it is unusual, at any time, to obtain such facilities from transparence or otherwise, as to allow disclosure of the hidden and mysterious operations of animal life. Perhaps I might have comprehended the process advancing better had the zoophyte borne an ascidioidal hydra, because the sanguiferous system is visible in various species at their various stages. But I had no reason to remove the hydra of the *Tubularia ramosa*, from its alliance with the structure of the polypus proper, in as far as that belongs to zoophytes of the Tubularian or Sertularian tribe.

Among the larger and more perfect animals, it is usually understood that circulation by the sanguiferous system must advance in a regular and uninterrupted course, else pernicious consequences follow. But, in as far as I have seen, no such regularity is indispensable to the health or safety of some of the lower animals ; nor can we even pronounce it permanent, where transparence of the subject allows protracted observation. In that before us, the circulation is sometimes accelerated, sometimes retarded—nay, it is occasionally altogether suspended—yet without evident injury. Further, there is much ground for assuming that the rate and proportion of the current are in a certain measure dependent on the will of the animal, or on the exercise of its faculties over its own organic structure. Amidst all this, we say the variable form of the soft bodied animals must be specially kept in view, the extraordinary change and vast disproportion produced of their different parts, and how much the whole system will be affected by it.

The provision of Nature for conducting a vivifying principle throughout the whole extent of animal organization, whereby it shall impart vigour to the remotest parts, surpasses all the admiration which mortals can bestow upon it ; and this marvellous expedient is rendered still more wonderful, by reflecting on the means adopted for its impregnation with atmospheric qualities devised for the common sustentation of the universe. Everything conspires to shew the grandeur of the plan from whence the world has originated. Perhaps we shall at last find the apparent vast diffusion in variety concentrated in some simple elements.

The history of no tribe of living creatures has remained so long in

obscurity as that in general of the transparent beings which we denominate Medusæ. It will scarcely prove more intelligible if we shall consider them only an intermediate race of animals, like the larva, chrysalis or nymph, among insects, only in the course of transition to some other form or condition, unless we shall actually witness their origin and their end.

I am not ignorant of the strong disposition of modern naturalists to establish the nearest kindred between the Hydra, comparatively few in number, and the legions of the Medusarian family, thickening the very ocean in their profusion; but I also know how very prone we are to grasp at every novelty, and our precipitation in adopting as facts what can be offered only as conjecture.

I say not this to impugn the observations of those ingenious naturalists who have proved the truth; but to restrain the hasty opinions of those who would reason less from facts than from analogies; and to enforce the expediency of accurate and continued investigation.

The preceding animals originated and disappeared without leaving any traces behind. Indeed, the smaller medusæ never leave any that I have seen.

Another species has sometimes appeared and decayed mysteriously, without affording obvious indications of its origin.—Pl. XI. figs. 11, 12. This animal occurs in April; the former is developed from June until August. It is an eighth of an inch in diameter, with 16 long slender tentacular or ciliary organs, disposed in four bundles, which issue from four marginal prominences. At the base of each set is a black speck. The transparency of the medusa is such that while suspended in equilibrium among the water, it is scarcely perceptible.

I shall be probably enabled to say a few words on the Medusarian race at a future opportunity.

The evolution of the *Medusa ocilia* is progressive, accelerated perhaps by external temperature. It has occurred to me under no other conditions than as above specified. A number of whitish corpuscula seem to be generated, rather suddenly, among the hydræ, either singly, in pairs, or in clusters of three, four, or five, as already stated. Each is affixed by its independent pedicle, and generally about the orifice of a twig of the zoo-

phyte. One wherein no subordinate organic parts were visible, on first inspection, was observed to unfold in three hours.

There is reason to believe that this Medusa is confined in a diaphanous vesicle or *involutrum*, remaining in its place after the animal has escaped. If actually so, which requires confirmation, we cannot but recognize strict analogy to the vesicles of the Sertulariæ, some being hardly perceptible after discharging their contents, from extreme transparency.

A colony computed at 130 individuals of the *Medusa ocilia*, was produced in four or five days: and there are grounds for assuming that successive colonies come from the same specimens of the zoophyte.

I cannot presume to affirm that any connection, immediate or remote, connects the *Medusa ocilia* and the *Tubularia ramosa*; far less to conclude that the former shall be metamorphosed in progress of time to the latter, with its numerous and beautiful appurtenances. I have not seen both the beginning and the end; nor does the fugitive existence of so delicate a creature seem well adapted for permanent observation.

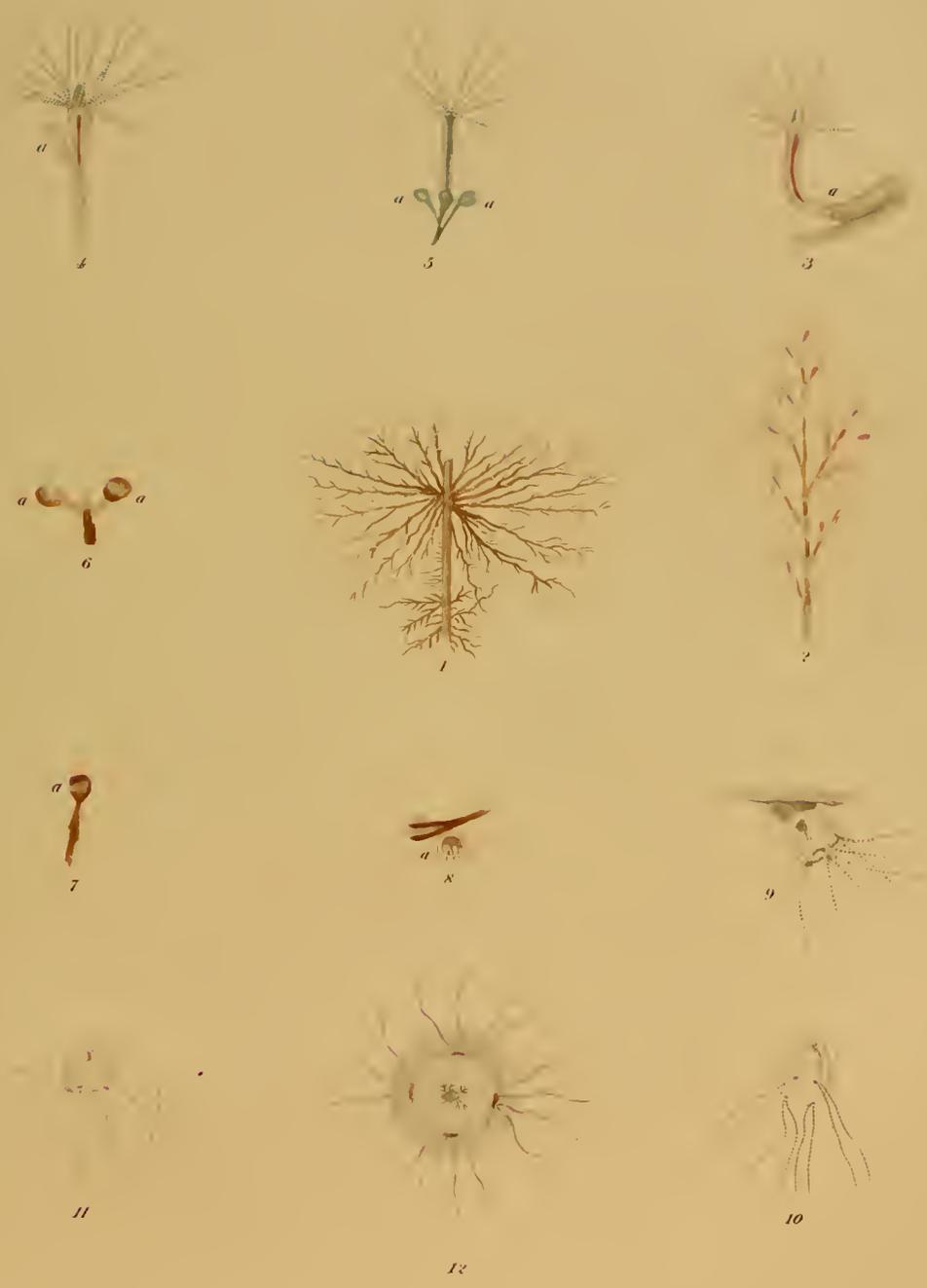
This is not the only example, it is true, which I have witnessed of Medusarian forms originating from hydraform products, as shall be explained in the proper place. But we cannot be too distrustful of inferences on such obscure and peculiar phenomena of nature. So many important facts may elude observation, so many delusive appearances are ready to bewilder the senses, we cannot desire too ample corroboration.

Perhaps the preceding facts, as well as the subsequent, may stimulate more intelligent naturalists, enjoying better opportunities than I have had, to seek their confirmation.

PLATE XI. FIG. 1. *Tubularia (Sertularia) ramosa*, investing part of the *Virgularia (Pennatula mirabilis)*, or Sea Pen.

2. Branch.
3. Hydra protruding from the extremity of a twig, *a*.
4. Hydra with an indefinite excrescence on the neck.
5. Hydra with three pyrula *a* (embryonic medusæ) at the orifice of the twig.
6. Pyrula at the extremity of a branch.

- FIG. 7. *Pyrum*, *a*, at the extremity of a branch.
8. *Pyrum*, *a*, unfolding as a Medusa.
9. *Medusa ocilia (octocilia)*, in progressive development.
10. The same free.
11. *Medusa duodecilia (ciliis duodecim)*.
12. The same, viewed in plane from below.
All the subjects of this Plate, except fig. 1, enlarged



Tubularia bamesa Medusa Celia

CHAPTER III.

THE HYDRA OR POLYPUS.

THE preceding facts, sufficiently interesting in themselves, require some farther illustration, for explaining the general nature of the hydra or polypus, so often referred to as forming a most essential part of the subjects described. This will enable the reader to comprehend still more satisfactorily the peculiar quality of those to follow, especially if never having himself beheld them in their native element.

From the material difference of *organization* in those living beings, which, along with *inorganic* matter, compose the substance of such animal products passing by the general appellation of *Zoophytes*, the name *hydra* is employed rather as a conventional term than as a definition, to signify that active portion endowed with evident sensation and spontaneous motions. Custom has sanctioned its application, like the use of other phraseology: it is attended with certain facilities; and it may tend to repress that inordinate multiplication of trivial nomenclature whose subdivisions threaten confusion to both the learned and the illiterate in the maze of interminable ramifications.

Had this work been more than a mere collection of memoirs from practical observations—a simple detail of facts—the useful arrangements of Dr George Johnston might have been beneficially followed as a guide; for that learned author, commencing with the hydra, lays down the elements of an easy partition of zoophytes, founded on the nature of the animated portion. He distinguishes them as *Hydraoidal*, *Ascidoidal*, *Helianthoidal*, and *Carnose*.

In as far as I am aware the hydra *proper*—that is, the *polypus* of

older authors—is a simple animal, uncombined with any other organic structure, and which, on dissection, has shown but little to the anatomist ; and that its form is permanent from the origin to the close of its existence.

On the other hand, in some instances, the hydra of zoophytes in maturity is simple ; it is almost always, if not uniformly so in the nascent state of others. In adult zoophytes, the majority of hydræ are combined with a simple inorganic structure, often that which is complex, a cell or a stem, or a boundless multitude of branches and terminal cells, with their tenants all enjoying an independent condition or reciprocally connected together. In some this connection is obvious ; in some obscure ; and masses of thousands of pinnate hydræ comprise the living animals, scarcely separated by a fleshy partition in the carnose tribes.

There are three hydræ in Scotland which I consider strictly of the *individual* nature of the hydra *proper*—namely the *Hydra viridis* and the *Hydra fusca* of the Systema—both inhabitants of the fresh waters ;—and the *Hydra gelatinosa, strobila, or tuba*, of the sea, which appear synonymous :—as *hydræ* all exhibit common properties. The body consists of a variable sac, having a dilatable orifice environed by tentacula, endowed with an adhesive and a prehensile faculty. The whole are highly carnivorous ; they propagate the young in their own likeness, by gemmation or budding from the side ; they regenerate mutilated parts : and adults, as well as young, if cut asunder, become entire animals.

Being hardy by nature, easily fed, preserved, and subjected to experiment, they are peculiarly adapted for minute and protracted study. Their accessibility, their size, and tenacity of life besides, wherein they surpass most of the zoophytical tribes, render them favourable objects for observation ; because the delicacy and minuteness of many others, not omitting the higher organization of a number, truly removing them from the genus Hydra, deny the same facilities to the naturalist.

When the fresh-water polypus became better known, before the middle of the preceding century, its singular properties aroused the admiration of those who devoted themselves to the investigations of Nature. To behold a living animal perpetuate its race, by simple gemmation from the

side, like the bud of a vegetable; and while the offspring was yet adhering to the parent, to witness another—a second race of descendants—originating from the first generation, seemed a disturbance of the appointed order regulating the conditions of existence. But, above all, to find a being endowed with life and sensation, as if indestructible under the edge of the knife, so that privation of the most important parts of the frame for conducting the vital functions, was only a prelude for the development of others to supply their place, revived the fabulous hydra of the ancients in actual verification.

Thus was the notice of physiologists irresistibly attracted to those energetic qualities of living matter restoring organic integrity.

Extending the field of inquiry, they proposed to apply to other creatures of the lower tribes, the name of the animal, the hydra, by which such admirable peculiarities had been displayed. Herein their plan was partly correct, and partly erroneous; for, taking only a superficial view of the aspect of such animals, those anatomical distinctions sanctioning their transference to other genera, either remained undiscovered, or they had not sufficient weight to lead to their removal.

Hence it is, perhaps, that *hydra* is rather a conventional term of general application than a rigid definition employed to signify that peculiar structure of the animal exclusively falling under it.

The only Scottish Hydræ of the fresh waters, which I can positively identify as different, are the *fusca* and *viridis* of the Linnean *Systema*; the former with six or seven tentacula, the latter with six, eight, or more. But the number of each is indefinite.—Pl. XII. figs. 14–20, inclusive, enlarged.

I do not recollect to have found the first with above seven tentacula. The young are pullulating from the sides of all but figs. 14–17. Fig. 15 was white or pale grey, which may be an accidental variety.

Neither of these species, especially the green, is uncommon in Scotland; but the properties and peculiarities of the genus having been long ago so copiously exposed by *Trembley*, *Bonnet*, *Roesel*, *Baker*, and other skilful experimentalists, it would be superfluous to discuss their history here.

Both of them have been hitherto considered animals in a perfect state: nor have I at any time discovered in our fresh waters any living being indicating an origin from their metamorphosis: neither has protracted observation on themselves afforded room for conjecturing it.

The most learned have not disdained a philosophical view of animals undergoing successive metamorphoses in their advances to perfection. Witness the admirable work of *Lyonet* on the Caterpillar of the Willow. Therefore I do not hesitate to assume the subject of the following paragraph, as well adapted for illustrating the general nature of many zoophytes, and in particular, the mode of their increment—independent of its own singular history. It not only elucidates the character of both simple and compound genera, but it shows how a thousand individuals may advance from one by progressive multiplication.

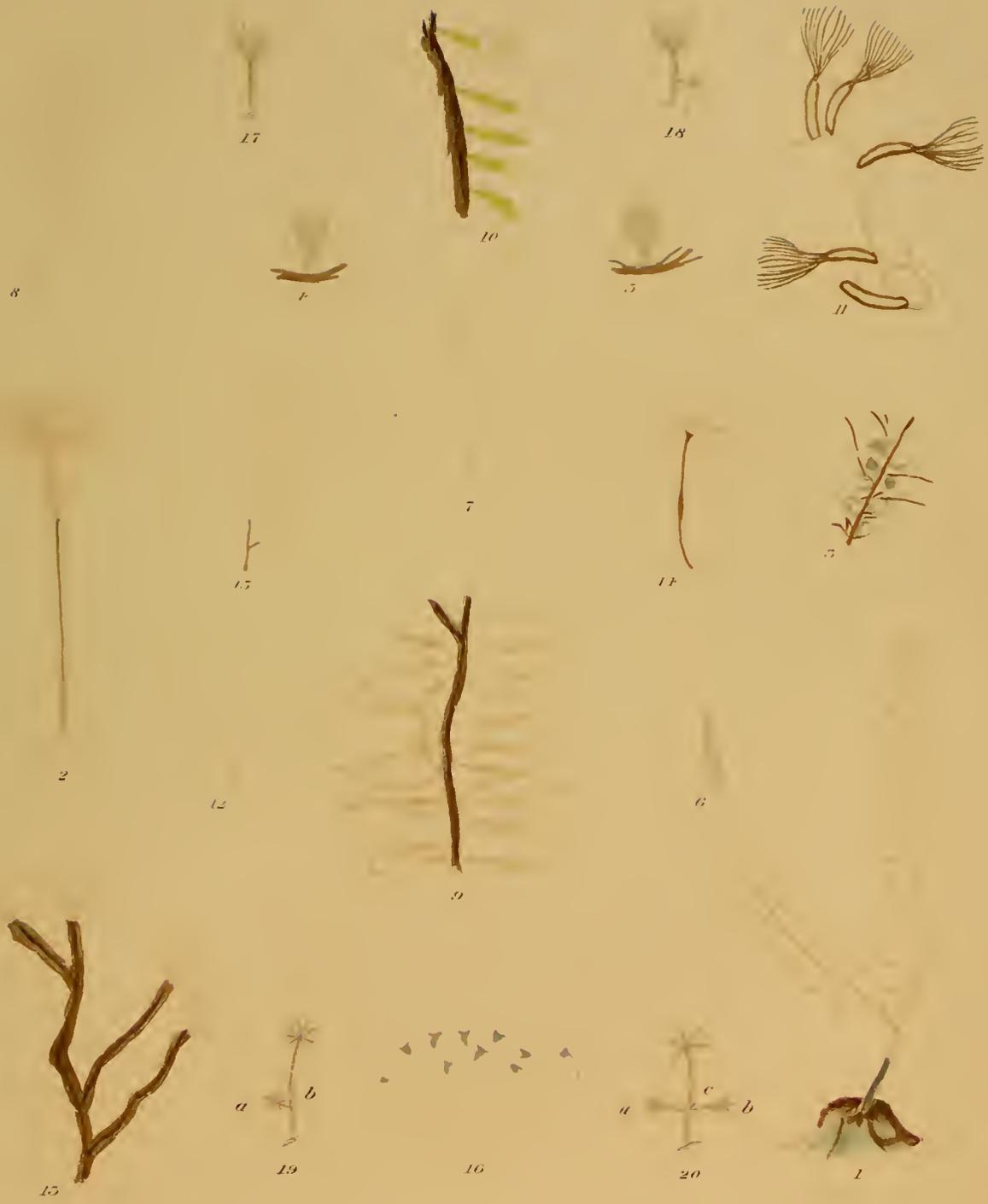
§ 1. HYDRA TUBA, THE TRUMPET POLYPUS.*—PLATES XIII. XIV.

Let me here premise, that some years ago, long after the subject of this paragraph had come under my notice, I submitted a few general observations regarding it, to the British Association for the Promotion of Science, during the sittings of that learned body at Edinburgh in 1834. As the study of Natural History was advancing but languidly in Scotland, my principal aim was then, as on previous and subsequent occasions, to engage the attention of my countrymen with the interesting phenomena, which they might readily discover among our national products. Therefore, selecting only the facts most easily attained, nor exacting painful and protracted study, I sedulously abstained from discussing various other im-

* Probably this is the *Hydra gelatinosa* of Müller, *Zoologia Danica*, tom. iii. p. 25. Pl. XCV. *Havniæ*, 1789, in fol.

In a work by a learned Norwegian author, *Sars*, of which I have very recently seen a copious extract in *M. Lesson's* *Acalephes*, he describes what seems the same animal, under the name of *Strobila*, I presume meaning the cone.

From his valuable details, it appears that he was the first who revealed to naturalists the remarkable metamorphosis undergone by the hydra.



Miscellaneous Diatoms.

portant and still more interesting points, though sufficiently acquainted with them. I believe now that it would have been better had I done differently, for it would have prevented certain authors from betraying themselves into very erroneous conclusions of the import of my observations.

I shall resume the subject more at large in this place, viewing the hydra, in the first instance, as a perfect animal.

The body of the *Hydra tuba* is a hollow cone five lines in length, thick and fleshy. Thirty or more very extensile, flexible, fine slender muricate tentacula descend twenty-one lines from the margin, collectively forming a beautiful silken-like pencil waving amidst the water. The mouth rises as a conic frustum among them, in the centre of the disc, much resembling the closed mouth of the Actinia; but there is no analogy to a proboscidal organ, either here or in any other of the hydraoid race. The natural colour of the animal is universally dingy white, sometimes faint orange, perhaps according to the season, but it is specially affected by the quality of the food. It is affixed by the apex; and is exclusively an inhabitant of the sea.—Pl. XIII. fig. 1.

Throughout there is a strong analogy in many prominent features of this animal to the nature of the Actinia.

Complete developement of all the parts of the *Hydra tuba* is best exposed under temporary abstinence: the observer will be disappointed of seeing them if resorting to his specimen in a state of repletion. While in abstinence, the animal remains suspended by the apex, the body lengthens, and the tentacula are extended to the utmost stretch in quest of prey. If sensible of its presence when inaccessible, the hydra does not employ them as instruments of capture in sweeping around, but the mouth widely dilating, projects the edge as a thin flexible lip in much action. Now, the capacious cavity of the stomach indistinctly exposes a kind of columnar range around the internal parietes, possibly corresponding with the external form of the body, at times bearing faint resemblance to a cluster column. Exposure so complete is very rare. The stomach is most capacious: when coloured food gorges the hydra, it is seen nearly at the apex; indeed, excessive distension seems to detach the animal from its point of adhesion, when it falls to the bottom of its vessel.

This is a creature far from being nice in the selection of food. It preys readily and greedily on most animal substances, and the quantities absorbed, are altogether disproportioned to its dimensions. Among the victims of voracity it is singular that living young Actiniæ should be acceptable prey, considering their congenerous nature, and the more so, that they seem incapable of making any exertion for self-preservation. In return, the hydra is devoured by the Actinia,—all conform to the general law whereby the weaker among carnivorous animals falls a prey to the stronger.

When sated, the hydra remains motionless, with the tentacula closely contracted. Judging by the long continued exposure of coloured food through the skin, digestion is probably very slow. If originally copious, the food is rejected by the mouth in a half-digested state, as with the Actinia. Like it also, if sparingly supplied, the whole is apparently absorbed into the system. Sometimes the mass is retained several days, though usually rejected sooner. The residue of a very voracious meal has been retained ten or twelve.

In farther correspondence with the Actinia, the senses of this hydra, excepting touch, are certainly most obtuse. Hunger merely induces the extension of the tentacula, but there is no evidence that the presence of the prey is discovered, otherwise than by actual contact. No searching activity of the tentacula is shewn even when food is within their reach : no perceptions regarding it are betrayed, unless the action of the lip, as above described, can be an indication ; and although the roots of the tentacula become somewhat more apart, and consequently greater dispersion of their extremities, nothing proves that it is for any important purpose. However, the animal is capable of raising large portions to its mouth ; and its pendent position is clearly the natural one, and for affording greater scope for the exercise of these flexible organs.

Speedy increment follows copious sustenance. All hydræ are then rapidly enlarged, attaining tenfold their previous size, if regularly fed ; and they become proportionally prolific. Along with emaciation, the colour fades from protracted abstinence.

This is an animal very impatient of the effects of light. While the whole organs are finely displayed in comparative obscurity, they con-

tract quickly, on removal to the light, and always as if to evade some painful impression.

Probably adhesion is spontaneous, as with the polypus of the freshwaters and the Actinia of the seas. But the *Hydra tuba* commonly remains stationary where it has taken a position; if affixing first to the bottom of a vessel, it continues permanently there. If dropping from its place when affixed to the side, or should the water be repeatedly agitated while either adults or young are loose, they seldom adhere afterwards; nor does the animal fix readily at any time.

Its trumpet form is sometimes entirely lost, and the figure of a hand bell assumed by the upper portion of the body, near the fixture of the apex, relaxing like a coarse thread, extending two lines or more. Then the remainder of its pendent body flattens in a campanulate form. When several of a group assume this figure, inexperienced observers might be deluded by the change.—Plate XIV. fig. 26; XX. fig. 19, *a*.

A locomotive faculty, though rarely exercised, and only in the lowest degree, is undoubtedly enjoyed by these creatures. The adult is never seen in the course of progression. Indeed, I doubt if its advance would be perceptible; but the young hydra withdraws unnoticed from the parent: and in event of successive or of a series of generations, the whole individuals constitute a colony dispersed around its original founder. Their segregation generally tends upwards.

Keeping this latter fact in view, it will be discovered that the like general principle governs the compound zoophytic tribes: the increment of the Sertularia is by ascending from the original cell giving birth to the whole.

Spite of advancing multiplication, numerous colonies of the hydra remain concentrated within narrow bounds. Though some adults seem almost constantly rivetted to the same spot, it appears essential that the young germinating from the parent's side shall be capable of removing, to leave room for more, as propagation is incessantly going on. After advancing in one direction, they sometimes recede a little, slowly and imperceptibly.

Thus the perceptions and active faculties of these creatures are ex-

ceedingly obtuse, imperfect, and limited, farther than seizing and ravenously devouring whatever prey they can master. From this, perhaps, they are always of small dimensions, when recovered from the sea. But, by plentiful supplies of food, and frequent renewal of their native element, they may be infinitely enlarged; and they can be preserved several years.

With age and increment the figure of the animal is considerably modified, then becoming more elongated in proportion to its extreme diameter. A colony under temporary abstinence is beheld in the most interesting form, displaying so many pencils waving like tresses among the water.

The peculiar habitation of the trumpet hydra seems the inner surface, and especially the upper cavity of empty oyster or other bivalve shells. If to be identified with the *Hydra gelatinosa* of Müller, a colony occurred to that distinguished naturalist on the under side of a marine fucus.

The oyster is very abundant in some parts of Scotland. The suspension of the hydra in its shell, together with intercepted view from the profuse vegetation fringing the edges of many, may account for it so long escaping the notice of observers. It diffuses any where, however, provided the position be favourable, and certainly best where pendent under shelter. It is obvious that a great colony on the lower valve of a large shell, afterwards described, must have been most likely preserved from some peculiarity, such as the shell resting at an inclination so as to allow the action of the tentacula.

Notwithstanding all this, it will be seen in the course of the following narrative, that the position of the original founder of the colony must be accidental, times out of number; and that the dispersion of the progeny is dependent on the place of the parent.

The shell of a *serpula* bearing a group of hydræ was detached from its fixture on an old oyster shell, and suspended by a silk thread passed through the empty tube on the 21st of November.

In three weeks, this group proved to be in fine condition. It consisted of three large specimens of a beautiful orange colour, and of seven smaller ones, dingy white.

Enlargement of the whole against January showed the advantage of their new position, where the height of the shell sustaining them had been so adjusted that food at the bottom of the jar was attainable by their extended tentacula.

The group had augmented to 25 on the 1st of April, when a fragment of the shell, with seven individuals, accidentally separated, leaving the other 18 adhering to the suspended portion. This latter alone continued under observation, the fragment being abandoned.

Supervening changes and a series of other accidents befell the group from the fragility of the shell. Portions of the surface, yielding in decay, carried off the animals adhering to them. But in August of the following year, or about 21 months from the commencement of observation, the group was crowded and beautiful.—Plate XIII. fig. 2.

The greater proportion of the whole separated seven months later, in April, and at length only six remained adhering in two years and a half from the beginning. One of them, if not belonging to the original ten, was of the first generation. The last of these six was detached in the following June, or in 32 months from the November first specified, when the shell proved so brittle that it crumbled to the touch.

Though many individuals which had formed the bulk of the group were preserved, their history, as a community, was prosecuted no longer. It is not that condition which admits the satisfactory elucidation of details.

The anatomical structure of the hydra proper has been as yet but insufficiently explained. In as far as I am informed, no muscular formation is ascribed to its parts, though certainly endowed with muscular powers: nor has any nervous or circulatory system been detected, though life and sensation be evident in the remotest extremities. Some have lately affirmed the existence of ova or their rudiments, thus reviving an earlier opinion, indeed the earliest of all, *omne animal ex ovo*. But I understand it to be a desideratum on the whole, among the most skilful naturalists, that many assertions were confirmed by undoubted experiment and observation anew.

Confining myself, however, to the origin of this marine hydra, and

the mode whereby it multiplies its kind, with the view of explaining the increment of the arborescent zoophytes by the latter, I shall offer a few definite remarks on the subject.

Propagation.—The faculty of perpetuating its race—that is, of beings precisely similar to itself—resides in each individual of the *Hydra tuba*. To that extent we would pronounce it a perfect creature of the same consistence and form from its earliest origin as derived of a parent hydra; and its descendants, derived in the same manner, are identically so down to distant generations.

In as far as may be judged, the perpetuation of the species—that is, of the *hydraform* species—is an irresistible result of mere existence, a consequence over which the individual hydra is not known to have any control, more than the individual vegetable has over the swelling bud or expanding blossom. Neither is it evidently dependent on age, at least in a general sense; for we can scarcely pronounce on that period when even a nascent individual is immature.

Let us assume, in the first place, an adult. If preserved in a suitable situation, supplied with food, and its renovated element in purity, an embryo speedily germinates from the side.

Thence it is natural to conclude that a germ, or deposition of elementary matter, subsists somewhere in the flesh—that, generated within as a compact substance, its way is made, by a regular process, to the exterior, where it becomes visible as a rising prominence.

Almost the whole of this animal's body is occupied by the stomach, which swells from the disc to the apex when distended with food. All reproductions or germinations necessarily ensue from its vicinity, and it is singular how much propagation is promoted by abundant sustenance, as already noted.

The embryo literally buds from the side of the parent as a simple protuberance, frequently accompanied by a long fleshy spur with an enlarged extremity. Its use is uncertain; nor is it permanent. But its existence seems solely dependent on the progress of reproduction; and as the early embryo advances to a later stage it disappears. This spur is previously endowed with voluntary motion; it curves and alters its direction readily,

from being quite flexible. It is seen of various dimensions; one half an inch long, and of *quantum* equal to six tentacula, has issued from the base of a young hydra still connected with the parent.

In the course of a series of observations on the progress of reproduction, I detached an adult from its site, on April 23, and deposited it in a watch-glass, where, owing to favourable circumstances, it soon adhered.

In four days, a spur issued from one side of the base, and a large protuberance with a row of papillæ, an originating embryo, was rising from the other.—Plate XIII. fig. 3. Parent, *a*; embryo, *b*; spur, *c*. All as on April 27.

On May 2, these papillæ had elongated into perfect tentacula, like those of adults, when both the parent and the offspring were fed.—Fig. 4.

Another protuberance on the opposite side of the parent was now visible, either obscuring the spur or incorporated with it, which protuberance, gradually maturing as a young hydra, was fed on May 17; and the subject, as consisting of three perfect animals and a spur, was delineated on May 21.—Fig. 5.

The parent and the progeny were still connected; but in other three days decisive maturity of the latter appeared by the separation and establishment of three members of the cluster as independent animals.

It must be understood that, in earlier stages, the body of the parent and the embryonic germination constitute a common integral mass; but as the uniting apex, or real basis of the embryo, is continually refining and diminishing, it remains very slightly connected with the parent. Farther security is therefore obtained by adhesion to some solid substance—here the watch-glass; then the offspring receding imperceptibly until united to the parent only by a slender ligament, its rupture or disappearance separates them for ever.

About May 24, the three specimens, *a*, *b*, *c*, were ranged in a straight line. At a previous period they would have been comprehended in a spherical triangle. Two protuberances, *c*, *f*, appeared on the opposite sides of the parent, *a*, with a spur from *c*. A prominence also rose from *b*; *c* showed nothing. But on May 29, a small hydra, *d*, which had originated from *c*, was established between *b* and *c*. A very slender ligament,

scarcely perceptible, still connected the animals, *a, b, c*. Of these two latter, *c, b*, the larger was *c*, the younger having perhaps got more food. Next day, May 30, the group appeared as in Fig. 6.

Within a fortnight, that is, on June 12, the whole group, from its new accessions, consisted of the earlier three, *a, b, c*, now far apart, and of *d, f, i*, being six in maturity. Besides these, a large protuberance, *g*, was issuing from the base of *a*, the previous site of *e*, or nearly so; which last, *e*, had detached itself, and was abandoned. A protuberance likewise rose from *c*.—Fig. 7.

A seventh perfect hydra had come from one side of *c*, on June 16; and in four days the colony consisted of eight.

The number of independent animals still continued eight on July 7. But concomitant changes prognosticated the difficulty of observing their progress much longer. Reproductions from each of the whole, were advancing, and particularly conspicuous in the larger, *a, b, c*. Some of their embryos exhibited the rudiments of tentacula; and spurs, which generally distort the specimen, were visible on the other five.—Fig. 8. The eight perfect animals are *a, b, c, d, f, g, h, i*.

On the 21st of July, or within three months, the specimen, fig. 3, distinguished only by a spur and a protuberance, on April 27, had 15 descendants, the whole having germinated from itself and its progeny. One or two others were lost by separation. Thirteen, all of various age and dimensions, were dispersed in adhesion over the cavity of the watch-glass, and two lay below.—Fig. 9.

Some, such as *d, d*, had subdivided; others were still connected by a ligament.

Now it appears that *a*, the original parent, was the lowest of the group.

But the progress of this colony could not be conveniently prosecuted farther, for the watch-glass, obscured by the muddy deposit of sea-water, precluded distinct observation. The slight adhesion of the young, as well as of their progenitors, proved an invincible obstacle to attempting its removal and purification. Therefore this group was abandoned.

Many objects, originally clean and beautiful, become foul and disco-

loured, by the mud usually suspended in sea-water, especially if taken from the flowing tide. Although this be ultimately productive of much embarrassment to the observer, its presence is so beneficial to various creatures, such as the *tunicata*, *vermes*, *annelides*, and others, that then they evidently thrive, while declining, from its absence, in pure and limpid water. Inadvertence to the fact, I believe, has cost me some valuable specimens.

Under such circumstances, inevitably supervening as in the preceding tedious course of observations, the watch-glasses should be kept in vessels comparatively of considerable capacity—in those containing perhaps from four to six or eight ounces of water. Also, they should remain in an inclined position, the convexity outwards, so that the tentacula of the animals pendent within shall have free scope below. Thus the muddy deposit, falling on the outside, admits of removal, whereas falling within, the hydræ are liable to injury by attempting it. The observer will find it more difficult to provide against obscurations and interruptions from the insensible residue after feeding the animals, forming a glutinous adhesion to the glass. Then the careful application of a feather, or a hair pencil, will be found useful.

Sometimes several germinations develop into perfect hydræ, the whole remaining united to the parent.

A solitary animal having been set apart, it subsequently displayed a family of four well-grown individuals issuing from about the base, to which they still adhered.—Plate XIII. fig. 10. In a week, the evolution of another had ensued; and the formation of two buds, with a serrated margin, besides fig. 11. Original parent in figs. 10, 11, *a*.

After undergoing several changes, accompanied by the increase of numbers, this group chanced to be committed to a vessel containing an *Actinia*, in the confidence of that indemnity to be expected from the quiet habits of a kindred race. Yet it was devoured.

Multiplication advances rapidly under the favourable conditions of genial temperature, copious sustenance, and the element frequently renovated. Did they often concur, we should more readily discover colonies of these animals in Scotland. Further elucidations of their history will surprise naturalists at their rarity.

A specimen having detached itself from the group represented, Plate XIII. fig. 2, adhered to the side of a jar, and showed symptoms of reproduction on June 26.—Fig. 12. In a week, further developement had followed, fig. 13. By successive evolution, this new subject consisted of the parent and five young sprung of it, on July 15. Twelve individuals with tentacula composed the colony on August 12; and twenty could be distinctly enumerated on the 1st of September. But it is singular that the parent hydra, *a*, as in a preceding example, was now the lowest on the side of the jar; all its progeny had withdrawn somewhat higher—several considerably so.—Fig. 14. On November 22, they had augmented to 32. About two years subsequent to the fixture of the parent hydra, fig. 12, to the side of the jar, the colony, after many losses, consisted of 45. Such losses are almost inevitable. The longer the period, the greater the chance of deperdition among a number of objects.

One of this same colony having dropped from its site in October, I transferred it to a watch-glass, which, after the animal had fixed, was kept in an inclined position, with the convexity upwards. In two months, nine young were generated, and on the first of March following, the augmenting colony consisted of 33 perfect hydræ, almost the whole being established distinctly and separately.—Plate XIII. fig. 15. Their number would have been greater had they not been fed rather sparingly, for the purpose of obtaining satisfactory delineation. Here was a rare example of not one being lost; and the concavity of the watch-glass, whence the colony was suspended, having been constantly downwards, it remained quite clean. In another month, the number reached 47.

The multiplication of these creatures, by the budding of each successive generation of the progeny from the side of its immediate parent, brings distant descendants into cotemporary existence. The accumulated multitude originating from a single hydra, can be neither foreseen nor estimated. It must depend on the duration of life and the rate of fertility. We are ignorant of both. There is no reasoning *a priori* of what shall be definite.

As the enlargement of the Sertularia advances, on corresponding principles, where the hydræ, or at least many of them, enjoy some better

shelter in cellular cavities for temporary retreat, it is evident that the more luxuriant specimens may consist of thousands.

It is impossible, I say, to anticipate the progeny to come of a single hydra. Propagation seems incessant. I cannot affirm that, as among a multitude of the inferior animals, it is dependent on the seasons. No doubt, there are conditions restraining multiplication ; but some of them are not yet understood.

On November 21, just two years after the group, Plate XIII. fig. 2, became the subject of observation, a specimen which had dropped from it was found adhering to the side of the vessel. Four or five embryos were now generating from the side of this hydra, which, being one of the largest size, had doubtless given birth to many previous descendants. In April following, the parent and its progeny had augmented to 20 independent hydræ, each affixed by its own apex, besides some others, still attached to those from which they were originating. The number amounted to 50 on July 23, when *a*, the parent of the colony, that is, of the four or five embryos on November 21, was much larger than any of its progeny. But in a month it appeared quite distorted, from a new budding of several more embryos unequally advanced. A year after having established itself on the side of the vessel as said above, its descendants—some of the second, perhaps of the third generation—amounted to 73. The size of the parent, *a*, still predominated over that of any of them except of one, *b*, which from being fed equalled it. On the 6th of December, 83 were enumerated ; and in addition to this great and rapid increase from one individual, the colony afterwards augmented proportionally.

The size of the hydra, *b*, which had equalled that of the parent, *a*, on November 21, now surpassed it on December 6, and young were budding from its offspring. The voracity of this creature rendered fish, and flesh, and all other animal substances grateful, for it was excessive. Portions above its own ordinary dimensions were absorbed at a single meal ; consequently its bulk enlarged over that of *a*, fed more sparingly. The body, from repletion, swelled to at least thrice its ordinary diameter ; and the animal adhering to the bottom of the vessel, not being suspended

above, fell over in a flattened form, as if incapable of sustaining itself upright. It would remain thus during two or three days at a time.

According as the food is absorbed in the system, or as its residue is rejected by the mouth, the symmetry of these animals is restored.

It is not surprising that distension from inordinate voracity should strain the narrow point of adhesion by so small a surface, and separation ensue. But the effects of repletion are different on the hydra and actinia, though, in many respects, they be much akin. The tentacula of the actinia are then finely displayed, as if having enjoyed its repast; while those of the hydra remain closely contracted, fig. 16, and the body is distorted as if suffering from immoderate indulgence.

Though the natural colour of the *Hydra tuba* seems dingy white, and always resolves into it, and though sometimes of orange or reddish tinge when recovered from the sea, the quality of the food affects the hue, and this for a considerable time. For example, specimens having fed on the *Gordius maximus*, a large black or purple worm, continued darkly stained for even two months afterwards.

Both the aspect and the fertility of the animal depend on its treatment. Nevertheless, many irregularities occur which cannot be traced to definite sources. The number of external organs is frequently very variable in some of the lower animals, and in none more so than the genus hydra, where the character of all they have is similar. The finest adults of the subject before us have at least 30 tentacula; but one of the largest size had only 16, while a young one, its progeny, still adhering to the body, was perfectly mature. The parent of a group of four had 20; the farthest advanced 16; and each of the other two had 12. The specimen, Plate XX. fig. 7, *a*, had just 16 in four months after representation there; nor could I find that the number had increased in three months longer. However, the original complement of tentacula, as will be seen of the originating hydra from another form, is two or four, advancing to eight and upwards.

As copious sustenance promotes fertility, some of the most numerous of the preceding colonies might have been doubled by unremitting care.

The mode of propagation which I have described does not, in my



Hydra tuba

apprehension fall strictly under the character of *fission* or *cleaving*, but is more properly to be distinguished as *gemination*. By *fission* we understand the division of a substance, each portion separating or carrying off a part of the original whole, which is scarcely applicable to the formation of a bud from the parent's side.

Whether the budding results from a germ come of an earlier principle, whether from the deposition of matter immediately secreted from the substance of the parent, probably the primordial elements of the subject *nasciturus*—of that being which is to exist by developement, are the same. All the works of Nature apparently resolve into great simplicity.

The preceding observations had been the occupation of many years. But various facts and ambiguities still remained for explanation. The immeasurable field, replete with animated beings, is such, and the portion to be traversed by an individual attempting to journey over it so limited, besides so many unavoidable obstacles in his course, he must often halt for repose and opportunity. Thence no one has been yet found capable, of himself, for composing the perfect history of any single living subject as proceeding from the hands of the Creator.

There is none of Nature's products which should be more common than the Trumpet Polypus; still it is not so. To seek for it purposely is vain; in truth it is of rare occurrence.

A group obtained in the middle of August had been comparatively neglected as of no farther use, but new circumstances of curiosity induced me to restore it to suitable treatment, on the 10th of September, for permanent observation.

This group consisted of ten small hydræ, occupying the cavity of a fragment of the *Solen siliqua*, or razor shell. They enlarged speedily by feeding, and the invigoration of renovated water, so that in five or six weeks they became sufficiently adapted for the object I had in view.

In process of time these animals spread over to the back or convexity of the shell, thus investing both surfaces by their multiplication and dispersion, during five or six months subsequently.—Pl. XIV. figs. 2, 3. In June following, or ten months after procuring the group, I found the colony on both sides, consisting of 50 independent animals; at least six

others had dropped from their site. Many are thus lost with the lapse of time, and some are also dislodged accidentally. In about two years, or little more, from the commencement of observation, when the number was ten only, the whole consisted of about *sixty* hydræ remaining, and now dispersed over both surfaces. In two years and a half, however, those adhering to the shell were reduced to nine, disposed on the sides towards the lower edge.

Gradual decay and deperdition still impaired their number, for the shell became very brittle with age, and it is this, amidst other inconveniences, that aggravates the embarrassment of watching the progress of subjects.

After repeating several incidental observations, previously made on mutilated organs, I considered it necessary to ascertain more decisively the kindred nature of this hydra of the sea to the fresh-water species of Scotland, so as to warrant its incorporation or otherwise with the same genus.

I do not recollect that naturalists have ascribed the property of recovering lost organs to any but perfect animals: for, if I be not mistaken, the numerous experiments related of regenerated parts, were made on those in their ultimate stage.

Nevertheless I confess myself extremely averse to such experiments, though no such tender scruples are entertained by others. Besides, where practicable, it is better that our studies should be confined to animated beings unconstrained and uninjured.

About the middle of October, or six weeks after new treatment had improved the group on the razor shell, the specimen, Pl. XIV. fig. 1, *a*, was bisected. In a fortnight, a row of regenerating tentacula extended two lines from the stump or under portion; and in another week the mutilated animal had become entire. It was delineated on February 13, or four months from the date of the experiment, along with its companions, all in the cavity of the shell, being seen at that time as above quoted,—somewhat exceeding nature—*a*, fig. 1, Pl. XIV. There it remained unchanged, but much enlarged, eleven or twelve months after bisection

Other two specimens were next subjected to similar experiment,—Pl. XIV. fig. 3, *a*, and fig. 3, *b*,—both being on the convexity of the shell.

The former, *a*, which is represented separately by fig. 4, was bisected with very sharp scissors, on March 12. The stump is seen, fig. 5, as remaining in its place after bisection.

In a fortnight, this stump had generated about sixteen long silky tentacula, fig. 6; but neither extending so equally nor preserving such regularity as shewn by specimens entire. However, they continued advancing, and the stump to which they belonged became a complete animal; when it was accidentally lost, along with some of its neighbours, above a year after the group had come under observation.

So much for the under half. In regard to the upper half, severed from fig. 4, that is fig. 3, *a*, bisected as already said on March 12, the wound had healed when delineated with the original tentacula, on March 29, fig. 7; enlarged, fig. 8. Thus two perfect animals resulted from the bisection of one.

But this last, fig. 8, subsequently exposed some peculiarities. Its tentacula were nearly but not completely obliterated. Several short, obtuse prolongations, unlike originating tentacula, next appeared on the 6th of May. The subject had undergone much alteration on May 25, then consisting of many obtuse parts, as more distinctly seen when enlarged.—Fig. 9. Farther alteration alike singular had ensued on the 5th of June, fig. 10, at which time these anomalous parts extended as tentacular organs of very irregular length and form. Some were long and slender like genuine tentacula; others thicker and shorter: but there being a constant tendency of nature to produce or to restore symmetry, the whole were approaching the proper shape in 16 days, or on June 21.—Fig. 11. This refined still farther, figs. 12, 13, as on August 21 and 29, when perfect symmetry had been acquired.

It still remained to be seen whether so great a mutilation as privation of half the body, which this subject had undergone, was now completely reintegrated, in as far as to carry on all the purposes of existence. Time alone could prove it; and the fact was at length verified indubitably by the gemmation of progeny from its side, and separating to enjoy inde-

pendent life.—Fig. 14. A young hydra, only a prominence on September 1, had withdrawn on the 21st.—Fig. 14, *a*. It had eight irregular tentacula in an earlier stage, and was connected by a ligament to the parent.

It will be preserved in recollection that the subject just described was the upper portion sundered from fig. 4, or what is originally named as fig. 3, *a*.

Pursuing the history of its companion, originally fig. 3, *b*, or fig. 15, which is the same as represented singly, an intimate correspondence will be found with that of the preceding subject as to the leading features.

The stump, fig. 16, remaining after bisection, had regenerated about 12 tentacula in a fortnight.—Fig. 17. The number of these, together with the dimensions of the stump, gradually augmented, and the whole of this mutilated portion became subsequently a fine and perfect specimen, giving birth to progeny.

It is therefore unnecessary to say more of the stump, fig. 16, the lower half of fig. 15.

But in regard to the upper half of fig. 15, or fig. 3, *b*, severed on March 12, it appeared with its original tentacula on March 29, as represented fig. 18; enlarged, fig. 19. Their irregularity was then conspicuous. Only their tips were visible on April 25; and soon after, these were totally obliterated.

This subject remained a shapeless mass on June 21, as represented fig. 20, at which time it had not affixed itself to the watch-glass wherein it lay; neither had it done so a fortnight later. The change was great, nor could I then account for it more than for the numerous prominences distinguishing the former subject, fig. 9, originally the upper half of fig. 4, or fig. 3, *a*

But on July 23, there was an obvious alteration of fig. 20 advancing, for it now exhibited several irregular tentacular organs spreading from the surface.—Fig. 21. The whole shape improved progressively; and on August 9, it had grown quite symmetrical, with a due proportion of silky tentacula.—Fig. 22. It was a perfect animal, in as far as regarded the birth of progeny, for within twelve days a young hydra, first budding from

its side, had removed to some distance, fig. 23, *a*; and while this young hydra, *a*, was advancing, another, *b*, had also withdrawn. Meantime, a new bud germinated from the parent, *c*, then entire, which continued to propagate.—Fig. 24.

Thus the upper portion, sundered from the specimen Plate XIV. fig. 15, may be traced through figs. 18 (enlarged, 19), 20, 21, 22, 23, 24. The first, fig. 18, representing that mutilated fragment: the last, fig. 24, representing the same fragment 150 days later, completely reintegrated, and generating a new colony.

As the stumps, or under halves of fig. 1, *a*, of fig. 3, *a*, and of fig. 3, *b*, which had all three suffered bisection, by removing the upper part, remained adhering, I say, as all three subsequently regained tentacula, and became the parents of future progeny, the reproductive faculties residing in them, not only for the restoration of lost parts, but for perpetuating their race, were not extirpated by such an excessive mutilation.

It may be remarked here, besides, that both the sections of the same sundered animal having generated progeny, demonstrates one of two facts,—either that all the embryonic elements are not concentrated in a single point, which would restrict their evolution as hydræ to one of the sections only; or that the elements of the progeny are secreted and deposited posterior to mutilation, to be evolved by gemmation at a suitable period.

No important injury had, therefore, followed bisection; for both portions grew, and fed and bred in the same manner as entire animals.

The preceding narrative proves, *first*, That redintegration of the organs defective in the *Hydra tuba*, follows precisely as after mutilation of those species of the hydra proper dwelling in the fresh-waters of Scotland. *Second*, That the elements of the progeny, whether in a primordial germ, or secreted and deposited from the parent, are neither restricted to a single point nor to one half of the body. *Third*, That both the stump below, and the section above, becoming entire animals, alike complete, by the evolution of new organs, and the preservation or acquisition of the faculties essential for the living creatures, the name and character of *hydra* had not been misapplied.

I speak of general results and appearances, for in a long course of

observations, certain anomalies and peculiarities interposed, which I cannot pretend to explain, nor can I even describe them intelligibly.

I might offer some vague hypotheses, indeed, trusting to futurity for their verification.

But maturely reflecting on that obliteration of the old, which was followed by the developement of new tentacula in fig. 20, I cannot avoid conjecturing it the effect of disturbing the progress of the wonderful alteration incident about the same season to this animal, as shall be afterwards illustrated. Let us remember that fig. 20 was the upper half bearing tentacula, sundered from fig. 15. Most probably by repeating the experiment in the course of March some light would be thrown on the subject.

Farther, in 17 days after severing fig. 8 and fig. 19 from their respective stumps, the former being the upper half of fig. 3, *a*, the latter the upper half of fig. 3, *b*, four ribs were rising from the circumference of each, and extending obtusely beyond the base. Irregular intervals separated the ribs.

A very slow horizontal motion was exhibited by fig. 20, at the period of delineation. Likewise two white fleshy corpuscula present, like fig. 25, were in slow horizontal motion. I could detect no external organs influencing them.

We have already traced the history of the sundered portion, fig. 18, being the upper half of fig. 3, *b*, as there represented on March 29, down to its aspect on September 29, as represented fig. 24, *c*.

Following it as then regenerated yet a little longer, it appeared in another week with the stomach completely everted, as sometimes occurs to the Actinia. But in two days this was returned to its proper place, the natural shape resumed, and the tentacula extended in regular order.

Two months subsequently, however, the whole tentacula dropped off in a bunch, without any obvious cause, and carrying a small portion of the body along with them. Next morning, this detached part resembled a small hydra crowned by irregular tentacula, remaining so for three weeks, when adhesion in a watch-glass had taken place. These organs amounted to twenty at least. The body thus naturally mutilated of the bunch and

fragment continued in its place; it became an elongated ovoid, and in three weeks had generated 12 or 14 tentacula, after which farther observation was abandoned.

In regard to this animal (the *Hydra tuba*), its propagation seems more dependent on sustenance than on age and dimensions. The number of organs is invariable in the higher orders, subject neither to multiplication nor diminution, unless to an inconsiderable extent where regenerated; but in the lower orders the discrepancy is so great as generally to preclude the determination of maturity by such a test.

The aspect of the hydra is considerably diversified. In perfection it is a pendent cone, or rather the gradual enlargement of a conic frustum, the margin of the base environed by long silky-like tentacular organs.

But the shape of the most vigorous is liable to some modification. The disc, with the marginal tentacula, can enlarge beyond the wonted diameter, and assume the resemblance of a flattened hand-bell, suspended by a slender thread, while all the portion above it is diminished.—Plate XIV. fig. 26; XX. fig. 19, *a*. This generally results from the sensations of an individual, but I have seen a number at once under the same appearance.

The preceding examples in illustration of the multiplication of the hydra, offer some anomalies when compared with that of other animated beings.

Amidst the functions annexed to protracted existence, scarcely any except those which are essential for self-preservation are passively or actively incident to the earlier stages of life, and especially in such creatures as shall finally acquire another and a different form.

Perpetuation of the race seems to be reserved by Nature, in general, as a property incorporated with that ultimate condition wherein all the organic evolution has been attained, wherein all the animal faculties subsist, and are exercised as indicative that the system is perfected.

I am not aware that progeny is derived from animals in intermediate stages—in those to be compared to the larva or the chrysalis, but that the offspring comes of the beetle or the butterfly, as the ovum from the frog, not of the tadpole. It is not said that an embryo or fœtus is endowed with

any other than the passive faculty of merely receiving such nutrition as shall promote its own advances towards maturity.

Whatever be the common rules adapted to strike the senses, neither age nor dimensions will prove perfection, both being relative characters.

The hydra perpetuates its race after principles adverse to those usual arrangements of Nature, of which we are enabled to judge. Its progeny is originating at the earliest visible stage of the parent, and this progeny, while still incorporated with that parent, is giving birth to offspring. The descendants to a remote generation are in the exact resemblance of the original hydra, their progenitor. They inherit its form and its properties unchanged.

My observations on the group investing the shell of the Solen, were continued as far as practicable, during two years and eight months: and on another colony and its descendants, they were continued for six years. Many specimens have been assumed and preserved besides, on different occasions, during the last twenty-three years at least.

From what has been said, the mode of increment, whereby the Sertularian and other compound zoophytes are augmented, will be the more easily understood, making some allowance for the diversities of structure.

The following conclusions may be deduced from the preceding narrative:—

I. The nature of the *Hydra tuba* is nearly identified with that of the hydra or polypus of the fresh-waters of Scotland.

II. The body consists of a dilatable conical sac, with a marginal row of tentacula around the disc, which are capable of extending five times the length of the body.

III. It feeds voraciously, and like the Actinia, rejects the undigested residue by the mouth, which is in the centre of the disc.

IV. It can endure long protracted abstinence, under which the size gradually diminishes, but is suddenly restored by sustenance, and it survives during years.

V. It is extremely prolific; and propagates by gemmation or the budding of the offspring from its side.



Hydra Tuberosa

VI. As the offspring withdraws from the parent, a connecting ligament is gradually attenuated, and at length ruptured, as in certain species of the Actinia.

VII. If rupture of the ligament be protracted, cotemporary progeny may continue budding, both from the body of the parent and from that of the offspring.

VIII. The elements of the progeny are not concentrated in a definite spot of the body of the parent.

IX. The hydra is very tenacious of life; it is endowed with powerful regenerative energies. It survives the severest wounds and lacerations, and reproduces mutilated parts.

X. It is endowed with a locomotive faculty, which is very rarely exercised by adults; and chiefly demonstrated by the young.

XI. Its natural and favourite position is suspension by the apex, allowing the free extension of the tentacula.

XII. It dwells in numerous societies, or lives in a solitary state.

PLATE XIII. *Hydra tuba*, Trumpet Polypus (*Strobila*).

- FIG. 1. Adult; body, *a*; tentacula, *b*.
2. Colony investing an old shell of a *Serpula*.
 3. Adult, *a*; embryo budding from it, *b*, spur.—*April* 27.
 4. The same farther advanced; adult, *a*; embryo, *b*; spur, *c*.—*May* 8.
 5. The same; embryo, *b*; spur, *c*; both now perfect hydræ, still connected with the parent, *a*.—*May* 25.
 6. The same augmented by new gemmation; the offspring withdrawing from the parent.
 7. The same colony farther dispersed. As *a*, *b*, *c*, here, and of the preceding figure separated, new animals, *d*, *f*, *i*, were interposed.—*June* 12.
 8. The same colony, consisting of eight perfect hydræ, besides embryos.—*July* 7.
 9. The same according to its final arrangement and aspect while remaining in distinct view. Some hydræ, previously single, *d*, *i*, have now generated others, *d*, *i*.—*July* 21.

10. A group consisting of the parent, *a*, and its progeny of four still connected with the body.—*May* 8.
11. The same, with a sixth hydra originating.—*May* 15.
12. A hydra, *a*, with indications of reproduction.—*June* 26.
13. The same, the reproduction having advanced.—*July* 3.
14. The same hydra, *a*, now the lowest of the group, all the progeny being above it.—*Sept.* 1.
15. A specimen, *a*, which was single in the middle of October, represented shortly afterwards in an intermediate stage, fig. 19; and as now seen with its progeny, generated subsequently.—*March* 1.
16. A hydra gorged with food, the tentacula contracted.
17. A hydra adhering to the bottom of a vessel. Distorted prominences announce reproduction.
18. The same, farther advanced.
19. The colony represented fig. 15, here seen in an intermediate stage, between October, when there was only a single hydra, and the month of April subsequent.
20. Colony generating from a hydra.

PLATE XIV. FIG. 1. Colony of the *Hydra tuba* occupying the concave fragment of an old shell of the *Solen siliqua*. The hydra, *a*, had been previously mutilated of the upper half, which was at this date regenerated.—*Feb.* 13.

2. The same colony multiplied and dispersed.—*March* 12.
3. Another colony on the convexity of the shell, derived from the former, fig. 1.—*March* 12.

Here the specimens *a* and *b* were selected for experiment.

4. The specimen *a*, just referred to, as in fig. 3, viewed separately as on that selection.—*March* 12.
5. Stump of fig. 4, remaining after the animal was bisected.—*March* 12.
6. The same stump, fig. 5, having regenerated the upper part with tentacula.—*March* 29.
7. Upper portion severed on March 12, from fig. 4 (originally fig. 3, *a*) as now seen on *March* 29.
8. The same enlarged.

9. The same enlarged as on *May 25*.—The formation altered.
10. The same as appearing *June 21*.—The prominences elongated.
11. The same approaching symmetry.—*June 26*.
12. The same become more symmetrical.—*August 9*.
13. The same upper portion, or fig. 7, quite symmetrical as seen *August 21*.
14. The same with its progeny.—*September 29*.
15. The specimen, fig. 3, *b*, viewed separately on selection for experiment.—*March 12*.
16. Stump of fig. 15, after bisection of the entire animal.—*March 12*.
17. The same stump having regenerated the upper portion with tentacula.—*March 29*.
18. Upper portion severed on *March 12* from fig. 15 (originally fig. 3, *b*), as seen on *March 29*.
19. The same enlarged.
20. The same, the tentacula being obliterated, enlarged.—*June 21*.
21. The same, with irregular regenerating tentacula.—*July 23*.
22. The same, having attained symmetry.—*August 9*.
23. The same having generated progeny.—*August 21*.
24. The same with additional progeny.—*September 29*.
25. White fleshy corpusculum in motion.—*May 25*.
26. Hydra relaxing from its usual form.

§ 2. ORIGIN OF THE *Hydra tuba*.—PLATES XV. XVI. XVII.

Hitherto we have considered the hydra as a perfect and independent animal, living for itself, and carrying on a race of beings, its posterity, in its own likeness. But we have still to penetrate farther into its nature. No doubt, some of the principal purposes of physiology are already fulfilled, and the reader will not find it difficult to understand from the preceding detail, the precise mode whereby such accessions are gained by Zoophytes as to render these productions of admirable luxuriance and beauty. It will be seen how they may originate from a single individual,

the parent of the whole; that their progress is derived from the animated portion alone of compound subjects, that which, to our apprehension, is exclusively endowed with life, sensation, and action: for although what we call the inorganic parts be indispensable, and form the instrument of the general union and connection of all, nothing denoting active animal functions is to be detected there.

The increment of zoophytes might have been explained as effectually perhaps from the multiplication of the fresh-water hydræ.—Plate XII. figs. 15–20, and the *Vorticella*, Plate XXI. But the superior dimensions of the subject I have chosen, the facility of preservation, and the certainty of witnessing its prolific qualities in the most convenient position, under suitable, simple, and easy treatment, render it infinitely preferable to the others. The chief obstruction to the wishes of the naturalist concentrate in the difficulty of obtaining specimens, for there is no known guide which can lead to their discovery.

The hydraoid zoophytes multiply in general by simple divergence to right and left in the same plane, a character peculiar to most of the ascidian zoophytes also, especially of the foliaceous genera. At the same time, multiplication by ascent is advancing in both, whence may be comprehended the rapidity wherewith vigorous specimens shall reach to thousands.

Strict conformity subsists between the increment of these and of the *Hydra tuba*. The original parent remains, in all, the lowest of the colony, or amidst the progeny diffusing around it. But there is one noted difference not to be overlooked. The *Hydra tuba* survives the birth of its own young, and also of their progeny, for some indefinite period; but the original parent of the *Sertularia* and the *Flustra* perishes as its posterity continue increasing by successive generations.

However, I shall rather reserve for the conclusion of this treatise a brief review of some leading principles governing the nature of such zoophytes, as have led us into more diffuse discussion in its course.

Meantime, let us consider how vast the proportion of the lower animals incorporated with the various hydræ in their more comprehensive signification; that multitudes in one or other stage are connected

with it in form or substance, sharing its intermediate nature. Further, that to the creature which we recognize under this name is assigned a most important province relative to the perfection and the perpetuation of some tribes which we deem the farthest removed, those which occupy a place altogether different in the order and arrangements of the universe.

Nothing is more frequently the subject of speculation among ordinary spectators, than the clear or coloured masses of a gelatinous-like substance strewed on the sea-shore, sometimes in great profusion, particularly towards the end of autumn. They are left there by the falling tide, either entire, of a circular form, or broken into fragments.

This is commonly called *Sea-blubber*. I do not recollect to have ever heard any other vernacular name applied to it in Scotland.

But here are beheld only the remains of the *Medusa*, a marine animal, alike curious and beautiful, which, in extraordinary variety, frequents the Scottish seas.

In certain years they appear in thousands. It is not accurately ascertained from whence they come or whither they go; but they seem to be dispersed over the whole world. In the year 1846, the fishermen told me they were embarrassed in casting their nets and sinking their lines from the multitudes absolutely thickening the sea. Baster remarks their singular abundance on the coast of Holland in 1762.

In the course of a series of experiments and observations for investigating the properties of these animals, I directed a number of very capacious glass vessels to be made, where a complete view of their singular formation and habits would be obtained while living amidst their native element.

Then I took four fine specimens of the genus now established as the *Chrysaora* of Peron, which, unless I be mistaken, is not distinctly noted among the profusion of synonyms occupying various general systems of natural history.

This species attains large dimensions; one of the four was sixteen inches in diameter, and of several pounds weight, and hence less convenient for observation than smaller subjects.

The animal consists of the segment of a sphere called the *umbrella*,

convex above, and concave or somewhat flattened below. A row of long slender tentacula descends from the circumference, which circumference is divided into 32 lobes, each lobe being imprinted with a dark brown patch speckled white. Four long frilled appendages of similar colour in the solid parts, but lighter in the frills, hang down from the under surface. Here also are four large cavities, each with an orifice converging towards the centre of the animal, wherein the ovaria, resembling clusters of grapes, are deposited. The whole surface is of different shades of brownish-yellow.

Selecting a specimen of this Medusa eight inches in diameter for more minute observation, I lodged it in a clear and capacious glass jar on the 24th of August. Herein the umbrella continued to collapse and to reach the surface by impulse on the water, as these animals do naturally in the sea. On gaining this position, the Medusa remained still and motionless, as if to be carried along by the flow or the ebbing of the tide.—Plate XV.

After transferring the largest of its fellows to another capacious vessel, I experienced very sensibly the noxious property ascribed to the race. My hands and wrists suffered burning heat for several hours, spite of being plunged immediately into cold water. It is thence that the Medusa is called the *Sea nettle*; and many accounts are given of the injury sustained from contact with it in those seas where it abounds. I acknowledge that I was long incredulous, especially because many may be handled with impunity, and from distrusting fishermen, who are too often addicted to exaggeration. A friend of undoubted veracity, assured me that having come in contact with some Medusæ, while bathing in the estuary of the Forth, violent inflammation of the skin ensued, which was accompanied by a serious attack of fever. I have no doubt, however, that several of the most marvellous narratives have come from those persons who were more alarmed than hurt, by finding themselves suddenly in so disagreeable a neighbourhood as amidst a number of Medusæ. It is not evident that these creatures employ any of their external flexible organs purposely to injure.

Although the specimen above quoted as eight inches in diameter seemed sufficiently vigorous, it could be kept only a few days from decay.



Medusa

There seems a natural delicacy incident to the whole tribe in confinement ; nor have I been able to preserve any adult individual above a month in activity.

This specimen being removed from its vessel on August 25, a quantity of brownish matter like dust remained at the bottom. Subjected to the microscope, it proved an host of animated creatures in quick and varied motion.

But to the naked eye they were hardly perceptible,—the merest specks, infinitely minute,—nor by an ordinary lens could their proportions be discovered.

Higher powers, next resorted to, shewed them white, opaque, and fleshy, tending to an elliptical form, though very mutable, one extremity generally broader than the other, with which each individual made its way among the multitude of its fellows.

Although such be the real and natural figure of the animal in vigour and perfection, some already betrayed incipient alteration in assuming a broader oval, contracting middle, a globular shape, becoming a thick spherical triangle, or exhibiting other irregularities. Nothing strictly angular was seen among them.

All were crawling below with a quick, smooth, lively motion. The body seemed consistent and soft, evidently yielding in pressure through the crowd. No cilia or other external organs, though probably present, could be detected ; for, perhaps the magnifying powers were insufficient.

On the whole the animals obviously participated of the nature of the *Planulæ*, above described as belonging to the *Sertularia ramea*, and of the others whereof we have yet to speak, as the origin of many zoophytes.—Pl. XVI. fig. 2, enlarged ; fig. 3, magnified.

After the lapse of other forty hours, the subjects of figs. 2 and 3, seemed of twofold composition, as consisting of a lighter margin now surrounding a darker interior portion of corresponding form,—previously, the whole had a uniform homogeneous aspect. The shape of others had also become considerably modified ; but whatever the outline of the exterior, that of the interior always corresponded : if the nucleus or inner darker

portion was long, short, spherically triangular, or otherwise, so was the marginal border, fig. 4.

The whole subjects inspected were at the bottom of a watch-glass; and all were yet in motion.

A great profusion of the brownish substance like dust had been discharged by each of the four Medusæ obtained on August 24. Next day, August 25, six vessels, each containing a portion of it, were set aside.

In forty-eight hours, namely on August 27, the appearance of spots of scum at the surface of the water in some of the vessels, announced the progress of certain alterations below.

On applying these spots to the microscope, they were plainly discovered to consist of the planulæ in a state of advancing metamorphosis. All remained still and floating. Some of the least altered approached a shuttle-shape, with an orifice in the centre: the ends of the shuttle were more prolonged in others,—several shewed obvious indications of four incipient arms, in unequal progress, around the central orifice, fig. 5.

On the following day, August 28, a remarkable change had ensued. The metamorphosis was rapidly advancing; for the elongating arms promised to be of peculiar tentacular texture, fig. 6, as amply realized in three days longer.

Now their extent equalled some diameters of the body;—the two from the ends of the shuttle remaining always more prolonged than the others, figs. 7, 8. Both the subjects there represented as the most favourable for illustration, floated reversed when delineated, whereby the orifice being below is not seen, and some of the tentacula, along with the upper surface, are directed downwards.

All this was an extraordinary exhibition in the offspring of such parents—that so lately issuing as mere and almost invisible dust from compact, massy, ponderous animals, alike singular in habits, in form, and in substance.

But Nature had an important purpose to fulfil: the apparently rude commencement had to be carried through, by wonderful expedients, to symmetrical perfection in the end. In eleven or twelve days after the



13



1



14



11

12



4



2

3



9



5



7



8



10



6



15

Progeny of Medusa

simple active atom,—the planula had been discharged from the unwieldy Medusa, it was converted to a stationary hydra !

This new animal was provided with a complement of eight arms, yet so immature as to be of unequal dimensions. Different groups, under metamorphosis, shewed the utmost irregularity in respect to evolution, to their shape, and proportions, figs. 9, 10 : nor was it until thirteen days later, or three weeks after their birth, that any appeared with eight regular tentacula.

Thus was a most perplexing problem solved—the *Hydra tuba* proved to have sprung of a *Medusa*.

The planulæ of the arborescent zoophytes already described, and many whereof we have yet to treat, are generated in external pods or vesicles, from whence they issue when mature into active life ; next becoming quiescent, and metamorphosing to the zoophyte. Here the host of planulæ is contained in bunches of capsules reposit in the ovarian sacs or cavities above specified as belonging to the under surface of the Medusa. The different capsules vary in size and in form —Plate XVI. fig. 1.

There is no doubt of the planulæ being originally ova ; and that their evolution advances as in the vesicles of the arborescent zoophytes, or as the rudimentary embryo retained in the capsule of the Tubularia.

I have seen a stream of cremacious-like matter absolutely flow from the ovarian sacs of the Medusa, proving exclusively incalculable legions of planulæ.

Much irregularity prevails in everything connected with the history of these animals. I cannot specify the longest period of activity by the planula. I have observed some in motion during 18 days, and some, from the *Medusa capillata*, during 19 days. The latter always advanced with the smaller extremity first, during progression, whether from natural habits or supervening incident.

The metamorphosis of that species of the Chrysaora, the more particular subject of these observations, commences very speedily, often within forty-eight hours, or even sooner, if the planula be kept still, which is essential. But there is no uniformity either in progress or in perfection.

In prosecuting the investigation of this subject still farther, I have availed myself of some very fine specimens of different species of the Medusa at different times.

First, I took five specimens of a kind which I shall provisionally denominate *Medusa stella*, from my inability to recognise it with certainty in the Systema, and afterwards six of the same.

All were of different dimensions, the umbrella of none exceeding fifteen inches in diameter, nor that of any under seven.

Perhaps this species has some affinity with the preceding, but it is of more ornamental appearance. The animal is of a faint yellowish colour, with either a brown spot or a circular ring on the summit of the umbrella, at a short distance from which a fine and conspicuous star of thirty-two rays is formed by the divergence of as many lines from points commencing them. This configuration will be readily understood from inspecting Plate XVII. Still farther outwards the margin is embellished by thirty-two brown patches, and a row of long slender tentacula falling from the edge. Four long flexible organs, with a double marginal frill, like the former, originate from below, somewhat different in different subjects. There are also four ovarian cavities below, each with a dilatable orifice. The skin of these cavities is wholly covered by a singular speckling; and so is the whole surface of the umbrella speckled, but in a different manner.

From the stellate figure above, and the four appendages being at some distance beneath the under surface, the animal cannot be mistaken.

The brown colour of these Medusæ seems derived from a peculiar matter. Sometimes the water wherein they die is deeply tinged.

All the eleven specimens were prolific. The specimen represented Plate XVII. having remained two days in a large glass jar, a brownish circular stratum, two inches in diameter, consisting solely of myriads of planulæ, was found under its position, by removal to another vessel on August 31.

Here the animal continued as in the last, rising to the surface, and collapsing its expanded umbrella, while the appendages were allowed to hang down to the bottom.



Medusa

When portions of the circular stratum were presented to the microscope, I could not discover any difference between the planulæ there and those of the preceding Medusa. They were white, solid, elliptical, and all in lively motion. Their extreme minuteness rendered the determination of their exact form very difficult by the naked eye.

Many of the planulæ were now set apart in different vessels, to remain for a certain time undisturbed.

The progress of metamorphosis, on the whole, narrowly resembled that of others, but perhaps with less irregularity, from the quiescence preserved; and some interesting illustrative facts were disclosed.

One of the vessels, a narrow cylinder, six inches deep, being examined in ten days, I found the water covered by a thick scum like cambric paper, and so tenacious that portions had to be cut out by scissors for the microscope.

Such portions proved wholly composed of metamorphosing planulæ, which were generally rounder, not so quadrangular, or rather so *obtusely cushion-shaped* as the former; nevertheless exhibiting considerable variety of figure. Four originating tentacula had become evident in a few, and in one of this description the distended orifice of the mouth exposed the internal cavity below.—Plate XVI. fig. 15. No planulæ now visible were unchanged.

All these subjects seemed imbedded in the scum, or they were perhaps adhering to the under surface of it, for in further progress many might be seen hanging down, as if suspended from that surface.

The quantity of scum thus covering the surface of the water in the vessels containing planulæ is very great. An observer might readily conclude that its presence and profusion indicated decay. But it is not so. I venture to conjecture that it may be more probably considered a concomitant on metamorphosis.

At first the planulæ crawl at the bottom of the vessel: very few under ordinary circumstances rise on the sides, nor are they to be often seen swimming. But after some time, a scum is formed on the surface of the most limpid element, even in tall vessels, amidst which they are motionless, in thousands. I know not how they rise, whether by some super-

vening buoyancy accompanying incipient metamorphosis, or whether by ascending the sides. Frequently there are scarcely any remaining below; but numberless specks, denoting their presence, may be also sometimes seen at the bottom, while the scum is composed of multitudes above.

Having shifted a Medusa of the former species from a capacious vessel, I poured off almost the whole water, leaving innumerable planulæ among the residue. This residue being next emptied into another, a smaller vessel, four inches wide by two deep, the bottom was entirely covered by planulæ. From the vast legions below I was apprehensive of decay, however, all remained vigorous: and in three days numbers were swimming throughout the water. In three days longer, the surface of the water was overspread by a film resembling cambric paper, obscuring the whole contents at the bottom. Extraordinary myriads of planulæ were in the vessel, so that, for more security, to avoid vitiation, and to give the animals greater scope, by increasing the quantity of the element, and to prevent interruption of the course of observation, I sunk this smaller vessel in one of much larger dimensions, wider and deeper. As the latter was gradually replenished, a compact circular scum, equalling the diameter of the former vessel, rose entire and unbroken, composed wholly of planulæ.

Though I describe it as wholly of planulæ, the scum consists also of a large proportion of glutinous matter along with them,—another remarkable provision of Nature.

The progress of that metamorphosis converting an animal of great activity to one in a stationary condition, seems to be attended with the exudation of a glutinous matter from the body. While active this would be of little use, but now it is different in becoming the means of security. Thus, where the animal occurs singly, and the change so far advanced that it adheres, a slight diffusion around the extremity, or point of adhesion, is perceptible by the microscope.

The secretion of this substance, I presume, is the origin of the tenacious scum; and owing to the incalculable numbers crowding the surface, the smallest quantity from each, would produce, when united, a compact matter wherein they might be imbedded.

The natural position of the hydra in maturity, being pendent, may account for its tendency to rise upwards in taller vessels, with the commencement or the progress of the change.

As the advances of metamorphosis evidently depend on circumstances, they must be attended with great irregularity. Many planulæ decay without any sensible alteration: in others the change advances tardily and with difficulty: the difference of a fortnight's progress, or much more, will be seen, in the state of two portions of the same brood at a given time; and in many, though great, it is never completed. But sometimes its progress is distinct during the course of a long observation. I speak of the progeny of *Medusæ* in general.

A nascent hydra may acquire eight tentacula within twelve days of its birth from the *Medusa*. But amidst above a thousand specimens of the same brood, I could discover only one with twelve tentacula in forty-five days.—Pl. XVI. fig. 14. Many others had then eight, which were long and deeply muricate. But some had only four, quite as long, and as deeply muricate. None ever gained more than twelve: nor of at least two thousand hydræ, originating at first in a vessel, did any survive, in seventy days from their production.

Unless in very favourable positions, it is by no means easy to follow the history of such minute specks as those of which we treat.

The most convenient method of observation is when they are affixed to watch-glasses. The progeny of the *Medusæ*, while yet planulæ, should be transferred to a flat vessel, some inches in diameter, filled to any height with water. One or more watch-glasses may be then inverted above the planulæ, and the whole allowed to remain perfectly still for several days. Meantime the planulæ rising from the bottom, in the course of metamorphosis, are intercepted from the surface of the water by the watch-glass, to which they will adhere. I have sometimes found them do so in two days. After remaining there two or three days longer, the watch-glasses should be removed to another vessel of water, and kept in an inclined position, the concavity where the planulæ adhere being downwards. Many young hydræ will be next seen, pendent by the prolonged apex, in the course of eight days. It is preferable to have only a few in adhesion, in-

stead of a number, confusing the view. The subjects secured in this manner are afterwards easily accessible.

I have attempted to feed these original hydræ with the expressed juice or minute particles of animal matter: but I cannot affirm it to have been attended with positive success. They are on the whole much more perishable than the young generated by gemmation from the side of the adult animal.

The preceding narrative proves that the parent of the Marine hydra, under discussion, is a Medusa. No such parent has been hitherto ascribed to the hydræ of the fresh-waters, though the resemblance between the two be so intimate: nor has any similar metamorphosis been conjectured.

Yet we ought not to relax our exertions to discover such a singular natural process there,—nor, I will own, should I be much surprised were something analogous found by the industrious explorers of the mysteries of the Divine creation.

§ 3. ORIGIN OF THE MEDUSA BIFIDA, THE CLOVEN MEDUSA.—
PLATES XVIII. XIX. XX.

We have viewed the subject of the first and second paragraphs of this chapter exclusively as a hydra or polypus, an animal apparently perfect in itself, and subsisting in independent life—presenting all the properties of that singular genus; nor exhibiting any such discrepancies as to sanction its removal to be incorporated with some other race. It visibly originates, feeds, breeds, lives, and dies, after the same manner as the rest of the species; therefore, in as far as we have gone, we should associate it with them. A creature which survives for years, which transmits its form, together with all its peculiarities, to its immediate progeny, and to remote descendants, seems at first sight entitled to a distinct position in the *Systema Naturæ*.

But as no observation can be too correct, nor any reasoning unsupported by direct evidence, too profound, so ought due precaution to warn the naturalist against receiving presumptions for facts.

We have still to look farther,—to dive deeper into the obscure subject before us.

From one notable peculiarity of the *Hydra gelatinosa*, *Strobila*, *Tube*, or by whatever name it shall be recognised, our notice must be now directed to an animal of altogether an opposite origin, one entirely different in form, in habits, and in permanence, though between the two there be a union or connection, hitherto insufficiently understood.

The figure and the properties of this creature annex it to the Medusarian tribes, whose history would admit of long and interesting commentary, as seen from a few preceding observations.

Meantime, I shall consider the being alluded to, nearly as I have viewed the former, that is, chiefly as a perfect and independent animal, or an animal advancing towards perfection, until more versant in its history. Herein there are various obscurities which I cannot pretend to explain. Nevertheless, the curious and inquisitive, whose attention is attracted to them, may be able to offer a satisfactory solution, through some *connected chain* of facts, of what has appeared to me enigmatical.

I confine myself entirely to what I have seen.

Long ago, I had remarked colonies of minute transparent animals, swimming in vessels of sea-water, during the months of February, March, and April. Their general aspect very much resembled a flock of birds in distant flight, as represented by landscape painters.—Pl. XVIII. fig. 1; Pl. XX. fig. 1. After being transferred to vessels free of other subjects, they continued several days in activity, and then disappeared. I could not account either for their origin or their transience. They occurred only at rare intervals, and always identically under the same form.

More accurate inspection on these occasions, and subsequently, showed the alliance of such creatures to that comprehensive genus the *Medusa*, both in configuration and in habits. But the date of their appearance did not correspond with the wonted periodical ascent or arrival of that tribe to the surface of the Scotch seas during the summer months. In the year 1826, I found them as early as the 6th of February.

The whole of this remarkable race is now partitioned into several divisions, founded on their common aspect or individual properties. But

some of the most important characters are so equivocal, and some species so difficult of attainment, that their proposed arrangement already requires revision. Nevertheless, the prominent features assumed prove useful for recognition. Among these are the substance of the animals, gelatinous, consistent, opaque, or transparent; their spherical, ovoidal, or campanulate form; circumferential lobes, or fringes; ciliated or simple tentacular processes; solid or hollow extensile and retractile appendages,—and altogether exhibiting such varied configuration as precludes the descriptive powers of language. Next are their delicate iridescent or deeply contrasted colours: their strange and peculiar motions, laboured, tardy, or expeditious, suspension amidst the water, or traversing it in all directions, by means of the fleshy oars which provident Nature has given them. Multitudes quitting their dark and wintry abodes below, or voyaging, from distant regions, come to embellish our Scottish seas, as if seeking to enjoy the fine and tranquil temperature of summer.

The species to which I shall devote a brief discussion here, and that only because it seems doubtful whether more skilful authors have preserved individual specimens under permanent observation, was not unknown to earlier naturalists. By Baster it was denominated *Medusa minutissima*, and being in fact among the more minute, it may be rather considered a microscopic object than otherwise. Its expansion is between one and two lines; nor have I been sensible of its increment during the longest period, that is sixty days, of its survivance.

This creature's body consists of a central disc, with from four to twelve horizontal flattened *cloven* lobes or arms. An organ like an obtuse-sided cluster column, projects from the middle of the *under* surface, corresponding to the site of the proboscis of other Medusæ, around the origin or base of which are four peculiar organs. That is the number when the set is complete, each consisting of two flexible members like fingers. The general aspect of the Medusa, enlarged, is represented Plate XVIII. figs. 2, 3, 7, 8; proboscidal organ *a*; lobes *b*. The four organs around its basis are seen figs. 4, 5. Also the general aspect of various subjects is represented Plate XX. figs. 4, 5, 23, 24, 25, all enlarged.

Each lobe is cleft half way down. A cone in the centre, at the

bottom of the cleft, is surmounted by a black speck, which a powerful magnifier exposes as a number of smaller specks on a lighter ground. This somewhat resembles the structure of the specks terminating the rays of the star-fish. Many consider the specks which are disposed at intervals on the margin of large and of smaller Medusæ as ocular, but it might be well to investigate whether, both there and in the Asteriæ, they are not rather of a glandular nature.—Pl. XVIII. fig. 6, magnified lobe and central cone. The whole surface of this minute Medusa is finely speckled or granulated, which, as the other parts, can be clearly discovered only by microscopic powers.—Pl. XVIII. figs. 7, 8.

The animal moves by jerks or bounds, from collapse of the body and percussion of the water by the lobes. As all other Medusæ, it shews a constant tendency to seek the surface by an oblique or perpendicular ascent. Sometimes, but rarely, in reversing itself, the proboscis appears like a crest above, fig. 3, which affords the most favourable view of the whole formation; and it generally drops gently down among the water, with the proboscis below and the arms extended. Resting in equilibrio, the proboscis is downwards, and the lobular arms slightly recurved, fig. 2.

This Medusa courts a moderate degree of light. Then it always rises to the surface, an invariable characteristic of the Medusarian race, for it seems adverse to their nature while in vigour to remain below. Weakness and inaction are denoted by their permanence there. But the light being bright the Medusæ incline to shun its intensity; though heat and light be the chief incentives to motion, not only among them, but of many of the lower tribes.

For the most part, the existence of the *cloven* Medusa is very transient. It appears unexpectedly, and in a few days it decays or vanishes. With the utmost precautions, I have never been able to protract its life above 55 or 60 days from its origin. On its earliest escape to an independent existence, it seems fully developed and endowed with ample vigour. No sensible increment, accession, division, or reduction of any portion ensues during the whole currency of the period here specified, nor any change or alteration farther than that concomitant on declining strength and activity. The size of the specimens repre-

sented Plate XX. figs. 5, 25, was then nearly equal, when 40 and 50 days old respectively. It is seldom, however, that any can be preserved so long. The whole individuals of a numerous colony perish successively. Their motion relaxes; it becomes feeble and laboured; they cease to ascend; and remaining at the bottom, their lobular arms closing over the disc, the whitened colour and globular shape show them like seed-pearls, when they languish and die.

Sometimes, while still somewhat transparent, they disappear from amidst the water.

Though occasionally recovered directly from the sea with other collections, I was led to remark that they had been chiefly observed in vessels containing the *Hydra tuba* or *Strobila* of M. Sars, and that, when removed, they were frequently replaced by others. But I could find no visible spawn, fragments, or other elements, to which I could reasonably ascribe their origin: nor were any Medusæ ever to be seen bearing the most remote resemblance to them.

Then and afterwards I found their greatest abundance in March; that they occur from the beginning of February, during 40 or 50 days; that they are not to be seen from that season, at least in captivity, throughout the rest of the year, in Scotland.

Many of the rules and principles which determine the multiplication of the highest orders, also extending to the lower tribes of animals, may suggest some analogies here.

Eight of the Medusæ being observed on February 6, in a vessel with many specimens of the hydræ which had been long under observation, they were removed a day or two subsequently. I conjectured them to have come in a replenishment of sea-water on the first of the month. These were succeeded by others appearing in the same vessel on the 14th and 15th. I had remarked a convulsive motion among the tentacula of a Hydra on the evening of the 14th, apparently from a Medusa having been entangled there. The like occurred next morning, when one was liberated.

Similar convulsive motion agitating the same hydra during the 16th, it was brought under closer inspection; for, unable to discover the like spasmodic demonstration among its companions, at least 100 in number, I

was surprised that, amidst such an host of enemies to all living creatures, —those mercilessly devouring whatever they could master—the Medusa should dwell with impunity, involved by the very organs of capture.

On dislodging the subject, apparently a hydra of medium size, with scissors, and transferring it to a watch-glass, nothing but the wonted convulsion, which proceeded from the clasping of the arms of a Medusa upon the surface, disc, or extremity, was seen on the morning of the 17th. However, several were swimming at large next day; the size of the subject had diminished, and it was visibly indented by deep corrugations.

But now I found, and in good time for correction, that I had been somewhat mistaken, as instead of a Medusa having been detached entire by the sharp pointed scissors employed, I had severed only the corrugated portion, along with a slice of the smooth fleshy basis sustaining it, as will be better understood in the sequel. In fact, the position of the subject precluded the free use of the instrument designed for insinuation of the points below each side of the apex, so that the edges had been applied.

The vessel whence this subject was removed contained a colony originally consisting of ten hydræ, which invested the empty shell of a *Serpula*, as described in a preceding paragraph. There the colony dwelt, fed, and bred by uninterrupted gemmation. Thus it was occasionally augmented naturally, and reduced accidentally, until in three years and three months not fewer than the number above mentioned, at least 100 of its members remained.

No other animal had been introduced among them.

The hydra, as observed, in its proper site is suspended by the apex, at some elevation, whence the body hangs down so as to afford free scope for the exercise of the descending tentacula. Therefore colonies in confinement disperse on the sides of the glass as most congenial to their nature. But the diminished proportions of the apex, which would be otherwise a sustaining base, sometimes renders their position so insecure that they drop from it.

Returning to the subject in the watch-glass, it resembled an inverted conic frustum of yellowish colour about three lines in length, proving then and ultimately to be wholly composed of *Medusæ*, in various stages, un-

less the thin slice below. The arms clasping at the summit belonged to the animal most mature. Many more in the lower part of this series soon became active; but in the portion still under them were absolute quiescence and indefinite forms. Seven advancing Medusa in all might be enumerated in the mass, in the course of this day, the 18th of February.

The subject is accurately illustrated by a satisfactory representation, Plate XVIII. fig. 13; enlarged, fig. 14: Medusa most mature, *a*; others less mature, *b*; slice of the fleshy basis, *c*.

The importance of this fragment, the slice, apparently so insignificant, will be shown afterwards.

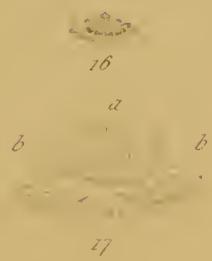
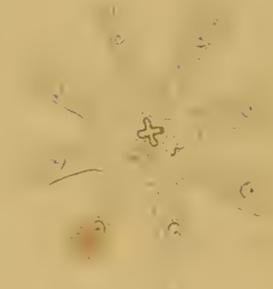
Next day, the 19th, at noon, a Medusa was observed to have quitted the subject, necessarily the highest in the series, and hence at the upper or larger part, and another swam at large in the evening. Further, a third having escaped on the following evening, all these three were free.

Next day, that is, on February 21, after vehement clasping at the summit of the mass, a fourth was liberated, while new struggles to escape appeared in the place it had left; and on the morning of the 22d, six in all were swimming in the water from further liberation during the night. A seventh, freed on the 23d, swam with the rest; and these seven, pursuing their course, or suspended in equilibrio, resembled as many minute stars.

To ascertain more correctly what might follow, I thought it expedient now to remove the whole, as they should have exhausted the number whereof the severed conic frustum had apparently consisted on the 18th. Still, the clasping of the arms of an eighth Medusa ensued, though not liberated until next day, the 24th, at which time the inverted cone, or series of animals, was much reduced from its earlier dimensions.

At this juncture there was reason to conjecture that the smooth slice, or basis of the subject, figs. 13, 14, *c*, adhering slightly to the watch-glass, was something different from the animals successively quitting their position above it, and that it was truly either an entire hydra, or a portion of one. Besides, a spur such as described in the preceding chapter had issued from it two days previously.

A ninth Medusa, which had been clasping feebly for two days, also



Alveolar Spira

was liberated on the 26th; and at the same date, a tenth likewise clasping, seemed nearly mature, while this last yet remained in its place, fig. 15, *a*. An eleventh, only partially developed, fig. 15, *b*, appeared rather towards one side, which could not be seen distinctly without the microscope. Several tentacular organs, supposed to be those of the original hydra, were now in view, when the subject with the two animals was delineated on February 26.

But these two animals remained so long in the same position, that I concluded some unnatural incorporation with the basis or sustaining substance, *c*, had certainly ensued, nor, that it might have been so, is difficult to be understood, considering the constant evolution and ready adhesion of living matter in such products. I daily expected their liberation, however, as the basis was firmly fixed, and extending on the watch-glass on the 6th of March, and was still more evidently a hydra.

On the 10th of March, the clasping of the tenth was alone visible; the eleventh had disappeared; and in a day or two its companion, the tenth, disappeared also, without liberation, that I could discover.

Thus the daily progress of this subject, apparently a formation on the disc of the suspended hydra, had been uninterruptedly followed from the 14th of February until the 12th of March, or nearly four weeks.

Ten or eleven days after separation by the sharp-pointed scissors from the side of the vessel, while Medusæ were coming to maturity, and escaping from the one extremity of the subject, the probability of its basis, the smooth fleshy slice, proving a hydra, was ratified by the partial protrusion of tentacula. The fact was verified by its subsequent adhesion and diffusion on the watch-glass; nor could any doubt possibly remain when, on the 25th of March, being entirely free of the Medusæ, its long silky-looking tentacula were waving in the water. Further, its nature was unequivocally demonstrated by the germination of a young hydra from its body a month later; and in May, another descendant of one or other of the two had established itself independently.

From this detail it is obvious, that the progress of the Medusæ to maturity is progressive, and that a considerable interval, perhaps a whole month, may elapse between the liberation of the first and of the last.

The preceding was among my earlier observations. Their extension and confirmation were desirable; especially from such subjects being rare and unmanageable.

Long afterwards, I availed myself of the under valve of a large specimen of the *Pecten Jacobæus*, a kind of clam-shell, which bore about 150 of the *Hydra tuba*, when withdrawn from the sea on the 21st of March. The external convexity was invested by the white *Alcyonium digitatum* or *Lobularia*: and a portion of the concavity, occupied by tubes of the *Terebella*, with and without their tenants. Having extirpated the former, and the surface being carefully brushed perfectly clean of impurities, and the latter, to which many hydræ were adhering, having been removed, I computed that about 110 specimens remained, distributed over the inner surface of the valve. The outside was quite free of them.

All were of very moderate dimensions, having probably dwelt in a barren place, as animals of this kind enlarge so readily where subsistence abounds. Some were symmetrical and perfect, with an ordinary complement of long flowing tentacula.

But, at least one-half of this numerous colony was undergoing a remarkable change; and to an indifferent observer, the shell had no distant resemblance to a surface overspread by above fifty grains of rice affixed by one end.

Those thus distinguished were interspersed promiscuously amongst the rest.

They exhibited various features. For the most part the hydræ definitely affected consisted of a smooth bulbous base, root, or foundation next the shell, surmounted by an indented or whirled cylinder, which was crowned by a circle of sufficiently active tentacula. The peculiar position of these hydræ denoted little distinction; all were pendent according to the nature of the tribe, some inclined and others curved slightly as they hung.—Pl. XIX. fig. 1, portion of the shell and subjects somewhat enlarged. Figs. 2, 3, subjects nearly according to Nature: the latter as they appeared a week later than in fig. 1, on March 29.

Many of these subjects were now environed by plain circles, as if faintly indicating segments; fig. 4, enlarged.

While in this state, such spontaneous influence is exerted over the whole specimens, that the contraction of the cylinder shortens the interval between the circles, or the whirls, if they be prominent, compressing them on the bulb. As the cylinder relaxes, the intervals are wider, and the whirls become more distinct; the subject is lengthened.

I call the formation a cylinder or roll, as in the earlier stages it approaches this figure; and it very much resembles a minute *rouleau* of silver coinage. Other subjects, farther advanced, exhibit waved instead of plain circles around the pillar, roll, or cylinder.—Pl. XIX. fig. 5; XX. fig. 2. Short clefts likewise indent the convexity of the waves, especially towards the row of tentacula still subsisting at the summit *b*.

It must be observed that this row of tentacula, consisting of twenty in some subjects, is remote from *a*, the smooth, simple, fleshy bulb.

The number of circles, whirls, or wavings of the cylinder are indefinite. All are not formed at once, and by the result it has been computed there were twelve, fourteen, twenty, or more; as many as twenty-seven seemed to belong to one specimen. The number augments: a plain whirl next the bulb may be converted to a waving circle in a day or two, or less. The advance towards change or maturity is always progressively upwards. Thus the portion of the cylinder next the bulb may be deemed an elementary stage, and the farthest from it the most perfect subsisting stage.

Desirous of pursuing the history of individuals from earlier date to the latest period, I detached several single specimens thus affected, by insinuating the point of a stout pen-knife, so as to split off a fragment of the shell, which was little larger than the base of each subject. This could be attached by some adhesive composition to a watch-glass, and suspended in a convenient position.

Several being obtained in this manner, all were isolated. They were such as Plate XIX. figs. 4, 5; and Plate XX. fig. 2; the last two being farther advanced than fig. 4, the first referred to.

The whole consisted of a plain adhering bulb, sustaining a prolonged roll or cylinder, of which the extremity was crowned by a circular row of tentacula.

These tentacula were not alike vigorous and active in all the subjects.

In some they were shorter and less regular. Indeed, if we reflect on their original office of seizing or conveying food to the mouth, their functions are now no longer necessary. Apparently the base of the pillar rests on the wonted site of the mouth of the hydra.

But in the next place, before the progress of the subjects composing the roll is very far advanced, the circular row of tentacula at its extremity disappears. It is entirely obliterated.—Pl. XIX. fig. 6. Now a new row is discovered,—sometimes emerging as simple stumps or protuberances,—from the circumference of the fleshy bulb whereon the root or base of the pillar is implanted, therefore, not in the vicinity of the first or terminal row. They are removed by a considerable interval.—Pl. XIX. fig. 6, *a*; fig. 7, *a*. Pl. XX. fig. 3, *a, c*; fig. 15, *a, c*. Their growth is more or less rapid. Sensible elongation ensues in 24 hours.

Meantime the cylinder is extended, the wavings seen on its surface next opening, like basket-work, allow the transmission of light through their interstices; the cylindrical form gradually alters, and the whole figure becomes an *inverted* conic frustum, enlarging *outwards*. The bulb also is refining into the shape of a hydra, on the disc of which the summit of the frustum is implanted.—Pl. XIX. fig. 8. The same, 24 hours later, is represented fig 9. The subject seems divided into several different strata, or if considered a rouleau, of several distinct coins.

As the subject approaches this stage, a convulsive motion is visible near the extremity, *b*, figs. 8, 9, comprehending three strata, perhaps, while below and nearer the new circle of tentacula, *c*, all is tranquil and quiescent. As the waves have been moulded into cloven lobes, this convulsive motion is occasioned by their clasping inwards, towards the central projection, *b, d*, fig. 9. Some animal evidently struggles for liberation, which, by vehement and incessant exertion, as said before, at length succeeds, and it swims at large as the Medusa.—Pl. XVIII. fig. 1; XX. fig. 1.

Such in abstract was the course of alteration of the subjects investing the shell of the Pecten; interspersed with which were numerous perfect and symmetrical hydræ.

First, a smooth fleshy bulb sustained a cylinder of about half its own diameter, indented by plain circles, which were soon converted to waving

curvatures. A row of 20 or 24 tentacula crowned the summit of the cylinder, which row disappeared or was obliterated as the waving in its vicinity deepened, and the diameter of the cylinder there expanded, that is towards the summit. Concomitant on obliteration of the terminal row, a new circle of tentacula, at first few, but gradually augmenting, was emerging from around the bulb, while the struggles of Medusæ, into which the waving strata were evolving, accomplished their liberation to swim unconstrained in the surrounding element.

Before I speak of the period required for this evolution, together with some incidental observations, I shall advert briefly to some facts of early occurrence.

I was then impressed with the belief of the original tentacula of the hydra undergoing a change, being obliterated by a foreign substance imposed or generated on the disc, and that, as this substance, in fact composing the roll, pillar, or cylinder, was dissipated, the tentacula resumed their extension. Certain circumstances seemed to sanction my opinion.

In the course of a long series of observations with which I was then engaged, a single hydra having fallen from its place, it was transferred to a separate vessel, wherein two years afterwards, its descendants were found amounting to 45. Of these 42, along with itself, occupied the sides of the vessel, and the remainder were affixed to the bottom. With greater care, perhaps, their numbers would have been augmented.

In two years and eight months from commencement of the observations, one in the new vessel, which I conjectured the common progenitor or parent hydra of this colony, dropped from its position on March 5. I wish to specify dates as a guide to the period when naturalists may expect a solution of their enquiries.

Next day the figure of this subject seemed elongating, and in three weeks the wonted pendulous roll appeared, as it lay in a watch-glass, as in Plate XVIII. fig. 9; enlarged, fig. 10.

Nothing but the colony of hydræ had occupied the vessel.

The animal had fallen on March 5; it was delineated on March 25. In five days the cylinder equalled about two-thirds of the length of the whole subject, the remainder being smooth. It was about a third of the

thickness of the smooth part, which I considered the original body of the hydra, now towards a line in diameter. But it must be recollected all these measurements and proportions are to be deemed only approximations to the truth.

Recently, preceding March 30, two of the largest companions of figs. 9, 10,—still suspended by adhesion to the side of the same vessel,—were undergoing a change, the tentacula were shortening. The body remained plump and healthy, when only the tips of the tentacula continued visible at the extremity of the pendulous prolongation.—Plate XVIII. fig. 11, *b*. This subject extended five-eighths of an inch. The pendulous prolongation of its fellow, fig. 12, whose tentacula had entirely disappeared, was still more ample on the 30th of March. Its total length was about five lines.

In a week, that is on April 8, numerous other specimens in the former vessel which had contained figs. 13, 14, were undergoing changes similar to those now described.

Suffice it to observe, in this place, that the pendulous rolls were gradually advancing to maturity, and progressively resolving into Medusæ as the former.

It is to be remarked of the four animals whose history is thus abbreviated, Plate XVIII. figs. 9, 10: 11, 12; 13, 14, 15, no other creatures had been in the same vessels along with them; nor could the strangers have escaped detection if there,—the vessels being only two inches in diameter. From the numbers in one of them, the hydræ were of all ages.

Although I have endeavoured to describe and represent the actual appearance of the subjects, and to follow the course of incidents as accurately as possible, there are still various points which I feel sensible of having overlooked, and others which there was no opportunity of observing, both meriting much farther investigation.

Certain facts admit of no dispute. Such as the existence of a vigorous hydra attached to a solid substance, with long flowing silky tentacula: an alteration in the figure of the body, or the formation of an embryonic roll of Medusæ on the disc; the gradual maturity of each Medusa, and its liberation from the roll; the disappearance of the original tentacula of the

hydra: the emerging of a new circle of tentacula from a smooth fleshy bulb, sustaining the embryonic roll, as the former are obliterated, and as the Medusæ approach maturity, the evolution of this fleshy bulb as a perfect hydra, along with their departure, which becomes the parent of progeny by gemmation, and its permanence as an independent animal.

Among the various questions to which the attention of naturalists should be directed, is—

1. How is the body of the hydra affected in the earliest stages of alteration? I rather thought that it was by progress downwards, the first appearance of change taking place near the circle of the original tentacula.

2. Is it truly an alteration of the body itself, or is the change from the embryonic roll being originally generated within the body, or upon the disc? I found it impossible to determine, until ascertaining this fact, whether the subsequent division and dissolution was that of the hydra itself, or of the product generated from it or upon it. I rather thought, when the most favourable view could be obtained, that the smaller end of the roll, when the rest had advanced, appeared as if inserted in the hydra's mouth, or where we should expect to find its mouth.

3. How and when is the original circle of tentacula obliterated? It appeared to me, that, as the waving of the cylinder deepened, the vigour and regularity of the circle I have described as consisting of 20 or 24 tentacula, were impaired; that they contracted and were effaced. I could not discover how, if they belonged to the fleshy bulb, they were conducted around the expanding Medusan lobes to the extremity. Had it been so, their obliteration might have followed simple contraction, and possibly they might have extended as new tentacula, for the hydra has uncommon power over its parts.

The terminating circle seems somewhat within the circle of maturing Medusæ. That is, the Medusan circle is of larger diameter than the tentacular circle.

This latter circle seems quite unconnected with and distinct from the highest Medusa, whose liberation, in as far as I could discover, never preceded obliteration of the tentacula. I have witnessed this incident, but the first Medusa escaping before me, was always free of foreign organs.

I have also seen several of the first Medusæ, both before and after liberation, and all alike free.

To these and other points I shall venture to direct the general attention of naturalists. Scottish observers will find the proper season of their enquiries regarding the hydræ indefinite, but regarding the Medusæ they are restricted from about the first of February until the first of May. No Medusæ were produced from the hydræ in my possession, after the 15th of April in the year 1846.

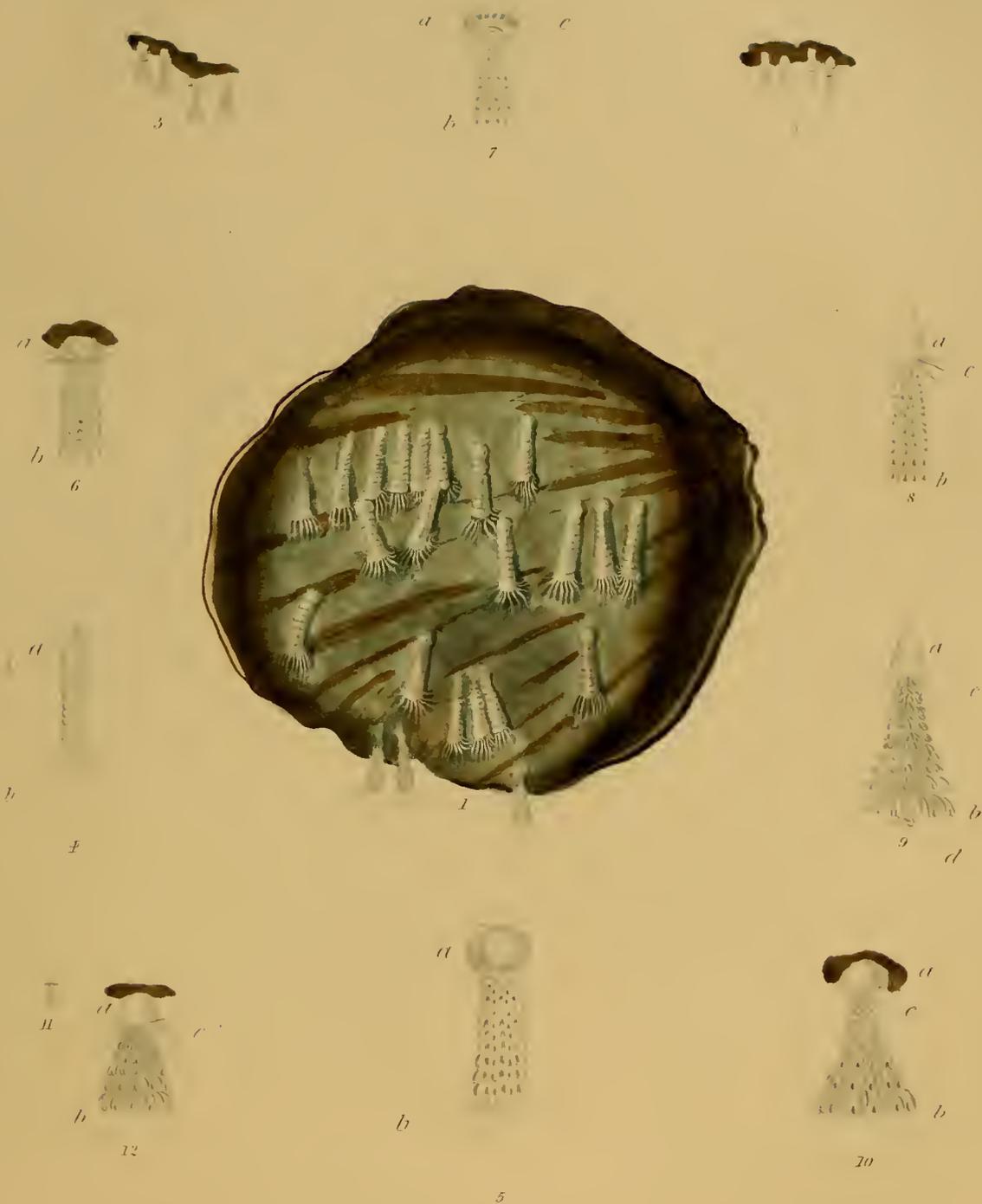
But the subjects are so diminutive and so perishable; of such rare and uncertain occurrence, as to preclude any premeditated course of observations; or the expectation that a series interrupted may be resumed and completed from new specimens, at any given time. Hence a perfect history of them would require the united labour of many observers for many seasons, aided even by fortuitous and advantageous incidents.

Little remains for addition to this already too prolix detail. It has become so from an anxiety to render an obscure and difficult subject intelligible by those who may not have the benefit of practical experience.

All the Medusæ in the embryonic roll are separate and distinct animals. Each is in close application to that which is next below, if itself be uppermost; or lays between two if intermediate. The proboscis is outermost if the individual be uppermost in the roll; thus all lie in the same direction, the proboscis outermost, as the Medusa escapes, from the next left behind. When the last remains in adhesion to the fleshy bulb, its proboscis projects outwards also. Thus the under surface of the embryo is always outwards, while a portion of the roll.

This is a singular arrangement: it shews that Nature designs that the maturity of the embryos, and their liberation into active life, should be successive. Whether the brood be confined within some invisible amnios, collectively or individually, in an earlier or later stage, is uncertain.

The period occupied by the change, and that which is consumed in the dissolution of an entire roll, is extremely variable. It usually takes several days. But I have seen a single Medusa free itself within three minutes after its precursor departed. The higher two of Plate XX. fig. 16, separated during observation. The four higher of Plate XIX.



Hydra Tuba Medusa Digida

fig. 8, having become more amply developed, as in fig. 9, were under such vehement exertion at noon, soon after obliteration of the tentacula, that I felt impatient for the arrival of my artist to delineate the whole subject while yet entire, which he accomplished.—Fig. 9. Accordingly, two together were liberated just as the drawing was completed. After struggling severely, they were free of each other. Many days sometimes elapse before dissolution of the roll as previously observed.

When a drawing of Plate XX. figs. 6, 7, was begun, the lower part of the roll was merely a smooth swelling whirl; but previous to completion of that and another, the conversion of the whirl to an early embryonic Medusa was perceptible. In nine days the whole Medusæ of this subject, fig. 7, were liberated, leaving the hydra free.

The period is irregular, as may be readily supposed from the unequal numbers composing the roll. I could not ascertain that above seven strata ever came to perfection in Plate XX. fig. 15. But in others they exceed twenty.

In proportion to the Medusæ liberated from the expanding conic frustum its dimensions are gradually reduced; but the symmetry of the sustaining bulb is improving, and its tentacula are extending. Their progress is alike variable; also certain parts are generated, which afterwards disappear.

Several Medusæ having escaped from Plate XX. fig. 8, only three or four remained on March 31, the bulb now becoming a hydra with extended tentacula. In five more days the hydra was symmetrical, with a long spur issuing from the side, fig. 9, which disappeared subsequently. In other three weeks, a young hydra had been generated, and on May 16 it was nearly as large as the parent, *a*, from which it had withdrawn, fig. 10. Fleshy portions, such as fig. 11, enlarged, promised embryos, but they disappeared. The hydra of this subject, figs. 9, 10, *a*, survived 125 days after being freed of the Medusa. It had also generated several young; but having gorged itself with food, it was lost accidentally.

If the period occupied by the changes is irregular in point of duration, the ultimate issue is definite. For example, the tentacula crowning a waved roll or cylinder implanted on a simple bulb, Plate XX. fig. 2,

were obliterated in two days, as seen by fig. 3. Then a different row of tentacula was advancing from the higher circumference or disc of the bulb, and four spurs afterwards disappearing were issuing from the base. Now, a hydra was forming of the bulb, whose long silky tentacula were waving in 25 days amidst the water, fig. 12. After other three weeks, the indications of progeny, shown fig. 13, were realized by the representation, fig. 14, of the perfect hydra with its offspring, as seen 53 days subsequent to the delineation of fig. 2. The progress of this subject was somewhat retarded by an accident. But in 121 days from that delineation, fig. 2, it had become fine, when its vessel was unluckily broke during the night, and the contents lost.

The changes and the multiplication of others proved alike evident and decisive. Thus the subject, Plate XX. fig. 15, so prominently distinguished there, after passing through the changes of 16, 17, and 18, became with its progeny as represented fig. 19, in 48 days. Following its course, first, it is seen as an enlarging waved *rouleau*, with a circle of above 20 tentacula at the extremity. This roll is sustained by a bulb with a circular row of shorter tentacula, *d*. An embryo, *e*, is germinating from the bulb. In a week, the farther or exterior row of longer tentacula has disappeared, and the inner or shorter row is extending, fig. 16, *c*. In another week, all the Medusæ composing the *rouleau* have escaped; the hydra, originally a smooth fleshy bulb, and its germinating progeny were advancing, fig. 17. The changes were great with the lapse of 15 days more. Now the progeny amounted to four, one of the number, a bud with developing tentacula; other two have withdrawn; the fourth, very minute, has sprung of some of the family, fig. 18. In 48 days the whole appear as in fig. 19. The parent became ultimately the finest of all the hydræ which had been simple bulbs sustaining Medusæ. It fed voraciously, and about three months after the whole Medusæ had been liberated it gorged itself to such excess, that the adhesion was lost, as I presume, from distension; thence it fell down and perished.

Amidst numerous examples which I have had an opportunity of witnessing, I shall give only one additional illustration corroborative of the general facts.

A vigorous subject attached to a fragment of shell on March 27 is represented, Plate XX. fig. 6; enlarged, fig. 7. The different strata of Medusæ are advancing rapidly to maturity: the bulb has attained the general form of a hydra; and its tentacula are extending with some regularity. Though pendulous originally, the Medusan roll has assumed a peculiar curvature, so that the most mature portion turns upwards. In 28 days longer, nothing of this subject but a vigorous and symmetrical hydra remained, fig. 20, which in 15 more, had become the parent of others, fig. 21; and in two months from the beginning, in March, its family had increased to seven members, fig. 22. This parent, originally a bulb on March 21, fed readily and copiously, and survived in fine condition 290 days from that date.

Thus it is unquestionable that, wherever there is a roll of Medusæ there is also present a hydra sustaining it, which is developed in symmetry as the Medusæ escape.

How this hydra comes to be present is a difficult question. Is it an original hydra, whereof the tentacula are obliterated, and the body compressed? Has the roll been generated by that hydra, or is it a foreign substance? Is the body of the original hydra actually partitioned into a number of Medusæ, all except a portion at the base, developing as a new hydra? If any of these facts be admitted, it would be well to see its confirmation. My original impression was, that the body of the original hydra still subsisted; that it was disfigured, compressed, the tentacula obscured, but that it recovered its shape. It is positive that, unless the bulb be a new generation affixed to the end of the Medusan roll, that the whole body of the hydra is not consumed and exhausted by the successive liberation of the Medusæ, for a portion becoming a symmetrical hydra is uniformly displayed from the point whereon the roll was generated, imposed, or rested.

It is unnecessary to recur to the history of the Medusa. Sometimes an unnatural adhesion of two or more takes place in the embryonic roll, from which they should be detached singly, in the regular course of its dissolution; and there are sometimes real monstrosities, as repeatedly occurring among the lower tribes.

Thus, more than two in adhesion, Plate XVIII. figs. 16, 17, fell from fig. 12. On another occasion two united, showing no disparity in the number of arms separated from a different roll.

A monstrous Medusa consisted of two bodies united by a fleshy neck, the one body with four, the other with ten arms.—Plate XX. fig. 24.

Are the four sets of flexible organs on the under surface rudimentary appendages?—Pl. XVIII. figs. 4, 5.

Although by repeated, long, and painful observation, I have endeavoured to learn the history of the *Hydra tuba*, and the *Medusæ* originating from it, my purpose has been but partially attained. I have selected many individuals, and I have chosen colonies of both to discover whatever changes they should undergo. The hydra grew, it fed, it bred, its existence was long. The Medusa lived, it neither fed nor bred, its existence was infinitely shorter; nor did it undergo the smallest change from the first moment of liberation for 55 days. Its life could not be protracted, on any occasion, beyond 60 days.

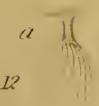
Between the form and habits of these two animals there is not the smallest correspondence.

At the commencement of my observations many years ago, I was not aware, as already said, of the Medusa having been seen by *Baster*, previous to the year 1765, and distinguished by him as *Medusa minutissima*. Therefore I named it *Medusa bifida* provisionally, from the *cloven* lobe.

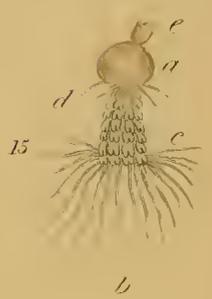
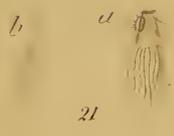
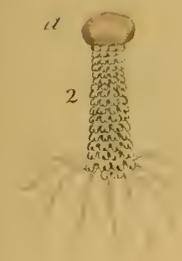
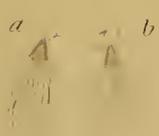
Names already given, if significant, should not be capriciously changed; and as nothing but the pursuit of truth ought to be the object of literature, so should naturalists always contemplate that laudable end, by endeavouring to penetrate the works of the great Creator, instead of engaging in controversies—an idle occupation at best.

My special purpose is now to explain the mode whereby hydraoidal zoophytes multiply their offspring, or enlarge their dimensions, as deduced from examples of the *Hydra tuba*; and if the student follows its progress, he will find the subject more easily understood.

The following conclusions, among others, may be deduced on the nature and the relations of the *Hydra tuba* and the *Medusa bifida*:—



c



Hydra Tubu-Medusa Bifida

I. The *Hydra tuba* is a real marine polypus, as distinguished by the identical properties characterizing the two species, *viridis* and *fusca*, dwelling in the fresh waters of Scotland.

II. It feeds after the same manner: its offspring are generated after the same manner, by a bud from the side of the parent, which offspring matures, establishes itself independently, and demonstrates precisely the same nature.

III. Both these marine and fresh-water hydræ are apparently perfect animals: they undergo no metamorphosis from the moment the bud is evolved into form; and they survive during years.

IV. Their nature corresponds in the tenacity of life: they enjoy to the utmost extent the property of recovering mutilated parts.

V. At an indefinite period, and under indefinite circumstances, a pendulous roll or column is observed, as if implanted on the disc of some of a colony of the *Hydra tuba*.

VI. The pendulous column is a roll of embryo Medusæ, resting in its earlier stage upon, or attached to, a smooth fleshy bulb.

VII. It is faintly indented by circles, and is terminated by a circular row of tentacula.

VIII. The indenting circles become deeply waved, the tentacular organs at the summit of the roll are obliterated.

IX. The circumferential waving indicates the evolution of Medusæ, which are farthest advanced towards the summit. From their enlargement the roll becomes a conic frustum, sustained by the fleshy bulb.

X. The Medusæ successively attain maturity: they struggle vehemently towards the extremity of the roll for liberation. A new circle of tentacular organs, prominent before disappearance of the old circle, and distant from it, is now evolving from the bulb.

XI. The Medusæ are successively liberated, and by their maturity and liberation the embryonic roll is dissolved.

XII. The season of their generation, production, and liberation, is limited by about 60 days, wherein the month of March is comprehended.

XIII. The period of their survivance, when free, does not exceed 60 days in confinement.

XIV. The fleshy bulb refines into a perfect symmetrical hydra, as the embryonic roll which it sustained is dissipated, and successive generations of progeny descend by gemmation from its side.

PLATE XVIII. *Medusa bifida*.

FIG. 1. Colony of Medusæ swimming at large.

2. Specimen enlarged; supposed proboscis from the under surface, *a*; cloven lobes or arms, *b*.

3. Specimen reversed; orifice of the mouth, *a*; arms, *b*.

4. Surface, shewing four external organs around the proboscis.

5. Another view of these organs.

6. Lobe or arm, shewing the cone in the cleft, surmounted by a compound black speck, magnified.

7. Granulated aspect of the under surface of a specimen.

8. Granulated aspect of the upper surface.

9. Hydra, *a*, with a *rouleau* or pendulous formation, *b*, seen as laying in a watch-glass, having fallen from its position.

10. The same enlarged, hydra, *a*; pendulous formation, *b*, being immature Medusæ.

11. Hydra pendent from the side of a jar, *a*, with a similar pendulous flexible formation, *b*; consisting of immature Medusæ.

12. Another hydra, *a*, become shapeless like the two preceding, with a similar formation, pendulous from the disc, *b*.

13. The pendulous formation with Medusæ developing, *a*, *b*; detached along with a slice of the base or disc, *c*, as now laying in a watch-glass.

14. The same enlarged.

15. Ultimate appearance of the same subject; tenth Medusa, *a*, struggling for liberation; eleventh, *b*, died; spurs or originating tentacula, *d*; the latter long and silky in three weeks.

16. Portion separating naturally or accidentally from fig. 12, proving two or more Medusæ united.

17. The same, enlarged; proboscis, *a*; arms, *b*.

The figures 1, 9, 12, 16, nearly of the natural size: the rest enlarged.

PLATE XIX. *Hydra tuba*, *Medusa bifida*.

- FIG. 1. Group of hydræ in progressive change adhering to a shell, enlarged.
2. Natural size and aspect of a different portion.
 3. Aspect of another portion, little exceeding the natural size.
 4. Hydra and *rouleau*, or cylindrical prolongation, with circular indenting, enlarged; bulb, *a*; tentacula, *b*.
 5. Subject farther advanced, the tentacula at the extremity subsisting, but the indenting waved.
 6. Subject still farther advanced: tentacula at the extremity obliterated. Another row originating from the bulb.
 7. The same, as seen 48 hours later.
 8. Bulb, *a*, with a spur at the base, and the cylinder from the disc, which is surrounded by tentacula.
 9. The same farther advanced; tentacula extending; Medusa greatly expanded; the lobes clasping towards the proboscis, *d*, which projects outwards.
 10. Specimen with Medusæ far advanced. Stumps on the bulb subsequently extending as tentacula.
 11. Subject natural size, consisting of a hydra with extending tentacula, sustaining several Medusæ far advanced.
 12. The same enlarged.
- All the preceding figures, except 2. and 11, are enlarged.

PLATE XX. *Hydra tuba*, *Medusa bifida*.

- FIG. 1. Group of Medusæ swimming at large; natural size.
2. Bulb, or developing hydra, sustaining a waved roll of early Medusæ, terminated by a complete coronet of tentacula.
 3. The same, having lost the coronet; another distant coronet, or circle, developing from the bulb, which is refining into the form of a hydra, with four spurs issuing from the vicinity of the base: all as seen 48 hours after fig. 2.
 4. Medusa as swimming at large.
 5. Medusa 40 days old.
 6. Bulb refining into a hydra, with tentacula sustaining a recurved column of Medusæ attaining maturity; natural size.

PLATE XX. FIG. 7. The same enlarged.

8. Bulb become a hydra, with extending tentacula, from which all the Medusæ composing the embryonic column, but three or four, had been liberated.
9. The same a week later, developed into nearly a perfect hydra, all the Medusæ being liberated; a spur, *c*, from the side.
10. The same in 46 days from the appearance of fig. 8. A young hydra, *b*, having been generated from fig. 9, *a*, now appearing as *b*, in this fig. 10.
11. Vegetation proving unproductive from the base of fig. 10, *a*, enlarged.
12. The subject *a*, figs. 2, 3, now become a perfect hydra; natural size.
13. The same with indications of gemmation.
14. The same five days later, *a*; with its offspring, *b*.
15. A specimen undergoing progressive change. Bulb, *a*; column of Medusæ advancing, *c*; crowned by a circle of tentacula, *b*; another circle, *d*, developing from the bulb. Embryo budding, *e*.
16. The same a week later. The former coronet, *b*, of fig. 15, obliterated; Medusæ come to maturity; tentacula from the bulb advancing, *c*; embryo, *e*, of fig. 15, having acquired tentacula.
17. The same a week later, now free of Medusæ; embryo improved; gemmation indicated from the parent hydra, *a*.
18. The same in three weeks; embryo budding, and young hydra having withdrawn from the parent.
19. The same as seen 48 days subsequent to the appearance of fig. 15, the family consisting of five independent individuals.
20. The subject, (figs. 11, 12,) 28 days later, now consisting of a symmetrical hydra.
21. The same in a fortnight, with its progeny.
22. The same 57 days later than figs. 11, 12, now a family of seven independent individuals. These are somewhat concentrated in the drawing, being much dispersed on a watch-glass.



Vorticella.



- PLATE XX. FIG. 23. Medusa with four lobes or arms.
24. Monstrous Medusa.
25. Medusa 50 days old, not having undergone any metamorphosis.
Natural size, figs. 1, 6 : 10-14 : 18-22.

PLATE XXI.

- FIG. 1. Vorticella, enlarged.
2. Extremity of a branch of the same, magnified.
3. Vorticella of another species, enlarged.
4. *Vorticella stentoria* ; group.
5. Part of the group magnified.

CHAPTER IV.

THE SERTULARIA.

THE preceeding observations on some of the Zoophytes already shew the very comprehensive signification of their name, as applicable to a large proportion of the animal creation. Within its sphere are included, solitary, simple, naked, and unprotected creatures: it also embraces *social*, complex, and well-sheltered beings, whether of pure organic formation or combined, as we shall see, with inorganic matter of opposite elements.

On quitting the fistulous Tubularia, where the delicate hydra, continually exposed to danger, is denied a receptacle for protection, we reach another race, the Sertularia, where it has always a safe retreat, within something whose substance may be compared to membranaceous texture. Again, leaving the Sertularia, we come to other tribes, for which Nature has furnished a strong calcareous dwelling.

We shall find, however, in the progress of our enquiries, that the configuration of the tenant sometimes undergoes a remarkable change, according to the substance of the inorganic portion allotted for its habitation.

The intimate resemblance of the hydra, I should say the identity of that animal, combined with inorganic parts so different that we might be scrupulous of allowing them a kindred place, is very strange. At first sight there seems no common resemblance between two of the hydraoidal Zoophytes, they are so far asunder. Neither is this less singular in the Ascidian genera, where, of two which are beautifully displayed, we observe the abode of one amidst a gelatinous mass, the other amidst a membrane, and a third, perhaps, retreating within a shell—all originating with themselves, and augmenting as they are enlarged.

The multitude of zoophytes having greatly increased, especially of later years, with the number of observers, has demanded its partition into lesser sections for convenience. But I am not aware that as yet the advances of knowledge actually admits the various divisions and subdivisions proposed by modern naturalists. I fear we are premature in receiving some of them ; for, allowing both their zeal and their intelligence, as observers, it seems to me,—I speak it with deference,—that we are still too deficient in *facts* and in *figures*, those radical elements, whereon alone unerring systems can be founded.

A strong propensity for the alteration of established nomenclature, attended by an undue anxiety for the constitution of additional genera, has recently predominated. Hence, precipitate observation has assumed trivial distinctions as important characters, to support the addition or the change, instead of permitting the favoured subject to merge among its fellow species of some well-known and well-marked genus.

Probably the multiplication of genera will prove less expedient than the enrolment of species. It can be scarcely doubted that, with the progress of more profound learning and investigation, so many analogies will be found as to consolidate a number of species into a separate genus, or to unite them to one already established : Also, that by the same means, certain genera now admitted would be reduced to species. The constitution of genera should repose on strong and indelible features, easily recognised. It should be framed on species bearing some prominent reciprocal qualities of form or of habits. But to found on the shape, the number and position of the hairs, bristles, pencils, scales, warts, and the like, newly revealed by every higher microscopical power, especially in the observation of minuter animals, would almost require, for the reception of each, some additional genus.

Perhaps as many animals, particularly of the smaller tribes, remain for discovery as those already known.

But I have never seen two animals exactly alike, however slight the difference. On very minute comparison of two species, unless the observer's views be proportionally enlarged, he will often question whether each does not pertain to another genus.

Common features must regulate the constitution of genera ; and the profound naturalist, when completely master of the *form* and the *facts*, will select such as are sufficiently prominent to sanction the arrangement of a *Systema Naturæ*.

In aid of this desirable object, I have endeavoured to point out some peculiarities in the living products already discussed, as seemed more interesting, and the least liable to be mistaken. I shall still continue a similar course ;—yet, without affirming that, spite of all the care bestowed on them, various essential characters have not been overlooked, or that I have not erred in respect to some which should be corrected.

There is no doubt that sufficient distinctions subsist among the animated tribes, to warrant the association of few or of many in certain sections, and thus to facilitate the prosecution of science.

It is from the conviction of some principles being hastily and inappropriately adopted, that the names deduced from them are not more applied throughout these pages. Also, I consider it, meantime, better to retain names already recognised, though not strictly appropriate, than to disturb their application by interference.

If we confine the Scotch *Tubulariæ* to zoophytes, “with a fistulous stem, bearing a hydra which has two separate rows of tentacula, and ovarian clusters interposed between them,” positive features of easy recognition define the genus, wherein the species comprehended are very few.

Were the name of *Sertularia* retained in its original sense, “a *plantula* or little plant,”—merely a diminutive, it would comprehend the great majority of those denominated flexible zoophytes.

I feel disposed to claim it occasionally as a useful and convenient auxiliary, for which no adequate substitute has been hitherto suggested. Our progenitors preferred brief and explicit definitions from clear and decisive features. They did not deal in many words.

Nothing can be more appropriate for common use than the definition in question, as in the *Systema*—“an *animal* growing in the form of a plant : *Stem* branched, producing *polypi* from cup-shaped *denticles* or minute *cells*.” Further, the genus was divided into two portions ; one with a *horny* stem, and furnished with ovarian *vesicles* ; the other having a *crus-*

taceous stem, tending to lapidescence, *with* rows of *cells* but *without* ovarian *vesicles*.

Endeavouring to reform the *Systema*, later naturalists have greatly restricted the genus *Sertularia*, by mutilating it of many important members. Of these they have constituted various new genera, not always successfully, and sometimes under rather capricious denominations, as well as founded on characters too vague and indefinite. Likewise the living subjects having been seldom studied, or even beheld in them, while the skeleton was not rare, has perhaps led more readily to the assumption of recently dead, and especially of dried specimens, as a guide for systematic arrangement.

Thus the inorganic parts are the basis of definition,—in the structure of the stem, distribution of the branches, the shape, position, and number of the cells; while the figure and the properties of their fugitive tenants remain totally unknown. Such must have been the obvious consequence of the method pursued. Many may have found it difficult to do otherwise.

A modern author, however, Dr George Johnston, in a comprehensive and excellent work on the subject, has gone far to rectify this defect, by arranging the zoophytes with due attention to the nature of the animals belonging to them. That author is entitled to the greater merit from the labour and difficulty of accomplishing such a task, for it has exacted equal skill and industry.

Naturalists attempting to extend and improve the general *Systema*, have been often unjustly and harshly blamed for apparent confusion and defective precision,—faults not their own, but originating with those writers whose works they were compelled to follow for want of better. Had figures always accompanied descriptions, how much would it not have promoted truth—how many complaints, and what grievous annoyances would it not have prevented

Having disposed of the *Tubularia*, and by some examples deduced from the nature of the hydra, having spoke of the process of increment, whereby zoophytes are enlarged, we shall resume an examination of several other subjects. But, always recollecting that as these are only a col-

lection of detached memoirs, it is with less anxiety about their position in systematic order than in the accurate detail of facts.

Unless in the stationary place of the head or hydra, while subsisting, the double row of tentacular organs, and the pendent ovarian clusters interposed between them, few positive distinctions will be found between the general nature of the *Tubularia* and the *Sertularia*. A fistulous stem, together with reproduction of the hydra, are not excluded from the latter. But the metamorphosis accompanying the propagation of the *Sertularia* is an important feature. Nevertheless, were the *Tubularia ramea* allowed to remain in the position that naturalists now assign it, the correspondence would prove still more intimate in a stem of aggregate tubuli and ovarian vesicles, bearing within them the elements of new generations.

The extremities of the preceding *Tubulariæ* are simply cylindrical; but, excepting in the last, the *Tubularia ramosa*, without a tubular cavity wherein the hydra can be withdrawn. The hydra which has rose within the stem to develop from its extremity, remains permanently there. But the extremities of the *Sertularia* are cellular, and a multitude of cells are implanted on the stem, boughs, and branches, whither the hydra can retreat for shelter,—all of various configuration. Some are little more than a simple orifice: some resemble a tooth, a cup, a flask, or a bell, with a smooth or a serrated lip. Some are armed with a longer or a shorter spine: or the margin of others is guarded by several extraordinary processes, extending in straight lines or in curvatures of inordinate length. The cells, with their tenants, stand on one or both sides, or around the inorganic parts: they are single, at distant intervals, in pairs, or in clusters, either crowded together or far apart: And they are seated on stalks, or branches, or twigs, jointed, whorled, or frilled. Remarkable profusion, along with the greatest variety, are exhibited throughout the principal and subordinate parts of the different genera and species constituting these products in perfection, which nothing but a copious series of accurate delineations from luxuriant specimens could illustrate.

Sertulariæ are beheld in every stage, advancing from meagreness to the highest luxuriance. That specimen which has an hundred or a thousand different hydræ, has an hundred or a thousand different receptacles to

shelter them. There are neither too many nor too few. The dwelling of each is coeval with the other,—originating jointly, but not invariably corresponding in duration; though in the hydraoid Sertularia, it is not, as many believe, a portion of the living tenant's substance. The cell serves as its proper habitation during life, and sometimes subsists permanently or temporarily afterwards. It is a place of refuge, always in ready preparation, whither the animal can retire for safety, or to undergo such organic changes as are incident to its nature; and from whence it can advance in quest of food, or to enjoy the salubrity imparted by its renovated element. The vigour and the disposition of the tenant are sensibly modified by these provisions for security. Unlike the inactive langour of hydræ, deprived of such receptacles, here it is quick and lively,—as if conscious of danger, it lurks below: it is cautious of advance, and precipitate in retreat. While completely unfolded, the whole organs suddenly collapse, it sinks within the cell in a moment, and crouching still lower and lower, lies quiescent, until, the dreaded peril over, it rises slowly as before, again to expand itself. All this is amply exposed by the transparency of the most capacious of the cells allotted for the dwelling of these timid diminutive creatures.

How interesting is the view of a luxuriant specimen of the Sertularian race,—one resembling the richest productions of the vegetable creation, shorn of its flowers and foliage in the winter season. Now the whole is still and lifeless: it seems hastening to decay,—to approaching dissolution. Let it remain undisturbed, and in a few moments it will be covered by innumerable animated blossoms, issuing forth from their cavities to the light. Then, after seeking their enjoyments in the plenitude of evolution, do they again vanish in instant retreat. Infinitely more than mere sensation, however, is manifested by this marvellous host. All have a common perception of what affects their common condition, while each has an independent sense, deduced by some comparative means, of the real circumstances peculiarly affecting itself.

All the inorganic parts of the Sertularia are of a tough and elastic texture; they are hollow, and occupied by a kind of pith, less evident than in the *Tubularia indivisa*. During its subsistence, the more minute

structure of these parts, the articulations and whirls, are obscured, which has induced naturalists finding them, exposed with the death of the product, and still permanent when it was preserved, to seize their characters for the basis of arrangement.

But the consistence of the body of the creatures belonging to the Sertulariæ is apparently not remote from that of the hydra proper, allowing some difference between those of hydraoid and ascidian formation. Although these tenants of the zoophytes be liable to perish from natural or accidental causes, their parts are by no means simply gelatinous, void of coherence and tenacity. Many of the ascidian are bound by ligaments to the interior of the cell, which aid their rise and descent; and in some, as the *Alcyonidium parasiticum*, the connection being ruptured, hundreds drop entire from their cells when the salubrity of the surrounding element is vitiated.

The nature of the asteroid zoophytes is different. The body of the hydra, rather fleshy, there forms an integral portion of the common substance belonging to the whole, from which it cannot separate by decay.

From this diversity of consistence, whereon diversity of structure is concomitant, these minute beings are endowed with a very different share of strength and tenacity of life. Those denominated helianthoids, as the Actinia, are the strongest of any comprehended among the race of zoophytes. They are void of a place of shelter; but some of the Sertularian hydræ can scarcely endure speedy transference to a fresher element. Removal from their native abode is generally fatal after the shortest season. Zoologists should thence value the correct delineation of perfect specimens as an accession to their knowledge of the animated world.

The life of the specimen is dependent on the subsistence of the pith; the life of the hydra on its connection with the body, but not of the continuity of the pith in the stem or in the other tubular parts. The life of each of a thousand individuals, though all sustained by diverging parts, supported on a single common stem, as rising from the root, is independent of that which animates all the rest. Though all may have been generated from elements repositied in the pith, whence their origin has been derived, the death of no one individual seems to affect its neighbour. While the

parts above and below are in absolute decay, an intermediate branch may exhibit all its vigour in luxuriant efflorescence. In the natural state, the decay commences with the lower ramifications; in an artificial state, the extremities of the various parts rather seem the first to perish. This certainly ensues with various species, when its rapid progress is always destructive of the specimen. Nevertheless, the subsistence of vigorous animated extremities may be long, and their reproductions numerous, while all the lower ramifications remain as inert matter, having lost both the vegetative and the vital principle.

From these reasons, and from constant exposure to accident, as well as the violence sustained in being withdrawn from their native places, perfect specimens of the Sertularia, always a delicate product, in any but the earlier stages, can be seldom obtained. Almost all have undergone extraordinary mutilation. Neither are any of the largest specimens ever animated throughout, so that each cylinder, denticle, or cell, contains a living tenant. This subsists only in portions of them. Though multitudes remain many have perished: whether from the distempers or casualties incident to the least, as well as to the greatest works of the creation.—*Death ensues because life has been.* Some elegant specimens, indeed, illustrate these pages. The reader would be incredulous were I to tell him out of how many rejected, or in the course of how many years.

The duration of the life of zoophytes is not easily ascertained, especially where an individual of a multitude may be replaced by regeneration. If conjectures shall be indulged, it must be from observation of solitary animals.

Independently of the preceding injuries from time or accident, the progress of nature itself proves destructive.

Every compound specimen, even a species which bears a thousand vivacious hydræ at once, seems to originate through the medium of a single individual animal. The *Sertularia*, *Flustra*, *Cristatella*, *Virgularia*, and the whole Alcyonic race, exhibit a single polypus, whose existence, in certain genera, is incompatible with the evolution of posterity from the specimen whereof it is the foundation.

Although many hydræ of the Sertulariæ may survive that progressive increment of the specimen adding to their numbers, this is utterly precluded in the Alcyonic masses, covered by a single stratum of asteroid hydræ, not half an inch high, while the mass consists of half a cubic foot in quantity. All the lower generations are overwhelmed by those above them. If I rightly understand the nature of zoophytes exceeding a single animated stratum, they are enlarged by extension above, not by accessions below.

The difference between the nascent Sertularia and the adult is often so great, that, to pronounce their identity would be fallacious. It is the same with other zoophytes. No one could recognise the *Cristatella* in the hydra quitting the ovum, more than the *Botryllus*, though not yet included in this class, in the early stages of its simple ascidian formation.

Among the adults themselves, there is also sometimes such a discrepancy, that practised observers may enumerate several as distinct species, which truly concentrate in one. Farther still, the naturalist may delude himself in comparing the dead with the living subject. Parts of the latter disappear with the fulfilment of their functions; parts of the former are obliterated. If features alter after an inexplicable manner during life, it is not surprising that greater changes accompany its cessation.

Thus the vigorous subsistence and the decay of the Sertulariæ may occasionally manifest anomalies, precluding all theories on their original formation and exact definitions of their organic structure: each discloses some peculiarity unseen in the other. The naturalist will vainly seek those vivid colours decorating some of the most beautiful subjects, unless amidst the waters of congenial salubrity. If framing his system on the articulations, whirls, grooves and notches exposed by transparence in decay, he will find few such guides in vigorous specimens, where they are rendered obscure or indefinite by the opacity of the neighbouring parts, and only to be shown by death. Neither shall he find in the decayed products whereon most systems repose, those transparent campanulate cells whither their timorous tenants can retreat for protection, together with those singular and varied prolific vesicles once loading the most luxuriant pro-

ducts. All have fallen; for their use being temporary, their subsistence is transient. Though the pith itself be the chief obstacle to detecting the minute formation of the inorganic parts of the living specimen, nothing is less permanent. It totally disappears. Portions of the skeleton alone remain, after preceding deperdition of life and organization; for I believe it to be true, that no more than what are comparatively mere fragments of the perfect subject continue entire.

If we are to ascertain the nature of the Sertulariæ, we should behold them complete, as in every stage, and under every aspect. Endeavouring to show the peculiarities of healthy, vigorous, and symmetrical animals, from the figure and arrangement of their mouldering bones, would never be satisfactory.

After some details on the appearance and properties of various zoophytes, we shall resume a more explicit view of the most interesting points distinguishing their history.

§ 1. SERTULARIA POLYZONIAS, *The Hoop Sertularia*.—PLATE XXII.
—The embarrassment regarding identity, which is very frequent, may be perhaps avoided, by selecting specimens with prominent features for illustration and commentary. They are apt to be undervalued if common, as we forget that what is rarely seen by observers is uncommon in respect to them; and that what is very common to us may be elsewhere scantily distributed. Subjects always at command are generally neglected; whereas they should be of all others the best understood. Attempting to inform our neighbours from a type of absolute novelty, which few, if any, but ourselves have beheld, would be a futile endeavour.

Probably this Sertularia is designated *Polyzonias*, from several belts or rings obscurely encircling the ovarian vesicles.

Specimens rise four inches high, by a stem which is slightly waved. It is meagrely provided with boughs and branches diverging to right and left, at irregular intervals, in the same plane, so that the whole specimen might be sunk in the thickness of pasteboard. Cells are ranged alternately on both sides of the stem and subordinate parts, always originating

from the convexities by which these are distinguished. They are somewhat ventricose, swelling downwards from a narrower circular orifice, whereon none of the teeth specified by Lamouroux have been seen, though several are on the orifice of the vesicles.

The cell is occupied by a hydra with about 24 or 26 deeply muricate tentacula, which expand about a line between the opposite tips. It is large in proportion to the cell, whence it protrudes by a long neck or body, and retreats completely within the cavity. Of all the hydraoid zoophytes, it may be rated the next in size to that of the *Tubularia larynx*. But the dimensions, vigour, and aspect of these creatures are extremely dependent on the salubrity of their element, and the peculiar state of the atmosphere.

The whole product is of a green colour, of various shades and intensity, which is derived from the pith, as the fistulous inorganic parts are transparent. In earlier stages the green is vivid. The stem of adults, or older specimens, is occasionally yellowish or brown. I have never observed the hydræ of any other colour than green, of different intensity.

The meagre appearance of the Sertularia is remarkable. Few specimens are equally luxuriant as the scantily clothed figures here represented, Plate XXII. fig. 1; the same enlarged, fig. 2; and most of the branches are frequently on one side, fig. 3. A stem has sometimes occurred, which, without having generated any branches, had above 30 alternate cells. One with 29 was 15 lines high, whence their dimensions and intervals may be computed. A large bough had 35 on each side, these being the most numerous ever observed.

The food of the smaller compound zoophytes is problematical; but it is obvious that all must have subsistence to sustain life, and promote enlargement. I was induced by the size of the hydra here to attempt feeding them with soft particles of the mussel, a substance the most grateful of any to most of the lower carnivorous tribes; and I believe that I succeeded. I thought the particles might be discovered in the remoter parts of the stomach, whither they were transmitted by a distinct channel. There the contents appeared as a dark internal mass, becoming ovoidal,

and the hydra distorted. If the particle be too large, it is retained a long time externally ; nor can it be forcibly removed without the visible reluctance of this diminutive being.

Some authors speak of such creatures as the *Animalcula infusoria* being absorbed by the Sertularian, Foliaceous, and Lunate Zoophytes.

Moderate light and heat, and especially the renovated element, invite protrusion of the hydra from the cell to enjoy their refreshing influence, fig. 4. Pertinacious retreat is frequently preserved, perhaps from the state of the atmosphere, as during a cloudy sky, or the greater chill of a north wind ; or an invisible slough may be separating somewhat like that of the Actinia.

Probably the hydra retreats within its cell to die ; but the life of each, being independent of the rest, the death of one does not affect its neighbours.

The ovaria, or vesicles of this Sertularia, are large in comparison of the cells, and of singular structure, being as if composed of united hoops or belts. The orifice of some is serrated.—Plate XXII. figs. 5, 6.

Prolific vesicles are rare ; indeed, specimens with any vesicles are far from common.

Several with living hydræ, and with vesicles scantily distributed, full of yellowish corpuscula, having occurred in September, seemed to promise progeny. All except two had discharged their contents in a few days, as an ovoidal or globular mass, about a line in diameter, adhering to the orifice. The mass consisted of from 17 to 20 pale yellow spherules, imbedded in the most transparent albuminous matter. Some were quite globular, even under the microscope ; of smooth, uniform, shining surface. Others were less regular. But nothing resulted from any of them.—Figs. 7, 8.

At the distance of several years, the subject was illustrated more satisfactorily. Specimens with lively hydræ, and bearing vesicles, scantily distributed as before, were obtained in July. Only one vesicle appeared among twenty cells ; however, three were on a twig. Those prolific extended a line ; the orifice serrated, and the cavity crowded with yellow

corpuscles, altogether resembling a bag of small shot under the microscope. Some vesicles contained 24 at least.—Plate XXII. fig. 6.

About 50 planules issued from the vesicles on the eighth of July, the specimens having been procured on the day preceeding. These animals were nearly a third of a line in length; the body plump, approaching roundity, somewhat flattened below, of a smooth uniform aspect, and darker in colour than straw-yellow. In course of their escape, they were obviously suspended from various parts of the specimen by an invisible thread; but when reaching any solid surface, they advanced with an equal, gliding motion, resembling that of *Planariæ*. The observer could not associate them with any other genus in the *Systema Naturæ*. No external organs could be detected by the most careful microscopical inspection. They assumed various forms, according to circumstances, and, as afterwards established, these were modified also, according to the period of their existence.—Fig. 9.

Many planulæ continued quitting the vesicles from the 8th until the 12th of July. They spread on the bottom, and crowded together on the sides of their vessels. Numerous dark green, thick, obtuse spines were rising from spots on the bottom, on the 14th of the month. Several were enlarging as buds next day, which had developed as a hydra from some others of them.

In the course of their progress, the spine is dark green, thick and obtuse; in further advance, the summit, enlarging, exhibits the hydra as a green bud within its cell, the spine becoming the sustaining stalk; also the green colour of the stem, shows a central pith, contained in a sheath of considerable width.—Figs. 10, 11.

A nascent hydra had 16 rather long and slender muricate tentacula; the orifice of the cell was somewhat oblique.

Prolific specimens having been committed to a vessel on the 10th of the month, were withdrawn on the 14th. Numerous planulæ quitting the vesicles congregated at the bottom, and now at least 60 spines had rose, that is, in four days from the time of their leaving the vesicles. But farther progress was slow. No second hydra had been generated against

the 31st of August, which was the latest survivance of any of the first from the spine.

The contents of the vesicle, though apparently fresh and entire, when discharged in a mass, may prove abortive, as previously stated. The spherules, which should have become planulæ, are then retained amidst the albuminous mass, which has been expelled more probably by some aërial expansion, than by an organic animal faculty.

A residuum frequently occupies the empty vesicle, having discharged its embryonic contents, which is of uncertain nature, fig. 5, *a*. We can scarcely consider it some organization, generating an elastic fluid, to burst the pellicle closing the mouth of the vesicle, if there be one, or otherwise promoting expulsion.

Illustrations of the process of progressive increment are obtained from this species of Sertularia in its earliest stages, besides those afforded by the young bred from the vesicle. An enlargement appears at the summit of a stalk, which is found to be invested by a delicate thin film, including twin buds composing it. These are unequally advanced; but as the lower matures, its higher companion forks off, and then another from this latter, the higher. The buds are nascent hydræ in their respective cells, each having, apparently, its own peculiar integument, within the common filmy involucre.

Rapid growth ensues. A young specimen, with only a single head on the 4th of October, had acquired six on the 20th, besides a seventh in embryo. Now, it had rose about seven lines.

A few facts regarding the evolution of the hydra and the regeneration of the product, were shewn by older specimens.

One consisting of a main stem and a single lateral branch, each extending about six lines, was selected for observation on March 9.—Pl. XXII. fig. 13. At that time it rose no higher than *b*. In the evening, four of its hydræ, *e, e, e, e*, displayed themselves from their cells on the stem *a, b*, and two days after, six on the branch *c, d*. Thus ten living hydræ then subsisted. But some of them generally lurked in concealment, for the temporary display of a whole colony is rare, though occasionally seen, even where very numerous, if circumstances be favourable.

Nine appeared on March 21; ten on the 23d; eleven on the 24th; but none on the 26th. The branch *c, d*, was decaying on April 17, and had perished on the 30th.

Probably the stem had been mutilated of a higher portion than *b*, previous to my acquiring it. At this point, a new organization, proving to be two originating buds, appeared on May 3, and one of them displayed a hydra on the 6th. Thus, at least 58 days from the commencement of observation had been required for the evolution of this new animal.

Other two were displayed on May 9 and 11: All three, *f, g, h*, manifested great vigour: and they subsisted until the 23d. Next day, the 24th, *h* still appeared. Thus the preceding hydræ survived about 14 days, none of them being displayed afterwards.

But, in the close, a new germination proving a hydra, was unexpectedly generated from the cell, *i*, near the root of the main stem, which continued flourishing until June 9. The higher portion was now in decay.*

Regeneration of the hydræ also ensued in another specimen.—Pl. XXII. fig. 14. On April 4, this consisted of a single stem, rising about six lines, with ten hydræ displayed, besides two cells, *a, b*, then vacant. Likewise a bud, consisting of two embryos, was far advanced at the summit, and these were displayed as perfect hydræ before the 16th.

Next, the cell *b*, previously vacant, generated a hydra, *c*, which, along with that above it, had decayed on June 9; and the upper portion of the stem folded down in decay over the lower portion.

While in this state, a regeneration of the stem shot up through an aperture in the fold. A new hydra also issued from one of the old cells, *d*.

The forking of two buds appeared at the summit of the regenerated stem, on July 11; they were flourishing along with a third on the 18th, and a fourth was displayed on the 26th.

During survivance of the regenerations above, vitality seemed extinct below: Nevertheless, a new hydra issued from *e*, the highest but one of

* The latest regenerations may not be represented if the drawings were completed previously. The subjects are represented as appearing at the date of their execution.



Portulaca Lychnis.

the old portion, which, with its collateral embryo, flourished on July 27. They continued displaying themselves until the first of August, when the course of observation was interrupted.

It is difficult to render this part of the subject more explicit without a series of delineations. But, in abstract, it concentrates in the fact, that the hydræ once replenishing the cells, are replaced after their decay by others.

Although so powerful a reproductive faculty resides in the *Sertularia polyzonias*, no satisfactory issue has attended experiments to obtain it from artificial sections.

As common to many of the race, prolongations are generated naturally from the lower extremity of sections, whether the specimen be flourishing or vacant.

Among other facts resulting from the preceding observations, it appears:—

I. That the regeneration of the hydræ, and of defective parts, sometimes ensues in the *Sertularia polyzonias*.

II. That a period of not less than 58 days may be requisite for bringing the dormant principle to maturity as a living hydræ.

III. That propagation of the species is effected through the medium of certain corpuscula generated in the vesicles, which issue forth in the form of active planulæ.

IV. That not fewer than 24 are sometimes contained in a single vesicle.

V. That the whole contents, as imbedded in a gelatinous substance, may be expelled from the vesicle, and prove abortive.

PLATE XXII. Fig. 1. *Sertularia polyzonias*.

2. The same, enlarged.

3. Branch, shewing the predominance of lateral vegetation.

4. Extremity of a branch with hydræ.

5. Relative dimensions of a vesicle, *a*, and a cell, *b*.

6. Prolific vesicle.

PLATE XXII. FIG. 7. Prolific vesicle, having discharged its contents in a mass, proving abortive.

8. Another.

9. Planulæ from the vesicles.

10. Nascent *Sertularia* originating as a spine from a planula.

11. The same, farther advanced, with the hydra budding in its cell.

12. The same; the hydra now mature, displayed from its cell.

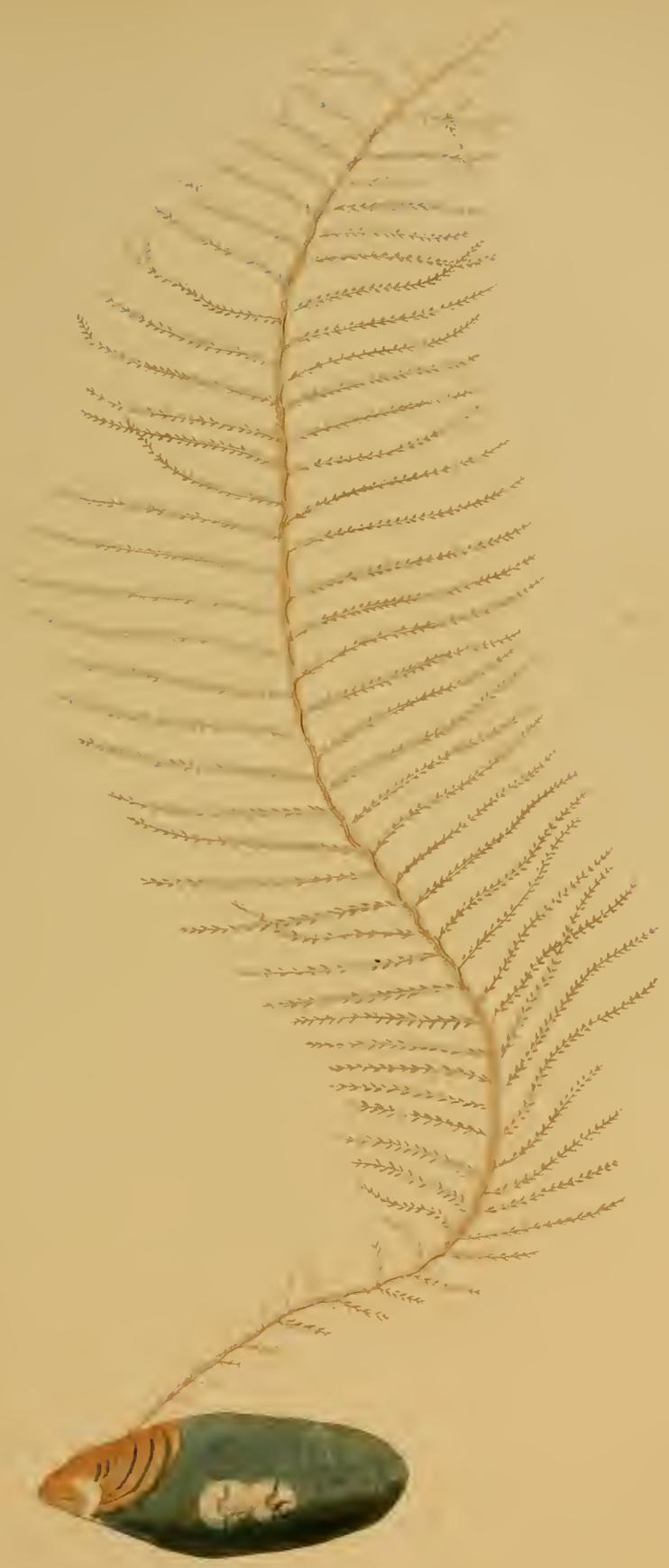
13. Specimen illustrating the regeneration of hydræ.

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

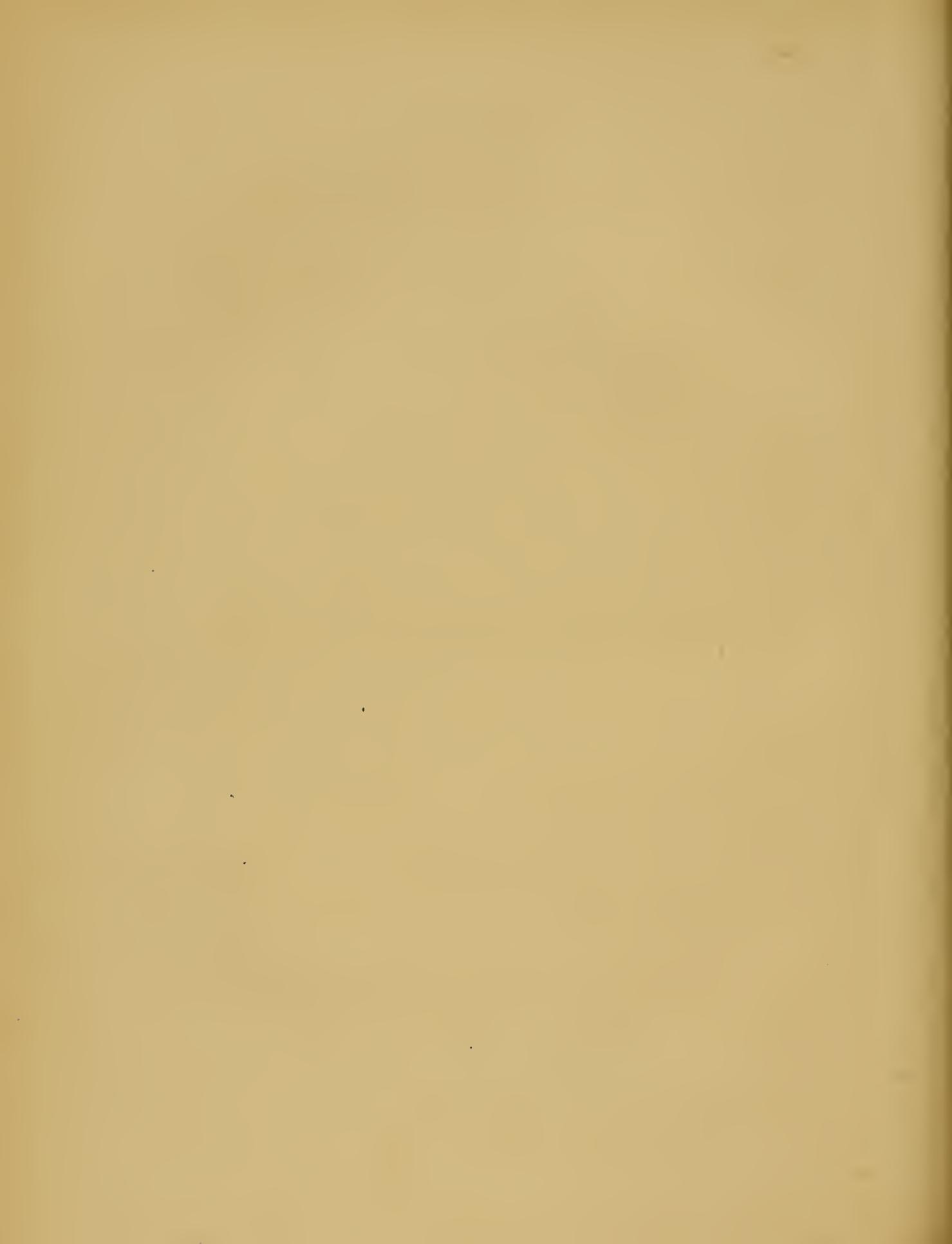
§ 2. SERTULARIA ABIETINA—*The Fir Sertularia*.—PLATES XXIII. XXIV. XXV.—Perhaps no animal product is exempt from individual distinctions, if those which are inscribed as the nearest kindred exhibit peculiarities. When such peculiarities are decisive in several, they constitute a species; and where some common features apply to several species, they are united as a genus. It is only by examining a number of specimens that the facts are discovered; but much difference of opinion must ever subsist as to what distinctions are sufficient to establish either genus or species; and it is not to be denied that superficial views have misled many naturalists. The presence or absence of an organ, the position and number of the various parts, their supposed use, their transience or permanence, have been all leading guides. Varieties are determined from the fainter differences.

The *Sertularia abietina* is thus named from its resemblance to some kind of fir, in conformity with the practice of comparing objects less known to those more familiar.

It rises nine or ten inches high, by a slightly waving stem, with branches diverging from each side in alternate arrangement, so that the extreme expansion of the product is about three inches, somewhat above the root. The branches shorten upwards, in proportion to their height on the stem, until only a single alternate cell borders the highest. The sides of the whole stem from the root to the summit, and of all the branches from the origin to their extremity, are clothed with a row of cells, also in alternate



Asplenium adnigrum



arrangement. This peculiar arrangement is the true formation of the adult, though the cells sometimes appear nearly in pairs. About 45 cells are on each side of the longest branch, and one on each side of the shortest. The branches issue from the convexities of the stem. An elegant recurvature, as of an ostrich feather, distinguishes this product, which is to be ranked among the larger flexible zoophytes. As all the parts diverge in the same plane, a specimen such as described might be sunk in the thickness of ordinary pasteboard.—Plate XXIII.

The cells, which are ventricose, or swelling in the middle, are inhabited by a grey or white hydra, protruding a long cylindrical neck and head, with about 24 muricate tentacula. These tentacula appearing to the eye a little enlarged, like so many rows of beads, environ a hemispherical central pouch. The hydra is quick and active, but not readily obtained alive. At least the proportion has been small amidst a number of specimens.

The species occurs in considerable profusion in the sea, at the depth of several fathoms, commonly rooted on old deserted shells. As if dwelling in society, many specimens are often found in close approximation. Those of larger dimensions are profusely invested by a minute, testaceous animal, the *Spirorbis*, or by another zoophyte, the *Cellaria*, or *Crisia eburnea*.

Recent living specimens are universally of a yellowish colour—honey-yellow; others, like many marine productions, have acquired an unnatural reddish hue.*

Naturalists understand the figure of the ovarian vesicle as a specific character of the Sertulariæ; but this opinion must be received under modifications sometimes perplexing, and yet insufficiently explained.

Vesicles are either simple or compound, that is, consisting of a single pod, with its contents, affixed immediately to the specimen, or of one more complex, being a pod sustained by an intermediate organization.

* The nomenclature of colours employed here is from a work on that subject by the late Mr Peter Syme, an accomplished artist, founded on one by *Werner*. Many drawings were executed for me by that artist.

Numerous simple and compound vesicles are crowded together on the branches of the *Sertularia abietina*. The former are ovoidal, like those of certain other *Sertulariæ*.—Plate XXIV. fig. 19; XXV. fig. 1. The latter consist of a hollow spherule, with an elevated vertex, sustained on a ventricose pedestal, considerably smaller, this pedestal bearing some resemblance to the ovoids. Eight or ten such compound vesicles, close in a row, may be compared to apples on the branch of a prolific tree.—Plate XXV. figs. 2, 3; Plate XXIV. fig. 3.

The same specimen sometimes bears both the simple and the compound vesicles.

Each kind of vesicle contains a single, vivid yellow corpusculum, in as far as I have been able to ascertain.

To determine the nature of the corpusculum, two branches, each with numerous compound vesicles, were suspended in a tall glass cylinder on the 1st of May. Eighteen planulæ could be enumerated at the bottom on the 10th of that month. These seemed nearly half a line long, round, one extremity obtuse, the rest tapering almost to a point, the surface smooth and uniform, of a beautiful vivid yellow colour. Altogether, this subject resembled a minute pear.—Plate XXIV. fig. 4, *a, b, c*: enlarged, A, B, C.

Some were observed on the side of the vessel. Their peculiar shape and evident solidity seemed unfavourable to ascent.

Another portion of the same *Sertularia* had been consigned to a vessel wide and shallow, so as to be accessible to the microscope—always a necessary precaution when intermeddling with diminutive objects. Here two or three similar planulæ appeared also, on the 10th of May, and on the 12th other two or three. Small yellow spots were seen besides. On May 13, three nascent *Sertulariæ*, all yellow, could be recognised; one rising as the prominence of a flattened spherule; a short spine issued from another: and from the third spot a spinous prolongation shot up about two lines, with the summit slightly enlarged. Towards next evening this enlargement was forking off nearly at right angles to the prolongation now seen to be a stem, which rose still higher, and it was evidently acquiring the figure of a cell. At this time the summit of the stem was likewise

swelling slightly, which augured similar configuration as the other.—Pl. XXIV. figs. 5, 6 ; fig. 7, enlarged.

The root, also, was losing its density. At first an opaque, flattened spherule, it becomes a thinner spot : ramifications diffuse within its circuit, very conspicuous in early stages, but growing daily fainter and less distinct, until disappearing in attenuation. On May 15, the under surface of the spot had broke into five ramified processes, which I can scarcely compare to radicles, some of them apparently preparing subdivisions, all deep yellow, darker towards the centre, and paler towards the extremities, these being still bounded by a circular outline, fig. 8, enlarged.

The nascent specimen, fig. 7, had acquired a second cell on May 15, a third on the 22d, and soon afterwards a fourth. Many stems had two, and a few had three ; but this specimen vegetated no farther.—Figs. 9, 10, 11, 12. Natural size, and enlarged.

Recurring to the tall glass jar, wherein eighteen planulæ were enumerated upon the bottom, on May 10, all were motionless on the 14th, though next day five or six still showed symptoms of animation. On this day, also, some bright yellow spots, each with a central spine, appeared just about the place the planulæ had occupied ; but none could be discovered on the side of the vessel.

Being less versant then, in the history of Zoophytes, from practical observation, the relation between the living planulæ, endowed with voluntary motion, and the stationary spots substituted for them, were to me very perplexing.

All the spots with a central spinous process were affixed to the bottom of the vessel ; but my perplexities were aggravated by next day observing a short spine shooting from the summit of several of the compound vesicles on the suspended branches.

Under the microscope, these spinous processes corresponded with the subjects of previous observation. Nothing farther was seen but the vascular pedestal, bearing the spherule, whence the yellow spine issued, which was not evidently connected with either the pedestal or the branch.—Pl. XXIV. figs. 13, 14 ; spherule, *a* ; pedestal, *b*, enlarged.

Besides these globules, from which a spinous process issued, a stalk

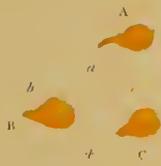
with two buds protruded from each of other two globules still suspended. The evolution of their hydræ ensued on May 21, when favourable microscopical observations ascertained, that the animals, of a grey colour, were each provided with about 25 deeply muricate, almost moniliform tentacula. They were of lively nature, enjoying the element, and seeking a safe retreat in their cells. It was easy to identify them with the hydræ of the adult product, which had borne the vesicles.

At this early stage, the real structure of the *Sertularia* afterwards disguised by supervening opacity, is admirably exposed: And here is shown, in an especial manner, the great advantage of examining living beings under every aspect. The stalk issues visibly through an aperture in the summit of the spherule. Its dark yellow pith is clearly followed upwards through the transparent tubular stem, until dilating above into the young hydræ, while the extremity of the tube itself is enlarged into cells, sufficiently capacious for their tenants.—Fig. 15. The spherule yet rests on its pedestal, though here intercepted from view.

The cells are generated simply by prolongation of the tube, and they stand in alternate arrangement, diverging to right and left in the same plane. But this prolongation is dependent on the vigour of the pith, for its presence is the indication of vitality. The evolution of the hydræ, in relation to each other, is successive. Thus the lowest flourishes first, and next that above it. As the cell seems derived entirely from the tube, so does the hydra seem to originate exclusively from the pith. The cell, once formed, does not depend on the subsisting of the hydra, at least in this species of zoophytes, but in some of the *campanulate* (Sertularian) zoophytes, the cell is not permanent.

The prolongation of the stem of the *Sertularia abietina*, is always in proportion to the successive generation of cells. One bearing only two, is of about equal length to three cells and a half. Deviations from regular arrangement frequently occur among nascent Sertulariæ.

Many young specimens had now two hydræ, with their cells, on May 24. An embryo, still immature, darkens a third cell, during the growth of this *Sertularia*, fig. 16. One had three hydræ, May 25, which continued in beautiful display until June 27, fig. 17; only a single specimen ac-





quired four. Its progress is shown in figures 5, 6–9, 11, somewhat exceeding the natural size, and the three latter figures, 7, 10, 12, enlarged. This same specimen had three cells on May 22, and next day four; and so it continued until July 25, when delineated; but decay prevented maturity of the fourth.

During observations protracted for several weeks on all the nascent Sertulariæ, fewer and fewer hydræ protruded from their cells, and this chiefly in proportion to the lapse of time from their origin. Several appeared on July 18; in another week only one, though the cells apparently still contained living inmates. Sometimes these creatures, and indeed the tenants of all Sertulariæ, persist in long retreat. When induced to issue forth by renovation of the limpid element, they speedily retire to their respective dwellings, after a transient display.

It is obvious, therefore, that two differently formed vesicles are borne by the *Sertularia abietina*, a fact also incident to a few other Sertulariæ. The precise nature of the pedestal I have been unable to ascertain; but circumstances infer that it may be possibly an ampullate or flask-shaped vesicle originally, whereon the other spherule is generated. Specimens have occurred with vesicles resembling the ordinary ampullate vesicle of the *Sertularia* or *Plumularia falcata*, and scarcely in less profusion, though of inferior fecundity. About 26 or 27, almost in a double row, with contents nearly white, were crowded towards the side of a branch not an inch in length.—Plate XXV. fig. 1.

Other specimens of the same group bore a compound vesicle, with a pedestal as those above described, the spherule containing a single yellow globular corpusculum, the pedestal vascular as before.—Plate XXV. figs. 2, 3. Planulæ of a fine saffron yellow issued from the spherules, about half a line long, the head obtuse, and the tail pointed, but not alike pyriform until beginning to contract, when some resemblance to those already represented ensued.—Fig. 4.

Here the reader should be apprized that great diversity occurs in the shape of the same planulæ, from whatever zoophyte they come. Nothing can be more variable than their soft, extensile, and contractile bodies, in motion or at rest: and according to the freshness of their element or the

temperature of the atmosphere,—and especially when about to undergo the metamorphosis incident to their race.

One planula, fig. 4, having become quiescent, a spine rose from it, which being sufficiently prolonged, exhibited two buds, almost mature, on May 1. The planulae of the same brood were only advancing in the vesicles on the 19th of April.

The evolution of the nascent Sertulariæ, from vesicles *in situ*, is a rare occurrence. We have seen that, from some unnatural retention in the cysts of the Tubulariæ, the organs of the young may begin to unfold. This may tend to corroborate and explain a figure given by Ellis, representing a hydra issuing from a vesicle of the *Sertularia pumila*. But it is to be noted also, that examples are not wanting of portions of the Sertulariæ vegetating through an empty vesicle, with a generated or regenerated hydra. I can account for it only from the sudden metamorphosis frequently rendering the planula motionless, and thus precluding its escape from the vesicle. But although this may ensue in the *Sertularia abietina*, the discharge of the planula from the vesicle, to undergo its metamorphosis unrestrained, is the ordinary and natural course whereby the species is perpetuated.

It is doubtful whether the vesicle is a permanent part of the organization in any of the mature prolific Sertulariæ. Here the foundation of the compound vesicle, Pl. XXIV. figs. 3, 13, 14, *b*, becomes more and more unstable, until at length its adherence to the branch appears to be preserved only through the medium of adventitious matter. Did the nascent Sertularia originate regularly in the vesicle, while subsisting, and were it still retained there during the fall, its fixture would be intercepted from some more solid foundation below, which could not but prove injurious. Therefore, evolution of the hydra within the spherule of the compound vesicle seems the result of unnatural retention.

Young hydræ have survived about a month. The *Sertularia abietina* is not uncommon, but such specimens as that represented are rare. Some consist of a greater number of subordinate parts.

PLATE XXIII. *Sertularia abietina*.PLATE XXIV. *Sertularia abietina*.

FIG. 1. General arrangement of the parts.

2. Cells and hydræ of an adult, enlarged.
3. Compound vesicles, *in situ*. Spherules containing yellow corpusculæ, *a*; vascular pedestal sustaining the spherules, *b*, enlarged.
4. Planulæ from the spherules, *a*, *b*, *c*; enlarged, A, B, C.
5. Nascent *Sertularia*, with the first cell advancing.
6. Nascent *Sertularia* with two cells.
7. The same, enlarged.
8. Root of a nascent *Sertularia*, enlarged.
9. Nascent *Sertularia*, with three cells.
10. The same, enlarged.
11. Nascent *Sertularia* with four cells.
12. The same, enlarged.
13. Nascent *Sertularia*. The rising spine shoots through the summit of the spherule of a compound vesicle, *a*, on its pedestal, *b*, enlarged.
14. Another of similar description.
15. Nascent *Sertularia*, with two hydræ, the stem having shot up from within the compound vesicle, *a*, enlarged.
16. Another, farther advanced, enlarged.
17. Another, still farther advanced, having three hydræ, enlarged.
18. Arrangement of the cells, enlarged.
19. Prolific *simple* vesicles, enlarged.

PLATE XXV. FIGS. 1-5. *Sertularia abietina*—details.

FIG. 1. Branch with ordinary ampullate or flask-shaped vesicles; enlarged.

2. Branch bearing compound vesicles.
3. The same, enlarged.
4. Planulæ from these compound vesicles, enlarged.
5. Planula metamorphosing; now a spherical segment with a central spine, enlarged.

§ 3. SERTULARIA ABIETINULA—*Diminutive Sea-Fir*.—PLATE XXV. figs. 6-13.—The narrow resemblance of this to the preceding species is such, that it might be almost supposed the same in an early stage, or a variety in miniature. But I have been unable to identify the two;

nor can I identify the present subject as the *Sertularia flicula*, or any other yet described. Therefore the appellation it now receives must prove either provisional or permanent, according as future observation shall determine.

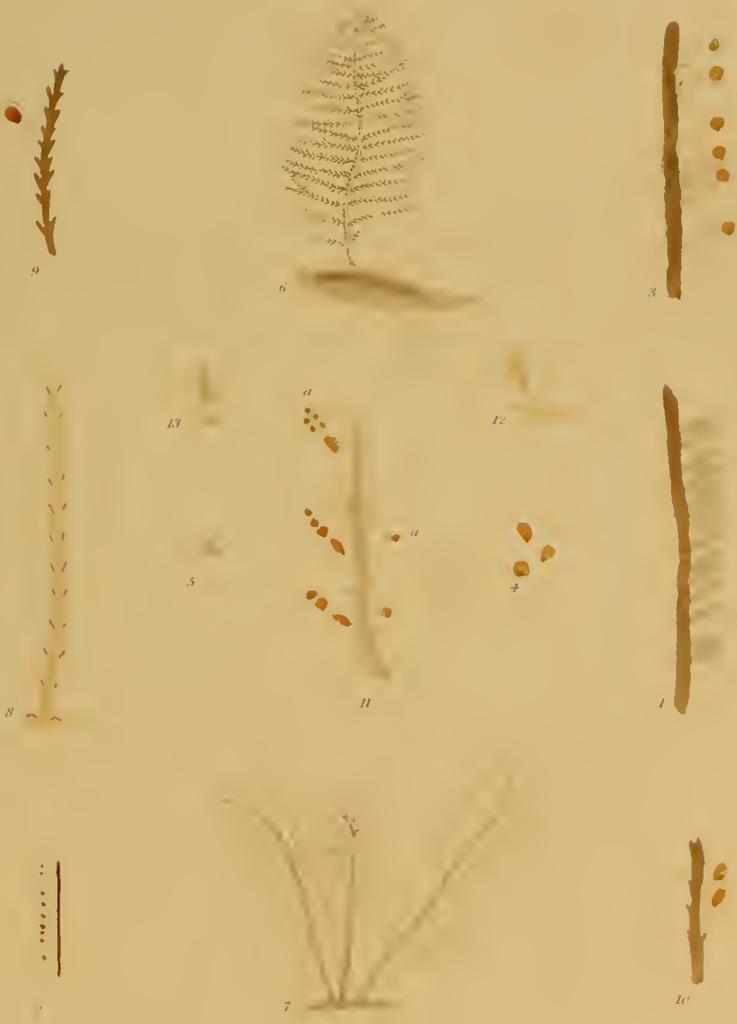
The shades of distinction separating some of the zoophytes are small ; their own formation is variable and indefinite, and they are in so many varieties, that very erroneous conclusions may lead us to diversify species, while the subjects passing through slight discrepancy of structure shall at length merge in one.

The *Sertularia abietinula* generally appears from one to two, or perhaps three inches high. Branches originate near the root, diverging and diminishing after the fashion of the former, and, like it, they are provided with few subordinate parts.—Plate XXV. figs. 6, 7. The whole are bordered by low denticles or cells, nearly in pairs, from which hydræ, with about 18 tentacula, are displayed. Branch enlarged, fig. 8.

Irregular articulations subdivide the inorganic parts, comprehending five or six pair, or sometimes only a single pair of cells. The contraction of the stem at the articulation, under the pair of cells where it is formed, is considerable.

For the most part, simple ampullate vesicles are dispersed over the branches, wherein the elements of the progeny are generated. These are seen as a bright yellow corpusculum of irregular form.—Plate XXV. figs. 9, 10.

When a specimen had been a few days in my possession, the vesicles under that aspect discharged their whole contents, perhaps prematurely, which now exactly resembled, in all respects, what is above described of the premature discharge from the vesicles of the *Sertularia polyzonias*. A transparent gelatinous mass remained adhering to the orifice of the vesicle, among which, instead of a single object as I had previously supposed, there appeared from one to six vivid yellow corpuscula, still of somewhat irregular form. The substance wherein they were imbedded was scarcely perceptible ; and, indeed, at one particular place, unless for the vicinity of the yellow corpuscula to the branch bearing the vesicle, the connection of the jelly with its mouth could not be known.—Fig. 11, *a*.



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None of the corpuscula proved to be spherical or of regular shape, under the microscope. But when viewed within the vesicle, the contents then appearing a single irregular corpusculum, may present that character, from the compression of several together.

Exact uniformity did not prevail in the vesicles of fig. 7. One had a kind of short spinous prolongation, fig. 12. In other specimens there was no sensible distinction, fig. 13.

This product usually occurs on old empty shells. I do not recollect to have found it on other substances.

Certain desiderata yet remain to render its history explicit.

PLATE XXV. FIG. 6. *Sertularia abietinula*.

7. Group on a shell.
8. Branch of fig. 7, enlarged.
9. Vesicle on a branch of fig. 6, enlarged.
10. Prolific vesicle.
11. Vesicles discharging yellow corpuscula amidst albuminous matter, enlarged.
12. Vesicle of fig. 7, enlarged.
13. Vesicle of fig. 7.

§ 4. SERTULARIA ROSACEA—*Lily Coralline*.—PLATE XXVI. FIGS. 1-13.
—This is a delicate product, generally pure white, or of the faintest grey colour: it rises two inches, or somewhat more, in height, by a stem perpendicular, or slightly recurved, from which boughs diverge, either in the same plane, or from around the circumference. Sometimes these are at right angles to the stem. Subordinate parts are few.—Plate XXVI. Figs. 1, 2. Articulations are seen at irregular and distant intervals, but only in decaying specimens; for they are inconspicuous in those which are vigorous, and the parts occupied by the pith.

The whole stem, together with all the subordinate parts, are clothed with long wide cells, disposed in pairs; and all the extremities terminate in a similar pair, mature or elementary, fig. 3. The cells incline outwards.

Many have a slight curve or elbow in the middle; and the orifice is generally oblique.

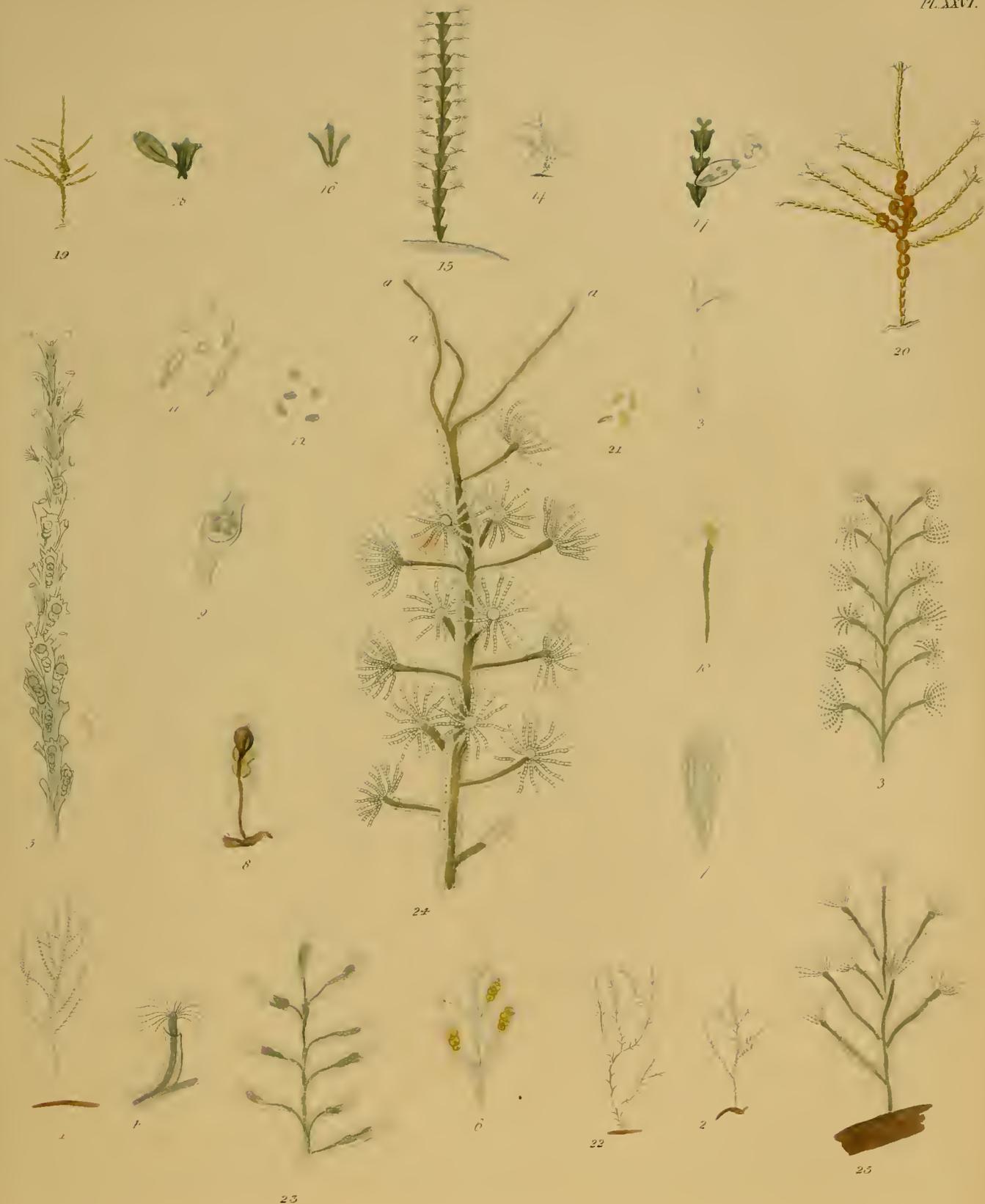
The hydra is light grey, provided with about 22 muricate tentacula, surrounding the low closed orifice of the central pouch. It is very lively, protruding a long and slightly tapering neck far beyond the mouth of its cell, which is extremely transparent, and it retreats suddenly within.—Fig. 4.

While in vigour, numerous hydræ, in all their vivacity, fringe the branches of this product; but their existence is brief in confinement; and when internal decay has consumed the pith, along with the living tenants of the cells, only a diaphanous skeleton is left behind.

Large and peculiar vesicles, alike difficult to be described and represented, are borne by the *Sertularia rosacea*, without any regular distribution. In some places they are single, elsewhere rather in pairs, or sometimes several in a line are crowded together; and they are interspersed with living hydræ on the same portion of the specimen, fig. 5. Their transparency is extreme, for they are scarcely visible by the microscope. All are fashioned somewhat like a tall vase, ribbed longitudinally by lines a little darker than the sides. Each enlarges upwards from its origin, and near the summit contracts by a mucronate smaller orifice, formed of points, shaped very differently in different specimens.—Figs. 7, 8, 9, 10.

Prolific vesicles occur in the summer months, May, June, and July, when they contain three or four white or yellow spherules above, towards the widest part, and sometimes appear sustained on a pillar within, fig. 9. The spherules unfold as a diminutive planula, not exceeding the fourth of a line in length, which issues from the orifice of the vesicle. These creatures are occasionally seen traversing their prison as they approach maturity, apparently seeking an exit, which is precluded by an invisible barrier. Having departed, they prove, like others, of variable form, move, become stationary, distorted, and undergo the wonted metamorphosis.—Figs. 11, 12.

The planulæ, from specimens obtained on May 1, had all metamorphosed to different stages on the 11th. Some consisted of a stem with a



Miscellaneous Lophytes.

long clavate summit. Others had two buds under a common involucre. Two days later one had a hydra with 15 tentacula, and two buds preparing above it.—Fig. 13.

In these young specimens, although the pith seems confined within its own peculiar channel, a wider cortical covering apparently forms the stem around it.

This product usually occurs as a parasite on other zoophytes; and it is often involved by the *Spongia coalita*, spreading rapid destruction around the precincts of its vegetation.

PLATE XXVI.

FIG. 1. *Sertularia Rosacea*.

2. Prolific specimen.
3. Branch with hydræ.
4. Hydra and cell.
5. Branch with hydræ and vesicles.
6. Section with hydræ and vesicles.
- 7-10. Vesicles full and empty.
11. Planulæ from the vesicles.
12. Planulæ from the vesicles.
13. Nascent *Sertularia* bred from a planula.

All the preceding figures, unless figs. 1, 2, enlarged.

§ 5. SERTULARIA PUMILA, *Sea Oak Coralline*.—PLATE XXVI. FIGS. 14-21.—This diminutive product occurs in considerable abundance as a parasite on some of the marine fuci; likewise it grows on rocks and stones. The *Fucus serratus* is most profusely invested by such quantities as almost to weigh down the leaves, when nearest to ebb tide.

Larger specimens rise an inch high, by an erect stem, from which a few boughs and branches, in the same plane, issue almost at right angles to their principal part. The whole is of greenish colour, and generally of rather a meagre aspect.—Pl. XXVI. figs. 14, 19. All the parts are bordered by a row of cells, which are arranged in pairs. Each pair forms a division or articulation, somewhat heart-shaped.—Fig. 16, enlarged. The

orifice of the cell opens simply from it, without any tubular prolongation. A white hydra, with about 19, and sometimes a greater number of tentacula, deeply muricate, protrudes its long neck from the cell.—Fig. 15.

Two kinds of vesicles have been observed on this *Sertularia*,—the one ovoidal, fig. 18,—having expelled its abortive contents; the other globular, fig. 20. The contents of the ovoidal vesicles are white or yellow. Some faint yellow planulæ have issued from the former, on the first of August, which offered nothing remarkable.—Fig. 21. The contents of the globular vesicles are yellow. No semblance of circulation could be discovered in the hydra.

A powerful vegetative faculty resides in the stem, insomuch that a prolongation, shooting down from a section, has been rooted in a night.

Much irregularity pervades this species, of which different specimens exhibit varied aspects, in the number and dimensions of the parts, as well as in the number and distribution of the vesicles. Sometimes one or two of the latter appear at a remote interval: sometimes several are closely huddled together, on or about the stem.

The facility of obtaining the product, however, renders it a convenient subject for observation.

PLATE XXVI.

FIG. 14. *Sertularia pumila*.

15. Specimen with cells and hydræ, enlarged.
16. Articulation consisting of two cells.
17. Ovoidal vesicle discharging its abortive contents.
18. Empty ovoidal vesicle on an articulation.
19. Specimen with globular yellow vesicles.
20. The same, enlarged.
21. Planulæ from ovoidal vesicles.

All the figures except 14. and 19. are enlarged.

§ 6. SERTULARIA HALECINA and Cognates—*Herring Bone Coralline*.
 PLATES XXVII. XXVIII. XXIX. XXX.—It appears to be very obscure what is the true *Sertularia halecina* specified in the Linnæan *Systema*



Portulacis Halimifera.



Naturæ, or in other systems ; or whether authors have in fact identified any one of such peculiar formation as to be exclusively thus denominated.

The figure given by Ellis, Plate X. *a*, N. 15, as the *Sertularia halecina*, is certainly from an indifferent drawing of what is named *Thoa Beanii* in Dr Johnston's useful work, Plate VI.

Thus the description and concomitant figure by Ellis do not distinguish any species recognized as the *Sertularia halecina* exclusively.

But there are several reasons for assuming that this species is seen under considerable modification, which has induced naturalists to establish as others, what may be perhaps only varieties. Some of these are certainly cognates—children of the same family.

Whatever may be the real critical distinctions among them, many interesting facts are disclosed by perfect specimens falling under observation. Therefore, while abstaining from all further controversy on the point, which can be of little importance to most readers, I shall speak only of a few individual corallines by this general name, which have occurred from time to time in the course of my investigations into the nature of zoophytes.

1. Among several specimens obtained on the last of December, one arose four inches high by a brownish stem, composed of aggregated tubuli, with large boughs diverging to right and left, each of which might be circumscribed by an isosceles triangle. This peculiar formation distinguished the other specimens, as it does also those consisting merely of a stem with diverging boughs, void of farther subordinate parts. All the boughs stood at an acute angle with the stem ; likewise the branches with the boughs ; and still more conspicuously the numerous twigs on each side of the branches,—the whole of these parts being in alternate arrangement. The prevalent colour of this specimen was greenish. Some very slender and diminutive, apparently mature white parts, are frequently seen on specimens, which seem neither spurious nor parasites. Though the stem be compound, the more remote organization, in as far as sensible, resolves into simple tubes.—Plate XXVII.

Hydræ of the wonted form, with 18, 20, or 22 muricate tentacula

issued from tubular cells, at the end of the twigs, which were encircled by a succession of ruffs or frills at intervals.

All the preceding specimens were laden with vesicles.

The common features of the product seem a compound stem of tubuli; subordinate parts in alternate arrangement rising at an acute angle with the principal parts; hydræ issuing from tubular cells terminating twigs distinguished by successive frills. It has always appeared doubtful, after innumerable observations, whether the hydra, being once extruded from the tubular extremity of the twig, preserves the faculty of again retreating completely within.

During earlier stages the stem is waved, and then, as in new accessions, the subordinate parts rise from the salient angles.

The discrepant aspect of different specimens is so great, as to occasion much embarrassment in determining the identity of species, or of concluding them varieties.

In endeavouring to explain the formation of this *Sertularia*, it must be observed, that the succession of ruffs or frills seen in the finest specimens, is not to be held as a definite character, especially if assumed as of a precise number. The hydra appears to be regenerated more than once from the same twig, and it is probable that each regeneration is accompanied by a circular enlargement, as a frill, of the orifice of the cell. Certain parts of a small specimen having been vacant of hydræ on the 5th of April, had generated about a dozen on the 12th, besides others advancing.—Plate XXX. fig. 8, enlarged.

Under favourable circumstances, the progress of such hydræ is well exposed through the wide transparent sheath inclosing the pith, fig. 9, where the head appears like a compact, solid substance at the extremity; then altering its shape gradually, until completely displayed, fig. 10. It is now discovered that the pith issues from the branch, and that the orifice of the first cell is under the disc of the hydra. If there was one from each cell previously in fig. 10, the hydra must have been close to the branch. The nature of such frilled intervals is also very explicit from Plate XXIX. fig. 2.



Scortularia Halecina?



New shoots originate from the most unlikely places. Thus a specimen above two inches high, quite vacant of hydræ, bore two minute sprigs with hydræ, the longest rising but a line and a half, all of vivid green.—Plate XXX. fig. 11, enlarged.

Where vigorous hydræ already subsist, the regeneration of others advances in their vicinity—the clear and transparent sheath showing their progressive evolution. Nothing can be more interesting than to witness the rapid refinement of an embryo hydra into perfect configuration, and the display of the organic parts actually completed under the observer's eye. My notice having been directed to a specimen wherein, from the highest of three frills, a dark green globular mass rose prominent as an acorn in the cup: in an hour it became somewhat clavate, while turned slightly aside, still enlarging without any indications of tentacula. But in another hour these organs became perceptible, through a very delicate transparent involucre protecting the mass. The head had now protruded almost entirely from the frill, and the extremities of the tentacula separating, having improved the symmetry of the parts, they were gradually and at length freely unfolded two hours afterwards in their due proportions. The new head of the finest green was perhaps the fourth which the twig sustaining it had borne in succession.

The hydra seems to develope as an enlargement of the summit of the internal pith, and bursts an integument on attaining perfection. Probably the budding Sertularia, like the budding Tubularia, is always thus invested, though extreme tenuity, added to the intimate application of the parts, may conceal its presence. In the Tubularia it is more conspicuous. Nature is careful to protect the tender organs of her originating productions, with an external covering suitable to their condition.

The extent of reproduction is indefinite; but presuming that successive frills indicate new evolution, it occurs no less than six or seven times. Specimens with three or four such as Plate XXIX. fig. 2 are frequent.

A vigorous reproductive faculty resides in the *Sertularia halecina* and its cognates, which is often displayed in another form, by vegetation from the extremities of sections. These coming in contact with a solid surface have a tendency to adhere, and to extend in irregular prolongations, sur-

passing the natural increment. They are then pale, and bear some short spinous twigs at distant intervals, from whence hydræ are generated.

Propagation.—There is no absolute uniformity in the size, shape, or colour of the vesicles borne by what I consider the type of the *Sertularia halecina*, if this distinction shall be allowed.

All the preceding specimens, of December 31 [p. 163], were laden with vesicles, Plate XXVII.; and what is now to be remarked in regard to them, has been also witnessed in many others.

The vesicles were of diverse characters, even of irregular shape; gibbous, or with a hump on the green parts of the *Sertularia*, Plate XXIX. figs. 3, 4; likewise grey ovoidal vesicles on the grey parts, fig. 5. But some green specimens have both gibbous and ovoidal vesicles, as figs. 7, 8. The vesicles shewn on fig. 6, were borne along with ovoidal vesicles; and the grey parts bore such as resembled figs. 9, 10, on the same branch.

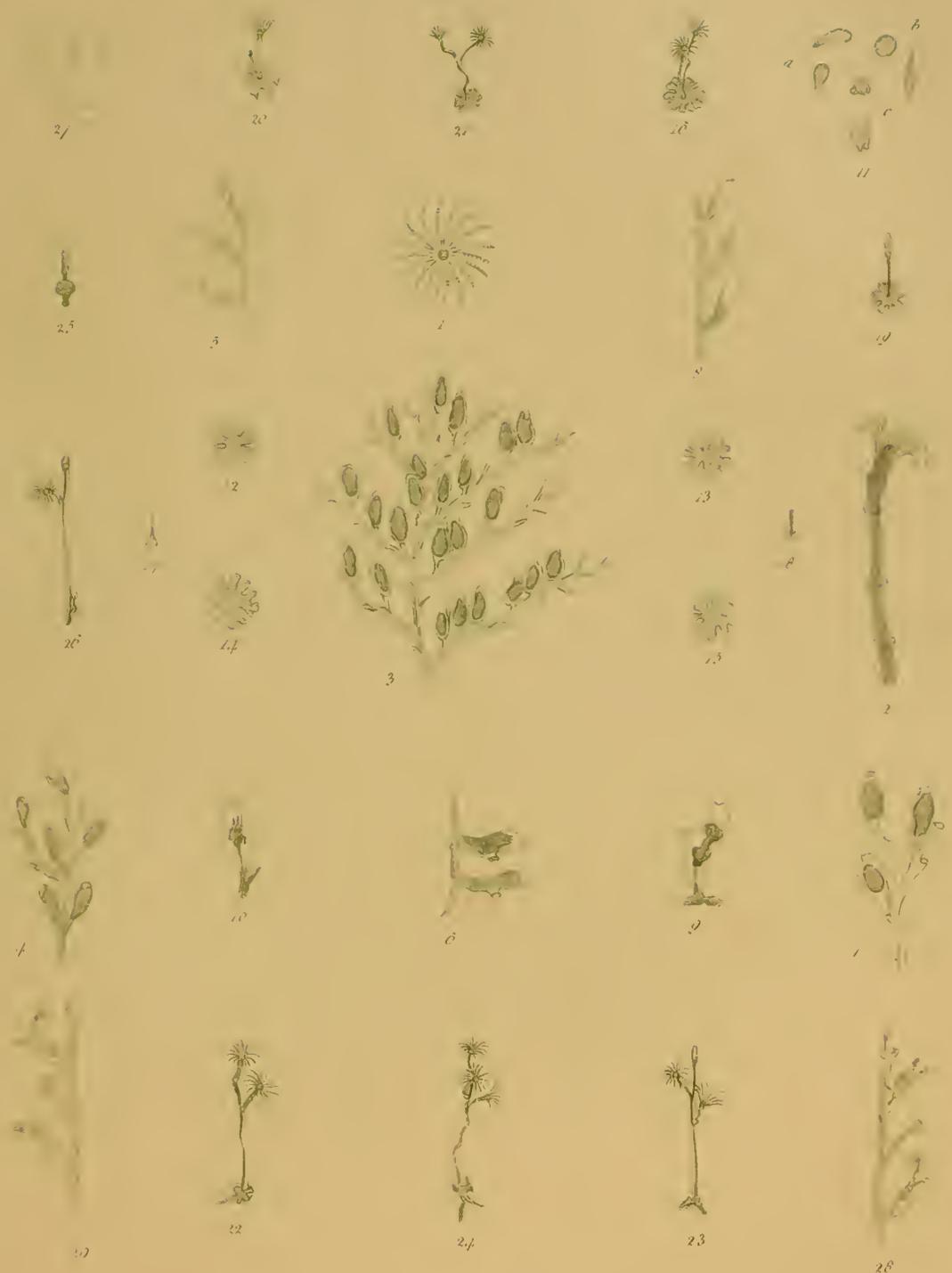
The different figure of these vesicles is seen still more distinctly in delineations of them, from green specimens of the *Halecina* and its cognates.—Pl. XXX. fig. 1; Pl. XXXI. figs. 4, 5, 7. The orifice of the one is in the hump; of the other in the extremity.

It is obvious, therefore, that vesicles of different formation are borne by the *Sertularia halecina*.

The vesicles of some specimens are green exclusively.—Pl. XXVII. Of others they are exclusively yellow.—Pl. XXVIII. fig. 1. The grey parts bear white vesicles.

As usual, the vesicle is the matrix wherein several planulæ, from whence its colour is derived, are brought to maturity; their numbers are commonly two, three, or four, in each.

The specimen, Pl. XXVII., produced both green and white planulæ, undistinguished by any features to render them remarkable. Many of the green were crawling in a smaller vessel, *a*, on the 13th of January, from which I shifted the specimen next day, to a wide shallow vessel, *b*. Many also appeared in the latter, on the 17th; and they had augmented to above 100 on the 18th, all pale green. A group, on the 20th, consisted of the planulæ, in every stage of animation and incipient metamorphosis, Pl. XXIX. fig. 11: the natural form being *a*, *b*, *c*; two others were contracting, and



Conularia tuberosa

a short spine rising from a third. The same vessel likewise contained an irregular substance, rather larger than a contracted planula, from which several spines were issuing next day, and which proved to have been originally some combination of the elements of young Sertulariæ.

On January 13, many planulæ, discharged from the vesicles of this specimen, Pl. XXVII., were crawling in the vessel *a*, above referred to from which this specimen was removed next day. All the planulæ were converted to roots with spines on the 20th, the latter unequally advanced, some being scarcely perceptible. It then appeared to me that the spine was prolonged from the smaller extremity of the planula. The diffusing root spreads with considerable regularity where only a single planula undergoes its metamorphosis, Pl. XXIX. figs. 12, 13, 14, 15; but it is somewhat irregular where more than one are in approximation, as fig. 16.

The nascent product was variously advanced on the 24th,—such as a spine with a root not yet diffused, fig. 17; or crowned by a growing bud, fig. 18; enlarged, fig. 19. There were also two rising from a root diffused irregularly, as above, in fig. 16; together with a hydra, and a bud from another, fig. 26; and one specimen with two hydræ, fig. 21. The hydræ of fig. 16, had each 18 tentacula; the front of one of them enlarged, fig. 1. It is unnecessary to say more of the brood in the small vessel receiving the specimen.—Pl. XXVII. originally.

This same specimen was transferred to a larger vessel, *b*, on January 14, wherein many planulæ appeared on the 17th, as above said. Having undergone their metamorphosis, a number of nascent Sertulariæ had two hydræ flourishing on the 31st of the month, or two and a bud: and one, the farthest advanced, had three. Therefore, the specimen with three, had reached this stage of maturity, from the planular state, in about a fortnight.—Pl. XXIX. figs. 22, 23, 24.

Certain anomalies occur among a numerous brood. The regular process of propagation is the discharge of a planula from the vesicle, its consequent activity; the cessation of motion, diffusion of the root, and a spine rising with an enlarged summit, which is next displayed as a hydra. But, sometimes no sensible spine rises above the diffusing root, thence further progress is arrested; and sometimes, though the planulæ be productive.

there is no regular diffusion. The spine rises from a socket, with an irregular extremity, fig. 25; and it advances so as to bear hydræ, by simple prolongation, without diffusion, securing it below.—Fig. 26.

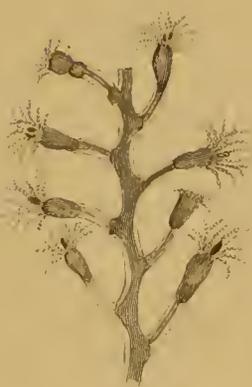
All these facts have been illustrated by a variety of observations made throughout the course of many years, and at different seasons of the year.

No essential distinctions farther than might be expected from the mutable form of soft-bodied animals, are seen among the planulæ.

A specimen with green hump or gibbous vesicles, such as Pl. XXX. fig. 1, produces green planulæ, figs. 2, 3. In all, where the regular process ensues, the root breaks into divisions, fig. 4; with originating stalks and nascent hydræ, figs. 5, 6. Some of these products are less regular, though all with pith, occupying a wide sheath, fig. 7, as previously explained.

But the observer is very liable to be deluded by peculiarities, the same specimen exhibiting hydræ from an orifice scarcely elevated above the branch which bears twigs with frills and hydræ, quite distinct and separate from them. There is also a most conspicuous difference in the form of the vesicle; for some green specimens bear both ovoidal and gibbous vesicles; and grey specimens or green specimens bear both ovoidal vesicles, and such as are of a very different character, as in Plate XXIX. fig. 6, already adverted to. While the green vesicles produce green planulæ, fig. 11, the grey vesicles produce grey planulæ, fig. 27. A few specimens bear a long green prunate or plum-shaped vesicle, which I have never seen in such maturity as to afford any produce.—Plate XXX. fig. 12.

The principal external difference sensible in complete adults is in some bearing green vesicles, as that of Plate XXVII. on the larger parts, and white or very light grey vesicles on the slender white parts, and in some bearing yellow vesicles exclusively, as that of Plate XXVIII. fig. 1. This latter was a fine and prolific specimen, the hydra pale green. The vesicles were in hundreds. Beautiful yellow planulæ issued from them about the middle of May, in such numbers, that, rising on the side of the vessel, their accumulation formed a yellow ring just under the surface of the water, fig. 2. A multitude of Sertulariæ sprung from them, the furthest advanced of which had thrè hydræ and a bud on May 26.



12

10

1



7

8

11

Portularia Halimifolia L.

The profusion of nascent Sertulariæ is sometimes very great. Above 300 were rooted on the bottom of a small vessel in a preceding year, on the 5th of February, from green specimens.

Facts of difficult explanation occur in the history of the *Sertularia halecina*, such as regenerating hydræ shooting up through the empty vesicles, Pl. XXIX. figs. 28, 29. Examples of this occurred in April. Some of the vesicles on specimens were empty; one or two hydræ were displayed from others. These must have issued from the pith of their respective twigs, which had certainly vegetated through the vesicle, from the stem, after its formation, and probably after having discharged its contents. It is not unlikely that some generation or regeneration of this kind may have induced naturalists to credit the developement of hydræ in the vesicle, which, if it does ensue, is only by deviation from the natural course, as signified previously.

2. Among the cognates of the *Sertularia halecina* is one designated by Dr Johnston *Thoa Beanii*. Lamouroux seems to have discarded the *Halecina* from its place among the Sertulariæ; and, if I understand his work, to have constituted a new genus of it named *Thoa*, comprehending two species.

This, the *Thoa Beanii*, rises three inches or more, by a stem composed of aggregated tubuli, together with boughs, branches, and twigs, all like the former, diverging on each side in alternate arrangement, but sometimes irregularly distributed.—Plate XXXI. fig. 1.

The adult is of a brown or olive colour; young specimens are white. The hydra of older specimens is green or greenish; but if the specimen be young it is white, as also from parts newly generated. It has 20, 22, or 24 muricate tentacula, for the number is not uniform; and when the product is in greatest perfection the hydra issues from the extremity of a tubular twig, having from two to seven frills, like those parts recently described. But on the same specimen may be sometimes seen twigs both without frills and with them. They are quite transparent in very small specimens, and always prominent where present.—Plate XXXI. figs. 2, 3. The hydra extends far from the orifice of the tube, when enjoying the freshness of its element, and retreats partially within if annoyed. There is here no proper cell.

The vesicle, in its most decided form, terminates by an ovoidal extremity; and a prominence, with a circular lip, rises from about the middle, or towards the end, fig. 4; living hydræ and prolific vesicles are contemporary on the same specimens, fig. 5. The vesicles of some specimens have chiefly contained four embryos, fig. 6, which, on maturity, as planulæ, seek an exit through the orifice of the circular lip, fig. 7. Having escaped, they traverse their vessel with the swelling head foremost, according to the nature of their race.

But the regularity of their planarian form is gradually impaired as the vigour of motion relaxes, fig. 9. They become quiescent, and a stem rising from above, indicates a nascent Sertularia.

On the 16th of October, specimens of this Sertularia, bearing white vesicles, produced planulæ of the purest white, very minute, the head much enlarged and obtuse. They swam supine, as most others do. The temperature at the time was extraordinary for the season. Others continued issuing from the vesicles, and after several contained in one of these gradually elongating from their globular form, and departing, two of perfect shape remained, which visibly followed through the circular lip, fig. 7, *a*. The orifice was then first discovered to be there, and not in the extremity, *b*, as I had conjectured.

Various white spots were consequent on the escape of the planulæ, the first bearing a hydra on the stem, eight days from the date of their production. The same interval elapsed on a different occasion.

In the course of other observations, specimens with a brown stalk and white vesicles, wherein I thought six embryos could be discovered, were set apart on September 30—the vesicles being of the preceding peculiar formation. Numerous planulæ appeared in the vessel in 48 hours, and several spines rising from circular spots on the bottom. Many nascent Sertulariæ, each consisting of a single hydra, were flourishing on the 5th of October. Thus, only six days had sufficed to bring them to maturity, computing from the discharge of the planulæ from the vesicle.

Numbers of planulæ were produced on this occasion, all pure white, of fleshy aspect, and not a third or a fourth of a line in length. They swam supine, and when dying without metamorphosis, they decomposed into granulated matter, such as follows the death of the planaria proper.

In respect of time, the progress of metamorphosis seems irregular, nor am I aware of any precise rules by which it is governed. Sometimes the circular spot speedily follows the departure of the planula from its prison. About 50 planulæ appeared on the bottom of a vessel with vesicles on the 4th of November. All these had ascended the side next day, and almost as many replaced them below. Numerous circular white spots with spines appeared on the 7th of the month, both on the sides and on the bottom of the vessel.

3. Until some learned naturalist, by the aid of the skeleton, and of living specimens, shall determine the absolute distinctions of the species here assumed as the *Sertularia halecina*, the following remarks are meant as generally applicable to the whole indiscriminately.

All rise from the root by a darker or lighter white, green, or brown stem, which consists in adults of aggregated tubuli. Renovated extremities or recent generations are pale green or white, the rest of the specimen being some hue of the preceding colours. The whole subordinate parts are in alternate arrangement. Originally the twig hardly rises above the larger member sustaining it: and it may remain alike low at a greater age. But it also appears so much prolonged as to exhibit from two to seven frills.

The hydra issues from the highest of these frills; but it is not retractile entirely within the tubular part of the twig. It is greenish or white. Adults, or those of larger and older parts, have from 20 to 24 tentacula.

Hydræ are regenerated from the same twig. A powerful reproductive faculty also generates shoots from the lower extremity of sections containing the elements of hydræ subsequently developing on them.

Numerous green or yellow vesicles of varied form are distributed over specimens. One about 30 lines high, and expanding as much in breadth, was laden by above 400 yellowish vesicles, dispersed over the boughs and branches, with a few up to the very summit on the stem. The yellow of the vesicle in contrast with the green of the other parts, rendered this diminutive product an elegant type of a fruitful tree. The form of the vesicle is much diversified. In some the orifice is at the extremity; in others a circular lip opens from a prominence near the middle.

The colour of the vesicle is derived from its embryonic contents—developing as planulæ, which, expelled from above, crawl away on reaching the bottom of the vessel below.

Prolific vesicles continue discharging planulæ during two or three weeks.

The planula, like that of other species, becomes motionless, and contracting in a circular spot, a spine rises from the centre, at the summit of which a hydra is advancing, while the root, diffusing below, breaks into divisions. This may be very distinctly seen by providing a watch-glass for reception of the planula, and reversing it as the course of metamorphosis proceeds. Sometimes the young *Sertularia* is seen floating inverted, with the root upwards, while in a very early stage, from having been accidentally detached in the commencement of metamorphosis.

The original spine extending as a stem, seems to consist of a single tube, very wide, formed like a skin or sheath, around the internal pith, when we may plainly discover that the extremity from whence the hydra issues has no cellular enlargement.—Pl. XXX. fig. 7.

The hydræ are developed progressively; some being always less advanced. They are displayed originally without any definite number of tentacula, such as may be distinguished as the complement of the race. Either 17, 18, or 20, for the most part belong to them. In fig. 7, as above, which is not so regular as many others, the one hydra had 17, the other 20.

An example occurred of the nascent zoophyte showing three hydræ within nine or ten days of its production, as an active planula, from the vesicle.

Although originating *Sertulariæ* follow the escape of the planulæ, by the natural process, whole colonies disappear without such a result: and they may resolve into the granulated matter above alluded to, concomitant, likewise, on the dissolution of *Planariæ*, or of some other semi-gelatinous animals.

Disturbing the planulæ seems to impair the process of effectual metamorphosis.

Prolific vesicles and living hydræ appear on the same specimen, but



Sertularia (Fors.) Beauv.

the mode whereby the vesicle and its contents are generated is problematical. When vigorous hydræ seem to originate from twigs rising through the centre of vesicles, it might be presumed that the vesicle has originated on the orifice of a twig opening from or sustaining it; or, that the twig sprung up after the contents of the vesicle were discharged.

After preservation for some time, the pith of the extremities exhibits symptoms of decay, which, in descending, impairs the reproductive faculty.

The hydræ are very susceptible of external impressions. I have observed the whole of a specimen, amounting to an hundred, with the tentacula closed up of a gloomy morning.

Many circumstances concur in rendering these Sertulariæ, whether varieties or not, favourable for general observation. I doubt not that other naturalists may ultimately show distinctions, which I have been unable to detect among them.

PLATE XXVII. *Sertularia halecina*. Adult specimen with green vesicles.

PLATE XXVIII.—*Sertularia halecina*.

FIG. 1. Adult with yellow vesicles.

2. Yellow planulæ from the vesicles, enlarged.
3. Two nascent Sertulariæ from the planulæ, enlarged.
4. Nascent Sertularia, farther advanced.
5. Nascent Sertularia, still farther advanced, having three hydræ displayed.
6. Nascent Sertularia with three hydræ.
7. Nascent Sertularia with three hydræ and a bud.

All the preceding, except fig. 1, enlarged.

PLATE XXIX. *Sertularia halecina*—details.

FIG. 1. Front of a young hydra, enlarged.

2. Hydra protruding from a twig, with frills.
3. Portion of a specimen with green hump or gibbous vesicles, enlarged.
4. Extremity of a branch with vesicles.
5. Ovoidal grey vesicles.

PLATE XXIX. *Sertularia halecina*—details.

- FIG. 6. Hump or gibbous vesicles, borne along with ovoidal vesicles, on the same specimen.
- 7-8. Vesicles of different figures on the same specimen.
- 9-10. Vesicles borne on the grey parts of a specimen.
11. Planulæ from the green vesicles of the specimen.—Pl. XXVII.
- 12-15. Diffusing root of nascent *Sertulariæ*.
16. Hydræ generated from two planulæ, approximated in their metamorphosis.
17. Spine and root in an early stage.
18. Budding spine and root.
19. The same, more enlarged.
20. Nascent *Sertularia* with a diffusing root.
21. Nascent *Sertularia* with two hydræ.
- 22-24. Young *Sertulariæ* bred from the planula.
25. Spinous projection from each side of a root.
26. *Sertularia* originating from an irregular root.
27. White planulæ from grey vesicles.
28. Regenerated hydræ issuing through vesicles.
29. Regenerated hydræ issuing through vesicles.
- All the preceding figures enlarged.

PLATE XXX. *Sertularia halecina* and cognates.

- FIG. 1. Branch of a green specimen with gibbous vesicles.
- 2, 3. Planulæ from these vesicles.
4. Diffusing root viewed from below.
5. Nascent *Sertularia*, with a hydra and a bud, bred from the planula.
6. Nascent *Sertularia* farther advanced, with two buds.
7. Nascent *Sertularia* from a planula, showing the diffusing root; also the pith within a wide sheath.
8. Specimen which regenerated a number of hydræ.
9. Regenerating hydræ not yet unfolded.
10. Branch of a specimen with hydræ.
11. Regenerated hydræ springing from an old branch.
12. Green prunate vesicles [p. 168].
- Only figs. 5, 6, are of the natural size.

PLATE XXXI.

- FIG. 1. *Sertularia* (Thoa) *Beanii*.
 2. Hydra.
 3. Branch with twigs and frills.
 4. Branch with vesicles.
 5. Hydræ, and prolific vesicle.
 6. Prolific vesicles.
 7. Planulæ about to quit a vesicle by the orifice *a*.
 8. Planula liberated.
 9. Planulæ metamorphosing.

All the figures except fig. 1, enlarged.

§ 7. SERTULARIA MURICATA.—PLATE XXXII.—In a depauperated state, the resemblance of this product to the *Sertularia halecina* is such, that we are prone to number it among the cognates; nor, until the peculiar substances which naturalists have denominated vesicles be proved prolific, do I feel altogether disposed for its exclusion.

The *Sertularia muricata* rises four or five inches high, by a stem composed of aggregated tubuli. Its boughs, branches, and subordinate parts, all diverge from each side of their principals in alternate arrangement.—Plate XXXII. fig. 1. The hydra, provided with about 22 or 24 muricate tentacula, issues from the tubular extremity of a twig distinguished by frills, whither it seems to have only a partial retreat, fig. 2. The stem of the adult specimen is brown; the hydra is green; and the whole product presents quite the character of the *Sertularia halecina* exhibited in Plate XXVII.

Various parts of this zoophyte, in its better state, are invested by peculiarly formed capsules or vesicles, cotemporary with the living hydra, and sometimes in vast profusion. Perhaps they exceed the multitude of the vesicles proper to other Sertulariæ, nor do they seem restricted to any particular part. The stem is often entirely covered by clusters huddled together in confusion.

This inorganic substance, if it be a vesicle, somewhat resembles a flattened filbert, attached by the shortest pedicle to the stem or branches

of the *Sertularia*, fig. 3. Its margin is serrated, or divided into obtuse processes, which also cover the surface, fig. 4. No regularity prevails in the dimensions; large and small vesicles are in close approximation; their colour, apparently derived from the contents, is greenish or yellowish. They are transparent when empty.

Though I have had many specimens at various seasons of the year, which were preserved with every possible care, the opaque vesicles became empty and transparent, without discharging any visible object. All my endeavours, which were not few, to discover the nature of their contents, have been defeated.

At different times I have been induced to question whether these innumerable muricate bodies, thus investing, even totally obscuring, the parts beneath them, are truly vesicles, or whether they are not rather extraneous substances. I conjectured them to be the capsular progeny of some of the Testacea, especially from the almost invariable presence of a minute *solen*, concomitant on that of the vesicle; and which may be seen crawling on the same twig, bearing both vesicles and living hydræ, as well as crawling on the sides of vessels with specimens, and on other parts, fig. 5, *a*, *b*. However, nothing has hitherto verified that conjecture; nor have I heard that the mode of propagation of the *Sertularia muricata* has been determined by observers.

PLATE XXXII. FIG. 1. *Sertularia muricata*.

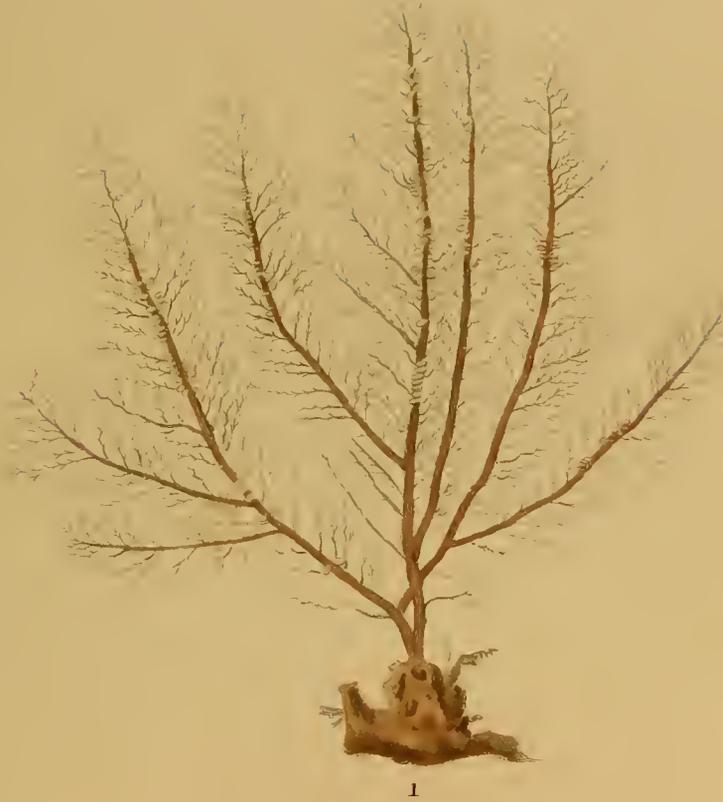
2. Hydra enlarged.

3. Portion with muricate vesicles, enlarged.

4. Vesicle magnified.

5. Portion with a hydra, *a*; and a minute *solen*, *b*, enlarged.

§ 8. SERTULARIA (PLUMULARIA) FALCATA.—*The Sickle Coralline*.—
PLATES XXXIII. XXXIV.—The arrangers of the *Systema*, finding the multiplication of species inconvenient, have endeavoured to rectify it by the strange expedient of erecting some of the species into genera, and fortifying that project by a new name, as if nomenclature, instead of physiology, were the foundation of permanence. Thus a few have been selected



Portularia Muricata L.

for enrolment as *Plumulariæ*, a few as *Campanulariæ*, and so on of others. This would be a laudable and a useful plan were it profoundly laid—were the distinctions so prominent and exclusive as to show a positive transition; but where they are slight or equivocal, they must be accounted of little avail.

Of this the subject of the present paragraph offers so strong an example, that recent authors debate whether it should be removed from the Sertulariæ. The point is unimportant.

The product is of delicate and elegant structure; its general configuration resembling a series of feathers implanted in spiral arrangement around a slender stem, which rises about twelve inches high. These feathers, like branches, extend from an inch and a half to two inches, shortening in proportion to their height on the stem: each consists of from 20 to 30 twigs, arranged alternately on the sides of the rib, and also shortening regularly in advancing towards the extremity. A slight general recurvature of the points characterizes the whole product, much tending to its elegance and symmetry, which, to be duly appreciated, requires the presence of its native element, waving amidst it; the height of the finer specimens being 300 or 400 times the diameter of the stem, precludes it from sustaining itself without the aid of the water.

The branches are neither in pairs, in sets, nor strictly in spiral arrangement on the stem; two or three, nearly in a vertical line, are above each other; and then, two or three, somewhat off that vertical line, above them, thus producing the apparent spiral exhibited by the position of the whole.—Pl. XXXIII.

The adult is yellowish and opaque; but, regenerated parts are pure white. Though occurring in great profusion, this product can be seldom procured entire, thus compelling the naturalist to represent smaller specimens or their extremities, for the sake of showing them in greater perfection.

The Sertularia generally rises by a single stem, whereon the branches above described are implanted. It is rarely of such luxuriance as to produce so large a limb as the lesser division appearing on the figure.

It will be observed that what I denominate a branch, issues immediately from the stem; that it is composed of a rib, from each side of

which the twigs issue in alternate arrangement. The upper surface of each twig is clothed with two rows, somewhat apart on the surface, of alternate minute low denticles or cells, inhabited by very minute pure white hydræ, having 15 or 16 muricate tentacula. The extremity of a branch, with its tenants, is represented as seen by the microscope.—Pl. XXXIV. fig. 1.

Both the organic and inorganic parts, I mean the skeleton, together with the hydra and its cell, are regenerated in the *Sertularia falcata*. The whole twigs of a specimen five inches high, bearing 24 branches, had suffered mutilation. But above 100 parts, with several hundred cells and hydræ, all pure white, were regenerated in March and April. A great contrast distinguished these reproductions from the older portions.

During spring, especially in March and April, and in the beginning of May, numerous white or yellow vesicles load the *Sertularia*, each colour belonging to its respective specimen; the two never being interspersed on the same specimen. The vesicle itself is perfectly transparent. Thus its colour is derived from the contents; but the yellow has always appeared larger than the white. Numbers of the yellow crowded together on a branch, perhaps 30, 40, or even 50 at a time, resemble so many minute lemons both in shape and colour.—Plate XXXIV. fig. 2. There seems no difference in the profusion of the white and the yellow, and the cells in the neighbourhood of either are occupied by living hydræ. Both are like an ovoidal flask, with a short tubular neck and a circular orifice, some having a margin or reflected lip, fig. 3.

The side of the vesicle is of such transparence as to expose what is within, and there from one to seven corpuscula may be enumerated.—Figs. 4, 5, 6.

Having selected portions of the *Sertularia*, with a number of yellow vesicles for a regular series of observations, I remarked some slight movement among the contents. The general configuration, the relative position, and the aspect of the included subjects, were changing; and in fifteen minutes the separation of one corpusculum, which rose above the other, proved its animation. It ascended slowly towards the orifice, and issued forth as leisurely; but when reaching the surface of the glass below, its course was sufficiently accelerated. This animal was of vivid yellow

colour, as while contained in the vesicle, not exceeding the third or fourth of a line in length, and during progression, shaped somewhat as a double cone or shuttle, but becoming linear as its motion relaxed.

Having heard some accomplished naturalists dispute the animation of the beings which are here designed planulæ, I am now describing, as previously and as I mean to do subsequently, such facts as bear testimony of it. We cannot be too scrupulous in admitting what seems an absolute metamorphosis without unchallengeable evidence. On weighing the import of the whole, the reader can exercise his own judgment.

This active motion of these and other planulæ indicated the presence of some external organs whereby it was effected. Yet on subjecting many of all kinds to the microscope, none such could be discovered. Neither have I been able to detect any cilia or ciliated apparatus on the contents, whether more or less mature, of the most transparent vesicles of the Sertulariæ. Possibly the powers employed were insufficient; but we know very well, at the same time, that the vermicular tribes are capable of very speedy motion without similar external auxiliaries, that mere undulatory alterations in the body are enough.

No planulæ had appeared on April 26, in a vessel set apart with specimens of the *Sertularia falcata* on the 23d; but 30 or 40 were seen next morning. Several corpuscula also occupied the bottom, and a very few were floating—circular under the microscope, of a greyish-yellow tinge, and about a third less than the extended planulæ. The number of planulæ increased so much next day, that portions of the vessel seemed yellow from their accumulation: many moving swiftly, others were contracting, fig. 7. On the 5th of May not one could be seen.

Meantime nascent Sertulariæ were springing every where, but chiefly on the bottom; they were also on the sides, some as high as the surface of the water. Many vesicles now appeared empty; yet the numerous brood still continued to be so much augmented, that although the vessel could not have contained above three ounces of water, at least 200 originating Sertulariæ were dispersed within it on May 13.

Spines rose as usual from circular spots; cells were generated on their summit, whose tenants, perfectly white, exhibited a long neck, and about

fifteen deeply muricate tentacula, on maturity. Two, three, four, or five cells were developed successively on some specimens. None acquired a greater number.—Figs, 16, 17, 18, 19, enlarged; also fig. 27, which is little larger than life.

In another course of observations, many short spines were rising from the yellow spots, in five days after the prolific vesicles had been set apart; and in two more days their nascent Sertulariæ had two, three, even indications of a fourth cell, all yellow. Thus they had attained such maturity in eight days.

The period is very irregular, for the yellow spots have appeared as suddenly as 24 hours from the escape of the planulæ; also, on one occasion, above 40 yellow spots were distributed throughout a vessel within 72 hours, during which interval 60 active planulæ had quitted the vesicles.

Prolific specimens having been lodged in a vessel on April 30, planulæ appeared on May 4, and spots next day. Another portion of the same collection of specimens was set apart on May 7. Nothing could exceed their fertility; they were laden with fine bright yellow vesicles, which discharged their planulæ under the observer's eye. In 24 hours, at least 20 circular yellow spots could be seen at the bottom, while many yellow planulæ, some of them double the size of their fellows, were in motion. On May 13, not fewer than 70 animals, of various dimensions, and in various states of incipient metamorphosis, all vivid yellow, appeared at the bottom of the vessel—almost the whole vesicles then being empty.

Thus the nascent Sertulariæ originate speedily, for they become firmly rooted within 24 hours of quitting the matrix.

Such changes as now described are great and striking. The motion of the vigorous planula in all directions is swift, though it is not swimming; the diffusing root, rising spine and unfolding hydra, look, as it were, the conversion of an animal to a vegetable product.

Yellow vesicles having been set apart, hundreds of planulæ soon after strewed the bottom of a vessel on the 25th of April, rendering every part of it quite yellow. Very few continued in motion two days later. Some were much contracted, others nearly circular. The water being renewed, all were transferred to a different vessel. Numbers now began to



Portulacaria Plumularia, Palcata.

move; and the whole, not under 150, collecting towards one part of their new habitation, then remained quiescent. Fifteen or sixteen days subsequent to their departure from the vesicles, their colour remained as vivid as ever; but the microscope betrayed an extraordinary change of configuration. Most of the brood had crowded together; many extended on renovation of their native element, and pursuing their course, they seemed to be occupied among neighbouring muddy particles, as if in quest of something there. But, at this time, all were clumsy and disfigured; some irregular, some truncate, others almost spherical—some not half the size of symmetrical animals.—Figs. 8, 9. Had it not been for uninterrupted observation, no one could have identified these distorted beings with the original perfect planulæ, Plate XXXIV. fig. 7.

Some of the original brood survived 27 or 28 days, though much contracted. Their vivid colour remained unfaded long after the symptoms of animation had ceased.

I have been unable to discover any essential difference relative to the facts disclosed by the pure white planulæ occupying the vesicles of the *Sertularia falcata*, and those afforded by the yellow. On the 7th of May, many of the white escaped from vesicles within which no motion had been sensible on the first of that month. They resembled the yellow exactly, only seeming of rather inferior size, Plate XXXIV. fig. 10, enlarged. But while inspecting this figure, it must be noted that the shape of the planulæ is liable to perpetual modification; it is dependent on many circumstances—temperature, time, age, as well as the will of the animal. The form of all, when most perfect, is certainly somewhat conical, with a rounded head, or anterior tapering downwards, and flattened below. Nevertheless, some appear of more linear form, the sides being parallel, and the extremities nearly equal, while in complete vigour.

It is established that when yellow planulæ occupy the vesicles, yellow spots originate on the vessel, and where the planulæ contained are white, the spots following their production are white. The observer, however, is frequently precluded from following this progress; he finds them without witnessing the appearance or quiescence of the planulæ. They originate unobserved.

Whether white or yellow, they are distributed throughout the whole interior of the vessels, precisely in such places as might be easily accessible by the planulæ. They are often seen in greater profusion on the sides, just at the surface of the water; and they are generally found higher and higher in proportion as the vessel is successively replenished. If some be seen adhering close to the edge of the water, let the vessel be still more replenished, others will subsequently adhere above them, should propagation continue advancing. Meantime, the observer may discover white or yellow corpuscula floating at the surface, which he would conclude to be spherules; but careful inspection proves them inverted nascent Sertulariæ, whose root has failed of adhesion.

In all this, it is impossible to avoid admitting the strict analogy between the preceding stages and circumstances of the progeny of the Medusæ, and those distinguishing the early existence of the Sertulariæ.

Following the design of Nature, it may be presumed that a regular tendency to adhere, as the planula becomes motionless, is for securing the diffusion of the root, as a sufficient foundation for the rising product.

Shortly after a glass cylinder had received prolific specimens, nearly a circle of spots appeared on the sides. The cylinder being emptied and replenished with water, an inch and a half higher than the circle, eight or ten spots, also higher, appeared subsequently. Twenty or more of the lower circle had become affixed in such a manner that their stems issued downwards; while the stems of the rest, adhering flat to the side of the vessel, shot forth horizontally. Spite of that irregularity, some of the inverted nascent products acquired five cells; and hydræ flourished from three of them. The young at the bottom were numerous; those on the sides few. All the vesicles consigned to the vessel were white; all the planulæ quitting them white; and all the spots were white likewise.

Adult specimens, with yellow vesicles, having been consigned to a more capacious vessel, yellow spots were soon after observed on the side, just at the edge of the water, or rather above it. Another smaller vessel being now sunk inside, to raise the water still higher, many additional spots appeared, within 24 hours, on that part of the side, which the elevated water reaching, had covered. Numerous yellow planulæ were like-

wise present. Eight days afterwards, the vessel being emptied and replenished, hundreds of nascent Sertulariæ were found overspreading the bottom, and many occupied the sides.

The planulæ often show a tendency to ascend, and the root detached may be borne upwards, which will account for the heights of the nascent products. Nor is the peculiar curve formed with the side of a vessel by fluids to be overlooked. At the same time, as in the progeny of the Medusæ, there are some principles producing such effects not readily understood.

Considerable disparity appears in the form of the nascent Sertulariæ. The root is of the same character as that of others.—Figs. 11, 12, 13, 14. A spine rises from a circular spot as usual, fig. 15, budding first into one cell, and then into a second, which is higher.—Fig. 16. The diffusing parts of the root extend farther, and become fainter with the development of the buds.—Figs. 17, 18. At an early stage the stem appears divided by deep-marked, irregular articulations.—Figs. 19, 20. But it does not appear that any strict uniformity prevails among the different young.—Figs. 21, 22. Their advance is progressive, denoted by the number of hydræ and buds.—Figs. 23, 24, 25, 26, 27. I have not been able to effect their preservation until the evolution of more than five.

From such early decay, it is impossible to discover how that modification finally converting this Sertularia into its proper form ensues. The disparities were so conspicuous, that, until numerous observations ascertained the fact, I found it difficult to reconcile the production of the various nascent products to a parent of the same species.

The following general results were obtained :—

I. The *Sertularia (Plumularia) falcata* is always of a honey-yellow colour, or nearly so, if adult ; the reproductions are white.

II. Numerous ovoidal vesicles are borne on the branches, during spring, which, on different specimens, are either pure white or vivid yellow.

III. The colour of the vesicle is derived from the contents, the side being transparent ; but both kinds of vesicle are never found on the same specimen.

IV. The contents consist of five or six corpuscula,—globular in an early stage, but in a later, relaxing into planulæ, which escape by the orifice.

V. The planulæ endowed with the power of expeditious motion, lose their natural configuration, and contracting in a circular spot, become stationary.

VI. A spine rising from the spot, enlarges as a cell at the summit, whence a hydra is displayed, proving the young Sertularia.

PLATE XXXIII. *Sertularia (Plumularia) falcata*.

PLATE XXXIV.

FIG. 1. Extremity of a branch with hydræ.

2. Branch bearing vesicles, slightly enlarged.

3. Vesicle with white corpuscula.

4. Vesicles with yellow corpuscula.

5. Vesicles with yellow corpuscula.

6. Vesicles with yellow corpuscula, relaxing in planulæ; one escaping from the orifice.

7. Yellow planulæ from the vesicles.

8. Yellow planulæ from the vesicles losing their proper form.

9. Yellow planulæ approaching incipient metamorphosis.

10. White planula from the vesicle, fig. 3.

11–14. Diffusing root from four metamorphosing planulæ.

15. Originating stem from a diffusing root.

16. Stem bearing two buds.

17, 18. Stems with two cells; partition of the roots disappearing.

19. Young Sertularia with a hydra and two cells yet untenanted; articulations indenting the stem.

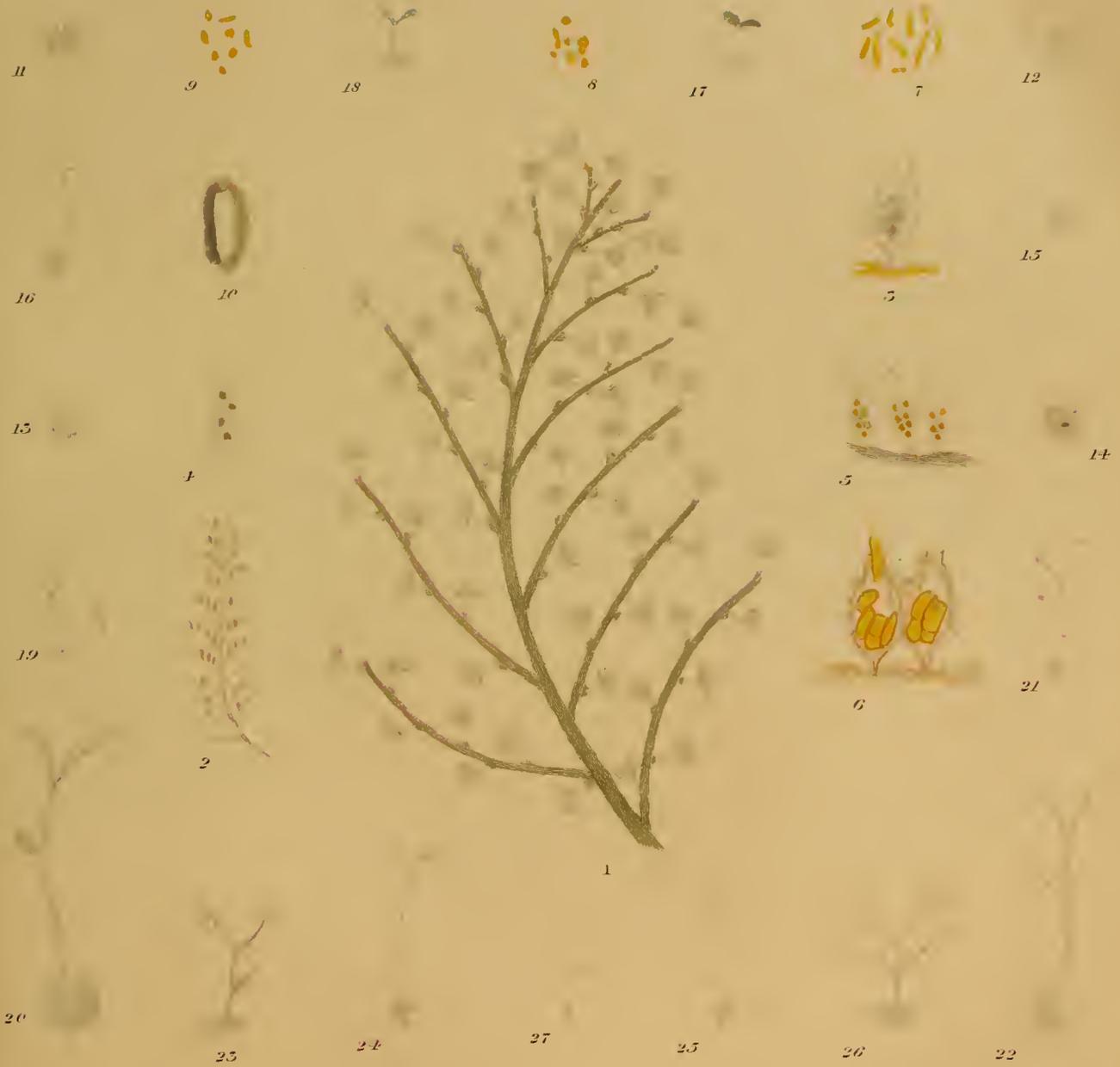
20. The same more enlarged.

21. Young specimen with three hydræ, the stem articulated.

22. The same more enlarged.

23–27. Young specimens of varied configuration.

All the preceding figures are enlarged.



Portularia (L.) Tuberosa L.

§ 9. SERTULARIA (PLUMULARIA) PINNATA.—PLATE XXXV.—This is a delicate product, truly resembling a feather. It rises three inches, or little more, in height, and is generally of a greenish colour. Slender twigs, with a slight elegant recurvature, issue from each side of the stem in alternate arrangement, shortening gradually as they ascend or descend from about the middle of the specimen, and terminate the summit by a mere projection.—Plate XXXV. fig. 1.

A row of low cells or denticles, somewhat apart, projects from the convexity of the twig, which, in a certain position, would induce the observer, by some illusion, to ascribe a spine to the orifice. Each denticle or cell is inhabited by a hydra, with about 20 muricate tentacula. When the product is in maturity, there is only one hydra on the twig at the summit, two on the next, then three, and so on to seven, beyond which number I have not observed more. The extremity of no part is a hydra, though it may be preparing from the evolution of one, for the mode of increment seems to ensue from a twin bud; the more mature of the twins unfolding a perfect hydra, and the other advancing beyond it, to develop somewhat later.—Fig. 2. The cells are low, but quite conspicuous, fig. 3; their tenants show nothing particular. The tentacula are rather short and stout.—Figs. 4, 5. A waving pith occupies the stem.

Numerous vesicles are huddled together on a portion of the stem, presenting a reddish or yellowish appearance to the eye from their accumulation. These vesicles are not of uniform figure, the edge of the orifice of some being even, while two or three prongs extend that of others.—Fig. 6. Each contains a single yellow or orange corpusculum, fig. 7, which is discharged as a planula at various seasons of the year, from July and August to December.—Figs. 8, 9. But all planulæ do not seem invariably of the same colour, as some produced in this last month, from what I concluded the same species of Sertularia, were grey.

The vesicles huddled together on the stem of a prolific specimen produced yellow planulæ, extending about a third of a line, on August 12 and 13. Several crawled along; the motion of others tended to an orbit from partial contraction of the body.—Fig. 9. One was monstrous.—Fig. 9, *a*. Roots were diffusing from this monstrous planula in a week; and in a few

more days a slender stem, with a bulbous summit, had issued from the roots. The stem of some others rose in extreme slenderness; but none produced hydræ, probably from some accidental cause.

PLATE XXXV.

- FIG. 1. Group of the *Sertularia (Plumularia) pinnata* on a shell.
 2. Summit of a specimen.
 3. Twig with cells.
 4. Hydra.
 5. Hydra containing some residuum.
 6. Vesicles, as seated on the stem.
 7. Prolific vesicles.
 8. Yellow planulæ from the vesicles.
 9. Planulæ from the vesicles; one monstrous, *a*, more enlarged.
 10. Nascent specimen from a planula.

All the figures of this plate, except fig. 1, are enlarged.

§ 10. SERTULARIA (PLUMULARIA ?) FASCIS.—PLATE XXXVI.—As this product participates of various characters whereon the later invented genera are established, its real position is somewhat doubtful, nor have I had a sufficient number of specimens in their various states to fix it.

The *Sertularia fascis* rises four inches or more in height, by a straight, erect, and rather inflexible stem, under half a line in diameter at the root. Alternate boughs, bearing very few branches, generally none, are meagrely disposed around the circumference. A single row of low denticles, for the most part on one side only, borders the upper surface of the parts, scarcely projecting above its level, and many of the extremities terminate in a denticle also. On some subordinate parts, a border of denticles appears on each side, but rarely. The denticles are usually separated by articulations.

The lower portion of the stem is composed of aggregated tubuli like a faggot, each most probably occupied by its peculiar pith, which substance is more distinct above, where exposed by the transparence of the single tubular parts. The waving form of the pith indicates an invisible side or



Scybalaria (P.) Parvata ?

boundary, separating it from the lower or under part of the branch.—Figs. 1, 2.

Above 30 boughs originate from the most luxuriant specimens.

The hydra inhabiting the denticle is retractile completely within, whence it rises to protrude a long neck, with from 25 to 27 muricate tentacula. It appears somewhat gross, the tentacula stout, and often much recurved or curled, previous to their full extension.—Figs. 3, 4, 9.

The whole product is greenish, of more vivid colour when young; the stem dark umber if old; and the hydra pale green.

Specimens are founded on old shells. When torn off, a small tuft separates along with the root.

Probably the stem and subordinate parts are invested by skin, which is perfectly transparent, and wherein the contraction denoting articulations is perceptible. However, the structure of the stem itself, farther than consisting of tubuli, and in being porous like wood, is not quite obvious. These features are seen below in the thicker parts; but above, the parts resolve into a single tube.

Regeneration.—While investigating the structure, I cut over some specimens near the root in December, and subdivided the sundered stalk of each into several portions. Vigorous reproduction followed. In five days, seven shoots, about the fifth of a line, or the sixtieth part of an inch long, were *descending* from the *lower* extremity of one of the sections; and next day, the prolongation of all still continued advancing in the same direction, *downwards*, inverse to that of nature, which is *upwards*.—Fig. 5.

Shoots more numerous and more vigorous *descended* also from other sections. Nine descended from one of them.

Another section, an intermediate portion of a stalk, an inch long, generated several shoots from both extremities. The vegetation advanced luxuriantly—more so from the lower than from the upper extremity. Two hydræ were developed here, and one from a shoot of the upper extremity in 27 days. This section had been kept in a horizontal position.

Shoots in an early stage are white. The specimens now under experiment had been procured on December 14. A section only four lines in length was made on the 16th. Vegetation issued from both extremities,

but now the upper portion was the more vigorous. Five shoots were formed there, bearing eight perfect hydræ on January 17, or 34 days afterwards; and from the lower extremity issued three shoots, on one of which was a single hydra at that date. The section lay horizontally; each set of shoots rose perpendicularly. This was an extraordinary regeneration from so small a fragment.

Among the other reproducing sections, one had regenerated five shoots upwards in the natural direction.—Fig. 6. These earlier reproductions are of a long clavate shape, whether the shoot be generated from the higher or lower extremity.

On the seventh day following the section, a new shoot or branch was evidently cleaving from fig. 6, last referred to. Next day, the eighth after section, a hydra, with a mouth like a cup, environed by 27 tentacula, was displayed from a denticle on a shoot of the same portion, fig. 7, *a*; and on the ninth day, a second hydra, *b*, was forking off *a*, or rather from the site it had occupied, being then decayed.—Fig. 8. Other two hydræ now appeared from different shoots in the vicinity—whence the progress of reproduction from the same section, figs. 6, 7, 8, is shown.

On the tenth day, the extremity of the shoots, *a*, *b*, *c*, fig. 8, had subdivided, the hydra, *b*, still subsisting.—Fig. 9.

The section lay in a horizontal position originally; and at first its new shoots issued almost horizontally likewise. However, by gradually tending upwards, they became quite erect in twelve days.—Fig. 10. In sixteen, six hydræ were still displayed; but in twenty-two, only two shoots, the taller with three hydræ, remained in display; in twenty-six, no more than a single shoot subsisted; and in three or four longer, the pith was totally consumed by the progress of decay.

The number of shoots generated from any section seemed to me indefinite, but I may have been misled by ignorance of the component parts, because the shoots might correspond to the tubuli. Ten issued from the stump of a specimen cut low, but only one from the stalk cut high. Each tube of the stem may be therefore endowed with a separate and independent reproductive property, while all resolving into one in the higher parts, it may concentrate there.



Asplenium (Thuidium) Thuidium

An evident tendency to the nature and form of vegetable growth, appears in the vertical direction of the regenerations. Shoots double the length of the shortest section above mentioned, rose perpendicularly from both ends, as it lay horizontally.

Long ovate vesicles, with a transparent integument, have occurred on this product in May. I could not observe that they occupied a peculiar place. Each contained from four to six corpuscula, chiefly spherical, or tending to this form, and arranged in a curve. They are very seldom found, and an interval of eight years having interrupted the prosecution of earlier observations, circumstances intervened, on their renewal, which prevented me from bringing them to a successful conclusion.—Fig. 11.

PLATE XXXVI.

FIG. 1. *Sertularia (Plumularia) fascis*.

2. Section, comprehending the extremity of a specimen which shows the arrangement of the parts; the cells and hydræ.
3. Hydra.
4. Hydra.
5. Section of a stem generating shoots by *descent*.
6. Section of a stem generating shoots by *ascent*.
7. The same, farther advanced. The evolution of a hydra, *a*, followed in eight days after the section was made.
8. The same, farther advanced, by the evolution of a second hydra, *b*.
9. The same, still farther advanced, as seen ten days subsequent to the section.
10. The same, with generations, as viewed by a lens, twelve days after the section. This is in a horizontal position, the shoots from each end are vertical. The preceding figures, on a larger scale, represent the section in a vertical position.
11. Section bearing vesicles. Hydra unfolding, *a*.
All the preceding, except fig. 1, enlarged.

§ 11. SERTULARIA ARGENTEA—*Squirrel's Tail*.—PLATES XXXVII. XXXVIII.—A complete dissertation on the tribe of Sertulariæ, should comprehend many other facts and subjects besides those to be found in

this treatise; but [to do justice to the subject, infinitely surpasses the abilities of any individual observer, especially one whose resources are limited. The history of even a single species cannot be effected within the course of several years. Neither are the finest specimens always accessible at pleasure, in their various stages, nor in that precise condition illustrative of their parts and properties. Thence we are compelled too often to be satisfied with mutilation instead of perfection, and with decay for vigour: we must submit to many interruptions, both from privation of our specimens, and from inability to obtain others of the race: or resolve to accept in the end a mere accumulation of isolated points, without the means of analysis and combinations. Thus it is, perhaps, that naturalists are usually content with founding theories, and detailing descriptions of dead subjects, from which so little can be gathered in proof of what is displayed by their animated state. Nevertheless, under multiplied disadvantages, if many tread a similar path, and if their industry be not absolutely unrequited, a mass of information is derived from their common zeal, ultimately profitable to the cause of learning.

I confess myself unable to determine whether the subject of the present paragraph be the *Sertularia argentea* or the *Sertularia cupressina* of authors, particularly from entertaining doubts whether the two be truly different. According to the concentrated matter, always so usefully brought together by Dr Johnston, I should incline to think it the *Cupressina*, but identification fails on resorting to specific detail. Neither is it to be entirely identified with the *Argentea*. Whence, to shun the perplexity, I had provisionally designed my own the *Sertularia uber*, from certain appearances, leaving future systematic naturalists to reconcile the differences.

Meantime, to avoid embarrassment from precipitate innovation, the name *Argentea* is retained.

This *Sertularia* is the tallest of the zoophytes belonging to the Scottish seas,—reaching nearly a yard in height. Therefore, in representing it from Nature, a smaller specimen has to be selected.—Pl. XXXVII. It rises from a root no larger than the scale of a herring, a mere speck in comparison to the length of the stem, which is surprisingly slender, and almost cylindrical throughout, but when in greatest perfection, a little smaller at

the origin. On divulsion of a specimen 27 inches high, from a shell, whereon it had been founded, a scale from the shell, under a line in diameter, sustaining the root, was separated. Here the stalk scarcely exceeded the size of a horse's hair, and consisted of a single tube. Four branches, in alternate pairs, issue from around the stem, nearly in a horizontal direction where lowest; and they subdivide dichotomously, or always by cleaving in two.—Pl. XXXVIII. fig. 1. These branches are short, contrasted with the length, for the tallest specimens might be contained in a vessel of about two inches diameter, whence the branch must be little above one. The general aspect will be seen from the Plate, XXXVII. Deep annulations indent the stem and branches at irregular intervals, comprehending from two to ten cells between them. These are more conspicuous in nascent specimens or in decaying adults. Two rows of conical cells, slightly curved like a horn, clothe the sides of the stem, branches, and their subordinate parts; but under considerable discrepancies in form and position. Those on the stem of younger specimens are sufficiently conspicuous, but the profusion of branches on the older obscures them. In these, the latter, they are more in front, in the former, more on the sides; their true arrangement alternate. It is to be remarked that the precise relation of the parts is affected by the increment of zoophytes; which creates some embarrassment in an observer comparing his subject with the observations of others. A notch appears in the orifice of many of the cells of this species, which is so deep in some, that the higher parts approximate a spinous formation.—Pl. XXXVIII. figs. 2, 3. The annulations of the stem, which are also a prominent feature in younger specimens, may readily escape notice in adults, both from the presence of extraneous matter, or on selecting too short a portion for inspection. Obliteration of the pith contributes to their exposure.

Considering the ample dimensions of this Sertularia, its hydra, with 20 or 22 muricate tentacula, is very minute.—Fig. 4. To the naked eye it is a mere speck, pure white, or of greenish hue. The contrast between these pale animals and the yellow or yellowish-brown of the rest of the product is great.

The *Sertularia argentea* is a zoophyte to be characterized as flexible

in the genuine sense of the word: the length of the stem is many hundred times its diameter, thence the presence of the liquid element alone supports it erect, and even then, the higher portion of the tallest, tends to overbear the rest.

Propagation.—After my earlier observations had been conducted during several years, their progress was interrupted by an obstacle of too repeated recurrence, a deficiency of specimens. I found it impossible to obtain any. During the preceding period, all the vesicles I had seen resembled a vase with a spinous prolongation, very distinct.—Fig. 5. After a long interval, several luxuriant specimens reached me on April 6, which were from 8 to 12 inches in height. The branches of some of them were yielding under a vast profusion of vesicles, resembling minute oranges. But, unlike the former spinous kind, they were of compound formation, consisting of a hollow pedestal, surmounted by a sphere about three times its diameter: and on the whole, bearing much resemblance to the compound vesicle of the *Sertularia abietina*, above described. Some spinous vesicles, together with some ampullate or flask-shaped, were present besides.

A number of the compound vesicles now contained one, two, three, or four spherical yellow corpuscula, very conspicuous, both in form and colour, through their diaphanous enclosure. None had more than four, many were empty, and hardly discernible, from transparence amidst the water.—Fig. 6.

A vesicle subjected to the microscope, exposed four internal corpuscula, one ovoidal, which betrayed symptoms of animation; the other three globular and still inert. The former relaxed still more as an ovoid, it began to move, then shifted its position in the vesicle, where there is always a considerable vacuity. On directing the microscope to another vesicle, the contents proved to be much farther advanced: three yellow animals, all mature, lay parallel to each other within it. One began to move: it glided slowly upwards to the circular orifice, which opens the summit of the sphere, from whence, protruding its head as if searching around, it dropped down among the surrounding element. The second, by a similar course, followed its precursor, within a minute, and dropped down also. Next,



Cortularia



Argentea

the third advancing in like manner at a longer interval lagged in the orifice, as if more doubtful of safety, but at last committed itself as its companions had done, to the water. Now, the sphere remained empty and quite transparent.

In this way, above twenty planulæ forsook their prison during half an hour's observation.—Fig. 7.

These beings proved very minute, not a third of a line in length, of beautiful vivid yellow, smooth, and uniform aspect as others; the body thick, consistent, and heavy, tapering slightly with obtuse extremities. They crawled slowly along.

The vesicles continued discharging multitudes of planulæ, rendering that portion of the vessels where they collected yellow from their number. In five days, at least 1200 had gathered together in the bottom of one vessel; and in two days more, at least 2000 in another.

Sertularia uber would not have been an inappropriate characteristic. None or very few of the planulæ ascended the sides of the vessels.

Let us follow the course of metamorphosis.

Planulæ issued from the vesicles on April 7. On the 9th, some apparently symmetrical the preceding day had now contracted, much after the fashion of those of the *Sertularia falcata*. An individual yet exhibiting progression was absolutely spherical.

The period of transformation and subsequent maturity were correctly defined. Vesicles taken from the specimens above quoted having been set aside on the 7th of April, planulæ appeared on the 8th. Circular spots with a spine were seen on the 10th, and on the 17th, hydræ flourished from the cells of the nascent Sertulariæ. The life of the planula, as such, had been thus abridged on the third day; and from the spot closing its existence, the hydræ had been perfected in other seven. Therefore, within ten days of the planula escaping from the vesicle, it became a Sertularia.

The spine rising from the spot was yellowish; the cell enlarging its summit rather of a long campanulate form; and the hydra had 15 tentacula.

These characteristics distinguished the young Sertulariæ.

Compared with the appearance of adults, their form was somewhat

embarrassing. But numerous observations prove the discrepant structure of the young and the adults, and even between the adults of the same species of many Sertulariæ. This is possibly shown under various modifications throughout the whole race. Only a single cell could be discovered resembling the cells of the adult; but this, together with the articulations of the stem of the originating, or of early specimens, established the identity, although there was no reason to doubt the correctness of experiments and observations. The cells were very transparent. — Plate XXXVIII. figs. 8, 9, 10.

The sphere is imperfect, in as far as being then open; were it permanently complete, the orifice would be obstructed.

On different occasions, both simple and compound vesicles have occurred on the same specimen.

A corpusculum, white or yellow, resembling those in the sphere, sometimes appears on the summit of the pedestal sustaining it.

One or two globular or somewhat elongated corpuscula, probably planulæ, are seen in the ampullate vesicles.

Besides these, yellow corpuscula have been also observed in the spinous vesicle above mentioned, but under certain irregularities. Of five or six on a branch, the first contained a large whitish corpusculum, the second a pale yellow one, the third two more vivid, the fourth had three like them. The fifth vesicle was crowned by an irregular transparent vessel, with a yellow corpusculum at the bottom, as if seated on an internal stalk rising up through the vesicle. Another portion of the lower branch bore nine spinous vesicles with still greater irregularities. Here a conical vesicle, or a long bladder with contents similar to the yellow globules, of the wonted sphere, supplanted it.

These varieties or anomalies are of difficult description to become intelligible.

When the great accumulation of above 2000 planulæ was verging to decay, and the whole water emptied on April 18, more than 100 spines indicating nascent Sertulariæ were exposed on replenishing the vessel.

Vegetation.—The origin and increment of organic bodies, always deeply interesting to the contemplative, though advancing in strict accordance

with the pre-ordination of nature, may be subject to such disturbance as perplexes us by apparent anomalies.

Some of these are beyond solution, or they lead to intricate discussion.

For the purpose of investigating the vegetative properties of this Sertularia, a specimen five inches high was sundered on May 26, at a point of the stem where it seemed tubular and empty.

The upper half, A, Plate XXXVIII. fig. 11, was now inverted, while the under half, B, remained erect, as in its natural position.

The higher part of A, which before inversion was the lower as far as *c* originally, shot a new generation, *c b*, upwards, June 13, which would have descended, had the natural position been preserved. At the same time, B, fig. 12, retained in its natural position, had generated the vertical shoot, *c b*, in the natural direction.

Thus were there two vegetations in opposite directions from the same point of the stem. They continued advancing nearly at an equal rate; but the vigour of B, kept in the natural position, surpassed that of A, which had been inverted, in the ultimate number of parts; for the portion *c b* of B no longer than as represented, fig. 12, on June 13, had become, on December 13, as *c b*, *c a*, *c d*, by new accessions.—Fig. 13.

On June 7, or twelve days after bisection of the stem, a very minute hydra issued from the lower twig of the natural regeneration, *c b*, fig. 12, which animal had been brought to maturity by this interval.

A new generation afterwards issued by descent from B, fig. 12, five months subsequent to the section, so that, on November 9, it was reproducing from both extremities.—Fig. 14.

One of the lateral shoots of this descending vegetation bore a young twig or upright stem, *a*, *b*, half an inch high, whereon three prominences, denoting incipient cells, were evident, October 31. These amounted to six on November 4, four being on one side and three on the other: eight on November 7, divided as five and three, and on the ninth, there were ten, divided as six and four.—Fig. 15, enlarged. On November 13, they amounted to fifteen, divided as eight and seven; twenty one on the 22d, divided as eleven and ten; besides which, a branch with four cells had

sprung from one side of the stem, on December 10.—Fig. 16. Their number on both sides of the stem itself, had augmented to twenty-five, on December 23, the lowest now exhibiting a prolongation which formed into a new cell, displaying a hydra two days later. Another prolongation, as if of two parts, appeared from the third cell below, on December 7; this became trifold on the 9th; and a hydra flourished from one of its cells on the 15th.—Fig. 17.

The young twig or upright stem, as above, *a*, *b*, ultimately remained nine lines high without farther accessions.

The germinating principle subsists very long dormant, and it is unexpectedly demonstrated. Above a year after fig. 12 had been sundered from fig. 11, a regular shoot with five cells on each side, issued from a branch situated about the middle of it.

The articulations, generally so indistinct in living adult zoophytes, were finely exposed by the young specimens.—Figs. 15, 16, 17. Neither their extent nor their number seemed to be regulated by a uniform principle. Most of them comprehended a pair of cells, or a space equivalent to the site of a pair; thence, though sometimes comprehending four, it is questionable whether another, or intermediate articulation, was not inconspicuous, simply from being too faint, or whether it was really absent as a deviation from the natural form and features of the species. The space intervening between the root and the first cell was indented by eight articulations.

The nature of this peculiar feature of zoophytes is not well explained—whether the articulation is a simple contraction of the parts; whether it is a real segment, wherein certain functions may be carried on independent of the other articulations.

It is exceedingly difficult to account for the generation of hydræ in these reproductions. The botanist will find a great analogy to the germination of plants, in their progressive increment generating buds instead of animals. But where animation is evidently in the development, it is perplexing to conjecture that it may be by the deposition of elementary atoms, commencing at some certain stage, which the product has attained, as in *a*, *b*,—fig. 14; or whether it may not be by the evolution of

latent germs, subsisting previous to origination of the horizontal thread, B, *b*.

From these and other observations, we may reach the following conclusions :—

I. Reproduction from different halves of a bisected stalk may ensue, at the point of bisection, in opposite directions, being upwards from the under half, and downwards from the upper half.

II. Hydræ with their cells are generated on both reproductions, if vigorous : if feeble there will be none.

III. A hydra has originated and attained maturity in twelve days from such reproductions ; and one has survived forty days.

IV. An originating portion, having 3 incipient cells on October 31, had acquired 33 mature cells on December 15, or in 45 days.

V. All the new parts are at first pure white, which, in time, is converted to yellowish-brown.

VI. The arrangement of new parts is by simple divergence in the same plane : an arrangement altogether different distinguishes the adult Sertularia.

VII. Original cells are obliterated by new branches germinating in the line of their axis.

VIII. Vesicles of various configuration are borne by adults, containing from one to four yellow spherules, developing as planulæ.

IX. The planulæ discharged by the vesicles have become motionless in three days ; and the hydræ of nascent Sertulariæ, generated by their metamorphosis, have attained maturity in ten days after the planulæ issued from the vesicles.

PLATE XXXVII. *Sertularia argentea*.

PLATE XXXVIII. *Sertularia argentea*.

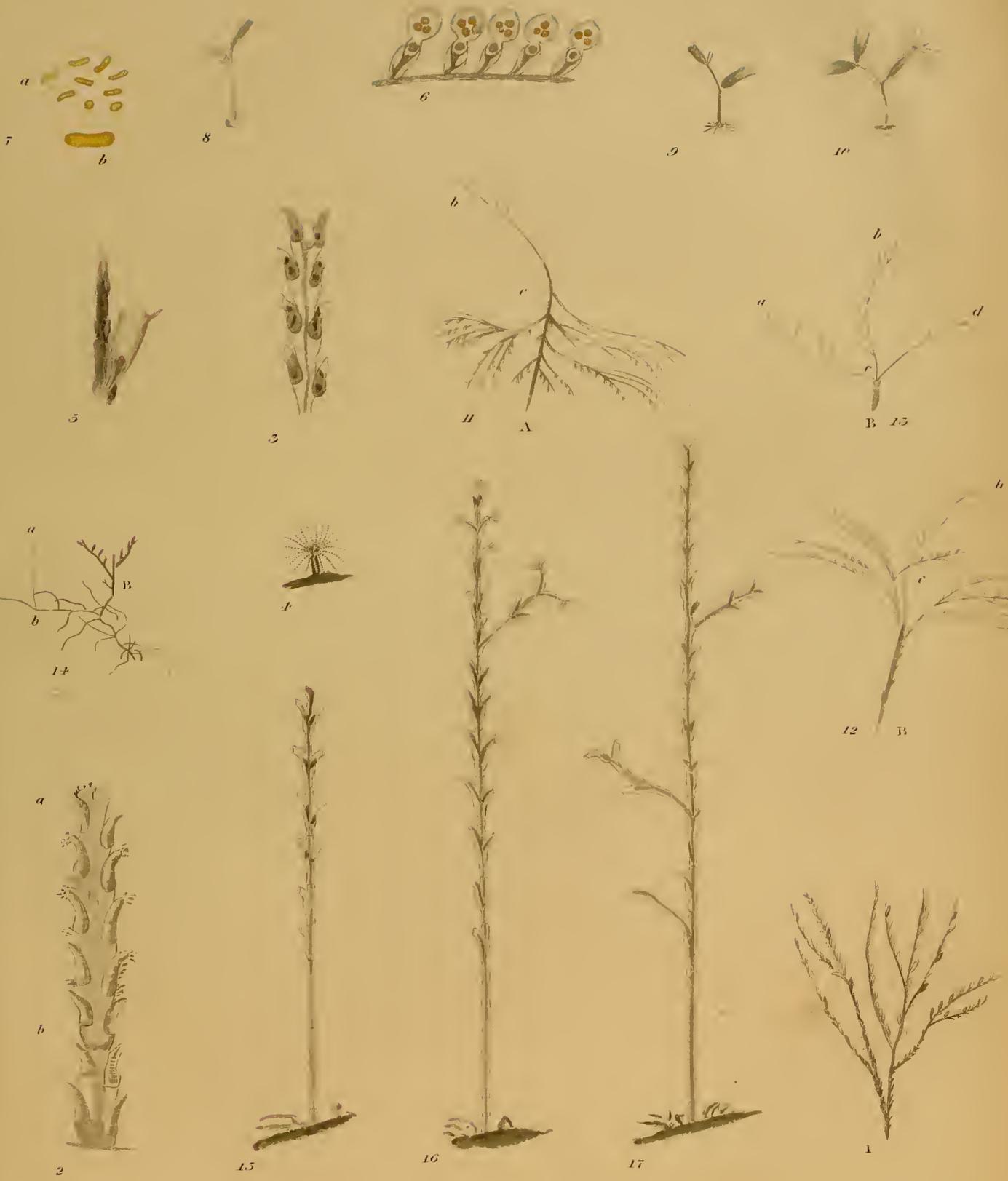
FIG. 1. Branch.

2. Section of the branch of an adult specimen, comprehending a complete articulation, *a b*.

PLATE XXXVIII. *Sertularia argentea*.

3. Section of the branch of another specimen, showing the figure and arrangement of the cells.
 4. Hydra.
 5. Vesicle.
 6. Compound prolific vesicles with spherules.
 7. Planulæ from the vesicle, *a*; one magnified, *b*.
 8. Nascent *Sertularia* from a planula.
 9. Nascent *Sertularia* farther advanced.
 10. Nascent *Sertularia*, still farther advanced, having two cells and a hydra.
 11. The upper portion, here inverted, of a bisected stalk, which consisted of A 11, and B 12, united at the point of division. Reproduction, *c*, *b*, as on June 13, from what had been the lower extremity, *c*, fig. 11, on bisection May 26.
 12. The lower half of the bisected stalk, preserved in the natural erect position, producing *c*, *b*, by upward vegetation, as appearing June 13.
 13. The same reproduction, *c*, *b*, fig. 12, with additional regeneration, *c*, *a*,—*c*, *d*, consisting in whole of three branches, on December 13. The portion *c*, B, as seen fig. 12, is here abbreviated.
 14. The same section, fig. 13, having generated reproductions from the lower extremity, B, a new stem, *a*, *b*, had arose from one of these, a lateral filament, which stem had ten cells on November 9.
 15. This new stem, *a*, *b*, with its ten cells, as appearing November 9, enlarged.
 16. The same, with its accessions, on November 22.
 17. The same, with farther accessions, as appearing December 13.
- All the figures of this Plate, except figs. 1, 11, 12, 13, 14, are enlarged.

§ 12. SERTULARIA ANTENNINA.—PLATES XXXIX., XL.—How numerous soever the multitude of living hydræ which shall be ultimately borne by any of the *Sertulariæ*, all those whose tenants are provided with muricate tentacula, originate from the planula so often referred to, in as far as I have been able to trace them. Whether a perfect specimen shall bear



Festularia rigens L.

few or many,—whether only one, if there be any such, or a thousand,—whether it be large or small, the common source of the product is that minute animal. We have seen how this creature, after an indefinite period of activity, is arrested, contracts into a circular form, from which a spine, with a cellular summit, arises, inhabited by a lively hydra. Likewise, it appears, how the evolution of subordinate parts is dependent on the presence of internal pith, gradually diffused by their multiplication and extension; that while the specimen survives, the tendency to continual increase precludes all conjecture of the dimensions to be at last attained. But these are evidently influenced by age and position.

Life once elicited in the form of the hydra, there seems an incessant generation of cotemporaries and posterity, until decay or interruption of the pith announces the presence of disease, or the approach of death, which infallibly follows.

Already have some prolific products been described, showing their inconsiderable size, though bearing a thousand animated blossoms, together with their subordinate organs. But others, still smaller, and occupying still more restricted bounds, sustain ten thousand, nay myriads innumerable, literally in such incredible profusion, that the free exercise of their parts is prevented by their reciprocal interference.

Such are the products I shall proceed to specify. But here the naturalist must not be satisfied with inspecting a single specimen, though, strange to say, that by multiplying the subjects of observation, he may be frequently involved in perplexity. Of this an example has fallen to my lot regarding the present subject: nor do I pretend to elucidate various points of its history so clearly, that I can hope to satisfy the reader: for in truth, they are most embarrassing. Therefore, instead of attempting to reason on the identity of two products, or on their difference, according to the assertion or the denial of preceding authors, I shall meantime simply hold them distinct, for the purpose of advancing a few special facts, illustrating the general nature of zoophytes.

There is no doubt that the different aspect of the two, which are denominated *Sertularia* or *Nemertesia Antennina*, and *Sertularia* or *Nemertesia Ramosa*, as well as the detail and arrangement of the parts, is very

great; and added to these, the circumstances concomitant on their propagation. I shall speak very briefly of both exactly as they have occurred to me.

§ 1. SERTULARIA ANTENNINA—*Lobster's Horn*.*—This product rises as a single slender stem, ten inches high, profusely clothed with short, delicate twigs, slightly incurving towards it, the whole being of a reddish or orange colour. The twigs environ the stem in a successive series of sets, ascending upwards, consisting of four in each, in alternate opposite pairs; that is, a twig of the pair opposite to its fellow, and the next pair of the same kind somewhat higher. The product is of a light feathery character; therefore, a group composed as sometimes seen of 100 or 150 specimens, resembles a rich flexible plume waving gracefully amidst the water. One feather of the plume is represented Plate XXXIX. fig. 1.

Low cells or denticles seated on the twigs are inhabited by very minute greenish hydræ, with 14 rather slender muricate tentacula, their roots apparently connected by a web formed of the expanded disc. These tentacula clasp suddenly together like some others. The hydra exhibits no prominent peculiarities. It proves extremely delicate, is seldom found alive, and it declines speedily. Both the stem and the twigs are distinctly articulated. If I have entered on no detail regarding this feature of the skeleton of zoophytes, it is because other authors have devoted so much attention to the subject. Besides, it is only in the dead and decaying specimen, not while it is beautiful and luxuriant, full of vigorous animation, that articulations can be discovered. Probably a few examples may be afterwards given for general illustration. The articulations of the *Sertularia antennina* are distinct; a spinous prolongation sometimes extends from the origin of those of the twig. Also, in some of the most perfect

* *Ellis*, referring to *Ray*'s having distinguished two species, unites them in one. *Linnaeus* seems to view the one only as a variety of the other. *Lamarck* and *M. de Blainville*, a very acute naturalist, name the species as 1. *Antennularia indivisa*; 2. *Antennularia ramosa*. *Lamouroux*, under his generic name *Nemertesia*—1. *Antennina*; 2. *Ramosa*; 3. *Janini*. Dr *Fleming*, *Antennularia antennina*.

specimens, a stump, which is apparently an integral portion of the stalk of the twig interposes on each side between two hydræ.—Plate XXXIX. fig. 2; twig and hydræ, enlarged.

Vegetation.—The vegetative faculty of this Sertularia is conspicuously displayed. A section three inches long having been deposited in a vessel on September 24, the pith of the middle decayed, but twigs issued from the sides, both above and below the vacuity; and from the extremity of the section also; hydræ were generated from the twigs, the first of them a month after the section had been deposited, therefore requiring that interval for maturity.

The upper extremity of an artificial section is likewise prolonged by reproduction, when new twigs originate from it, resembling the slenderest needles. A stem thus regenerated or prolonged, had 13 series or sets of such needles. Of these seven bore prolific cells; but none had above two. Where progressive increment is advancing, prominences on the stem denote incipient twigs, whose gradual growth admits the evolution of cells. The hydra first displayed is from that cell of the twig nearest the stem of the Sertularia, and the second hydra from the cell next to the first. Therefore, the most distant embryo is the least mature.

Propagation.—The stem of this product, which rises singly, is environed by ovoidal vesicles, with an orifice somewhat heart-shaped, immediately lower than the convex summit of the vesicle, and almost invariably opening inwards. The vesicle stands in the axilla formed by the twig with the stem.—Pl. XXXIX. figs. 3, 4.

A single yellow embryo originates here, so large that there seems no room for more. It is evolved as a planula, surpassing the size of any that I have seen issuing from a Sertularia, for it is nearly the twelfth of an inch in length.

Five specimens, crowded with vesicles, were obtained on November 19. Sometimes these are in such profusion that the stem seems of unusual thickness. Here all were of the same ovate formation, the orifice inwards, and each vesicle containing a single embryo. Several having been set apart, planulæ of a fine yellow colour, and of the preceding ample dimensions, appeared in the vessels on November 22.—Figs. 5, 6.

The planulæ, from a state of activity, contracted and became motionless : being moulded into vivid yellow spots. These soon exhibited a rising stalk, whereon projections denoted incipient twigs, from which hydræ were subsequently generated. I shall insist no farther on the history of this species of the Sertularia, which has never occurred to me under any other aspect than as a single red slender stem, with an ovate vesicle in the axilla of the twig and stem, producing one large yellow planula.

§ 2. SERTULARIA (ANTENNULARIA) RAMOSA.—This product, which is either a different species or a distant variety of the preceding, affords greater scope for observation.

Adult specimens rise four, five, or six inches high, by a short, bare stem, composed of aggregated tubuli. Numerous boughs and branches above, diverge at a large angle from their respective principal parts, the whole thickly clothed with twigs exceeding half an inch in length, and sometimes bearing 14 or 15 denticles on the upper side. Owing to the recurvature of the twigs outwards, many specimens present a rich plumose appearance.

The product is usually of a vivid green colour, sometimes of a yellowish shade ; the lower parts dark, however, or of dingy orange, the higher and newer tending to dingy yellow.—Pl. XL.

The hydræ are greenish, provided with 19 or 20 muricate tentacula. They are lively creatures, contracting and clasping together suddenly, but of delicate nature, and difficult to be preserved, which, with the tendency of whole specimens to decay, should warn the naturalist not to postpone his scrutiny of the parts, if expecting to find them animated. No peculiarities distinguish the hydræ, except their identity with the muricate tribe. The interval between the denticles or cells, is equal to the expansion of the hydra.—Pl. XXXIX. fig. 7.

It has appeared to me that, from the tendency of the growth, the expanded extremities of a luxuriant specimen might be circumscribed by an elliptical outline. The specimen, Plate XL., which is to be considered a fine one, rose between four and five inches in height ; its diver-



Portularia (Sesuvium) antoniana L. G. Ramona 7-11.

gence was six inches by three, computing from the opposite extremities of the parts.

The stem of the *Ramosa* is generally very short. It consists of tubuli, of which at least an hundred are aggregated when it is a line in diameter. The central tubuli are almost black; those towards the circumference are replete with the pith. A transverse section of the stem exposes a kind of porosity resembling what may be discovered in the thin slices of certain species of wood, under the microscope. But the pores are neither of regular figure individually, nor in regular arrangement.—Pl. XXXIX. fig. 8. This fasciculated structure, which is very obvious below, disappears above and there the different stalks of the parts resolve into a simple tube.

The stem of several specimens of the preceding red species, the *Antennina indivisa*, which were some inches high, but of smaller diameter, proved a simple thick-sided tube. The aggregate tubuli of the *Ramosa*, however, are of perfect and independent organization, such as renders each in vigour capable of regenerating new parts.

On forcible divulsion, the root of this product, the *Ramosa*, separates as a flat mossy tuft, about half an inch in diameter: but the presence of what is either a mass of foreign matter, or a multitude of short radicles, obscures its true formation in the adult state. It is sufficiently evident in an early stage.

Vegetation.—The regenerative faculty seems more vigorous in this Sertularia than in any of the race,—to which we may possibly ascribe the great embarrassment of observers in determining its distinctive features. Such a property, nevertheless, renders it a favourable subject for physiological enquiries.

A group of the green *Sertularia ramosa*, most narrowly resembles a plantation of pollarded trees in miniature. Dark, aged stems, sustain fine green vigorous reproductions above, of all dimensions and in every stage.

If the upper portion of an adult be sundered, shoots issue from the tubuli of the stump remaining behind, both from those towards the centre and from others towards the circumference. Great analogy here appears to the vegetable creation. Subsistence of the pith is indispensable to the

life of the product. Its regular decay commences in the subordinate parts, at the point farthest from the principal part. When beginning at the extremity, decay descends gradually from the newest, slenderest, and weakest parts towards the stronger and older. But its progress may be arrested, and then vigorous regeneration ensues from the point of interruption. Next, the transparent vacant tubular portion above, which the pith had occupied, drops off, and a new shoot rising from the stalk thus mutilated, is clothed in time, like its precursor, with twigs, bearing cells and hydræ. Intermediate interruptions of the pith from decay, throughout the stem and branches, produce similar consequences. Besides these, many sproutings vegetate from the lower parts of vigorous branches, where none were previously seen. All this contributes to the luxuriance of the product, and thus the various parts in various progress, and of varied hue, tend to render these *Sertulariæ* an accurate resemblance of a pollarded plantation.

From the extraordinary effects of decay and reproduction, I have seen a well-marked specimen, so completely changed in the course of a few months, that unless it had been kept under constant observation, nothing could have identified it. This specimen consisted of eight or ten boughs and branches originally. In the course of ten weeks all the larger limbs were reduced to half their pristine length or less, by progressive natural mutilation. Meantime, supervening reproduction had generated above thirty new shoots from different parts,—some of them an inch long; whence, by privation and accession, the greatest alteration appeared throughout.

In one instance, an entire stem vegetated from the lower end of a section which had been taken from the summit of a branch.

Such an extraordinary diversity of aspect, not only in different specimens, but in the same specimen, merely resulting from time and circumstances, renders it difficult to assume such indelible characters as shall distinguish many zoophytes.

Both the red and the green *Sertularia antennina* occurring to me have been always founded on shells.

Propagation.—In the determination of genera, species, or varieties,

the peculiar mode whereby the race is carried on, may prove of great assistance. Little difficulty is experienced here, among the higher departments of zoology, but on descending to the lower, the subject becomes more obscure.

In considering the two products before us, we find the red *Sertularia antennina* rising by a single stem, clothed with innumerable slender twigs, issuing immediately from it, that it bears ovate vesicles set in the axilla formed by the twigs with the stem, each producing a single very large planula: and that the entire specimen may be contained in a cylinder ten inches high, and of eight lines in diameter.

On the other hand, contrasting the green *Sertularia (antennina) ramosa*, we find the adult always consisting of a number of subordinate parts; first boughs originating from the stem, then branches profusely clothed like the other with twigs, but never occurring, to me at least, nearly of equal height, nor bearing similar vesicles exclusively on the subordinate parts.

In very luxuriant specimens of the latter, that is the green, there are interspersed among the various parts, long slender twigs or branches, bordered on each side by the finest, most delicate hairs with cells and hydræ; and bearing long ampullate vesicles.—Pl. XXXVIII. fig. 9.

The last are frequently in vast profusion; sometimes pure white, sometimes reddish, according to the nature of their contents. These vesicles do not in the least resemble the ovate form just described. But considerable difference appears in the length and obliquity of the neck, as well as in the colour, of those of different specimens.

Such are the vesicles usually occurring on the *Nemertesia* or *Sertularia ramosa* of Plate XL. But to comprehend the subject sufficiently, would almost require ocular inspection of the original, for description is not to be conveyed in words.

On the 29th of October, the contents of some prolific vesicles, which had been set apart two days preceding, were found in various progressive stages, and presenting obvious diversity of appearance. Minute spherules or spherical triangular prisms were among them.

Life became evident in the contents of several vesicles now subjected

to the microscope. The spherules were gradually developing in a prismatic form ; and one, as if elongating to its proper figure, deliberately ascending the side of the flask, issued head foremost from the mouth. But it first hesitated there a moment, then dropped down through the water, wherein its fall was sensibly retarded, as if by an invisible thread, and on reaching the bottom, it glided swiftly away. In a few minutes, another rising within the same flask, forsook it under similar circumstances : and then a third followed after a short interval.—Pl. XXXVIII. fig. 10, *a, b*.

The planula thus produced is very minute, not exceeding the sixth part of the size of the single yellow planula from the ovate vesicle of the red *Sertularia*—by which I mean in the quantum of matter. It is white to the eye or grey in the microscope, the head obtusely rounded and about twice the diameter of the opposite extremity, which is obtuse also.—Fig. 11.

The most prolific vesicles of fig. 10, contained about twelve spherules indistinctly disposed in a double row.—Fig 12. But the contents of others amounted to 24, 26, or even 30, under similar arrangement.—Fig. 13. A branch, scarcely half an inch long, bore fifteen prolific vesicles, besides a sixteenth empty and transparent. No definite forms could be discovered in the contents of some ; others contained irregular spherules, which, in several, were evolving into triangular prisms, denoting progress towards perfect planulæ, escaping from the rest. Fifteen embryo planulæ filled a vesicle, all losing their spherical form, which, along with the contents, also discharged from another vesicle, during observation protracted an hour and a half, constituted a brood of 30 mature and perfect subjects in whole. These animals did not surpass the third or fourth of a line in length. No difference from the preceding which had escaped from the vesicle just referred to, could be recognised except in colour, these last being faint pink, while the preceding planulæ were white. They betrayed no activity, unless in quitting the vesicles, which, correctly or not, was ascribed to the coldness of the day. Now the power of a retaining filament was very evident. Everything would have sanctioned the association of these creatures with the *Planaria* proper, in figure, motion, and in habits.

As this insignificant branch bore fifteen vesicles, wherein from 15 to 20 planulæ belonging to each could be enumerated, its fruits amounted to between 200 and 300 in whole.

None of the animals escaped from fig. 13, during observation, though all relaxed into ovoids and prisms, and altered their reciprocal position.

The perfect transparence of the vesicle, exposes whatever succeeds within as the contents are gradually discharged.—Fig. 14.

Specimens of what might be denominated the *Nemertesia ramosa*, occur, with a short stem, boughs, and branches, set at a large angle, together with the prolonged, slender, and very delicate twigs above described, as issuing from parts of the latter. Two such specimens had a ruddy tinge towards the root, while of a dull yellow colour above, where the pith had decayed. The articulations were distinctly seen. Living hydræ occupied the portions entire.

A profusion of ovoidal vesicles, with a heart-shaped orifice, were set in the axillæ formed by the parts of these specimens, each containing a corpusculum, which came forth as a pale yellowish planula, quite the sixteenth of an inch long. It swam supine as the Planaria, and it might have been identified with the planula, coming from the ovate vesicle of the former species, the *Sertularia antennina*, rising by a single red stalk. Similar facts have recurred at different times, when many planulæ were produced.

Besides such ovoidal vesicles, the delicate, slender, plumose twigs bore transparent empty flasks.

Thus the same specimens bore ovoidal and ampullate vesicles.

But greater perplexities have occurred from other specimens, bearing three distinct vesicles on their different parts, stem, boughs, and branches. Such specimens, green and branched, which I concluded the *Ramosa*, were obtained in October. The vesicles consisted of *first*, the *ovoid* with a lateral orifice as described, which never contains above a single planula, and remains empty and transparent on its departure. *Second*, a *cornute* vesicle, or one like an *inverted horn*, the larger diameter outwards, with the extremity a circular mouth: the vesicle set round the stem, after the arrangement of the ovoidal vesicles, being also of about the same capacity.—

Pl. XXXVIII. fig. 15. *Third*, Long flask-shape or ampullate vesicles sustained on the twigs issuing from the branches, which vesicles were not half as large as the horns. Yellow planulæ, half a line long, were produced from these cornute vesicles, exhibiting nothing remarkable.—Figs. 16, 17. They proved rather languid, owing to the chill of October. Some remained entire; others were contracting in two days; and soon after several decomposed into granular particles, as incident to the *Planaria*. Then, the *Animalcula infusoria* are speedily generated.

In regard to the *cornute* vesicle, that or one narrowly resembling it, is represented in *Lamourou's* work on the Flexible Corallines, as distinguishing the *Nemertesia Janini*, the second species of his genus *Nemertesia*. Almost the whole descriptions of that Treatise seem to have been derived from dried specimens, and possibly from very small fragments of them; whereas, in those presenting such varieties, or anomalies, as two or three different shaped vesicles appearing on the same specimens, all its parts must be brought into view.

I shall merely allude to another vesicle which I was induced to ascribe to the *Sertularia* or *Nemertesia ramosa*, of this paragraph, without having had leisure and opportunity to confirm the fact. Thence, on future investigation, it may be found to belong to some cognate. In my specimens, numerous vesicles resembling a vase with a serrate orifice, were crowded together on one side of the stalk, not being disposed around it like the ovate vesicle of the lobster's horn. But this contained a single large planula, with a ruddy tinge, about the sixteenth of an inch in length. Above fifty were produced on September 13, during the course of a single observation. From some unknown cause, a ropy scum formed on the surface of the water in the vessel containing them, which being removed, by replenishment to overflowing, exposed slender spines with an enlarged summit rising from stellate roots. In 24 hours, that is on the 18th of September, a lateral bud, beside the enlargement, displayed a pale green hydra with 16 muricate tentacula. The root had now partitioned into ten or twelve heavy divisions, bounded by a narrow transparent margin. The hydra flourished before the spine had rose three lines. But neither did it, or any others generated on the same occasion, survive above three days.—

Plate XXXIX. fig. 18., Serrate vesicles, producing a yellow planula.
Fig. 19., Nascent Sertularia from the planula.

Amidst considerable embarrassment on the subject, the preceding, combined with other observations, seem to warrant the following conclusions :—

I. That there are two distinct species of the *Sertularia antennina* of the older authors.

II. That the *Sertularia antennina* of the Linnæan system, the modern *Antennularia indivisa*, appears as a single ruddy stalk, ten inches high, begirt by slender verticillate twigs, and bearing axillary ovate vesicles, each containing a single yellow planula.

III. That the *Sertularia antennina* of the same system comprehends also a greenish shrub, diverging into boughs and branches, clothed with twigs: likewise with slender, prolonged, plumose vegetations sometimes interspersed, whereon, besides hydræ, are borne long, ampullate, axillary vesicles, each containing many planulæ.

IV. That three vesicles, all different from each other in form, may appear on the latter, the *Sertularia (Nemertesia) ramosa*.

V. That vigorous reproductive energies reside in the *Ramosa*, which are readily and frequently exhibited: while similar energies are feeble and rare in the *Antennina indivisa* or *Lobster's Horn*.

PLATE XXXIX.

FIG. 1. *Sertularia antennina (Antennina indivisa—Nemertesia Antennina)*,

Lobster's Horn.

2. Twig with hydræ.

3. Section of a stalk with a vesicle.

4. Section of a stalk with vesicles.

5. Planulæ from the vesicle.

6. The same enlarged.

7. *Sertularia (Nemertesia) ramosa*. Twig with hydræ.

8. Section of the stem.

9. Plumose prolonged twig, with hydræ and axillary vesicles, enlarged.

PLATE XXXIX.

10. Vesicles crowded along the rib of a twig. Planulæ escaping from the vesicle, *a*, *b*.
11. Planula free.
12. Prolific vesicle with a double row of spherules.
13. Prolific vesicle, with the contents changing their shape and position.
14. Prolific vesicle, with the contents, originally spherules, relaxing into planulæ, one of which is advancing to the orifice.
15. Section of a stem with cornute vesicles.
16. Planulæ from the cornute vesicles.
17. Planulæ from cornute vesicles.
18. Section of a stalk bearing prolific vesicles, with a serrate margin.
19. Nascent Sertularia, from the planula.

All the subjects of this Plate, unless fig. 1. and fig. 5, are enlarged.

PLATE XL. *Sertularia (Nemertesia) ramosa*.



Portulicaria a. L. Linn. 1753.

CHAPTER V.

CAMPANULARIA.

IT is less from conviction of its use or necessity than from the expediency of compliance with modern fashion, that the present title is applied to the brief chapter introduced here.

Besides, I cannot but judge it questionable whether the genus *Campanularia* should be retained in the *Systema*, at least as now constituted.

If new genera are to be framed from the partial dismemberment of those already established, and augmented by the incorporation of other species, we expect, in the first place, that they shall be founded on indelible characters; and, in the second, that an incongruous association of the component parts of these species shall be avoided.

Naturalists, perhaps too earnest in quest of ostensible distinctions to warrant a change of nomenclature, or to facilitate what they presume are better arrangements, have precipitately adopted as permanent features, what time and study will prove no more than transient.

An example may be probably found in this paragraph. But it is not for that reason the subject is introduced. On the contrary, as we are still engaged with the hydroid arborescent zoophytes, it is for farther illustration of their nature. We also find an opportunity for resuming a view of some remote connection between the origin of one animal and the existence of another, without being able to trace any reciprocity either in form or in habits, between them.

While shortly treating of the *Tubularia ramosa*, in another place, something was said of the mysterious appearance of certain species of Medusæ, and the perplexities wherein they involved the observer. Were

similar instances recorded, our embarrassments might be relieved : for more frequent, easier, and stricter investigation being admitted, doubtless such a train of discovery, and thence the solution of what are to us the most abstruse problems, would follow.

Thus let us patiently persist in our enquiries after the purposes of Nature.

§ 1. SERTULARIA (CAMPANULARIA) DICHOTOMA.—*Sea Thread Coralline*.—PLATE XLI.—The Sea Thread Coralline is one of the most delicate, elegant, and interesting, among the numerous race of arborescent zoophytes, which none of the names hitherto bestowed on it are in the least calculated to express. According to Pallas, it rises a foot in height, whence the species is distinguished by him as *Sertularia longissima*. But none of my specimens have exceeded nine inches. Much allowance must be made for the situation of all such products : nor, on comparing certain apparent discrepancies among those occurring to me, do I think that I have either had the finer specimens, in their greatest luxuriance, or that I am yet enabled to ascertain what are the existing varieties.

This zoophyte rises erect by a dark brown tubular stem, extremely slender, being truly no thicker than a silken thread, but tough and elastic. The whole skeleton is waved—the stem less sensibly, owing to its greater length ; the branches, by about 30 or 40 of which it is environed, are more decidedly so. Here the reader may preserve in recollection, that such products lose much of their original character, simply by increment. Hence, on ascending to the nascent state, it is impracticable to determine what the early zoophyte shall be, unless having seen the parent. Twigs rise from the convexities of the branches of this Sertularia, which, instead of termination by a tubular or cylindrical extremity, dilate as a bell of inconceivable transparence and tenuity. A specimen, eight or nine inches high, might be covered by a hollow cone, four inches wide towards the base.—Pl. XLI. fig. 1.

The skeleton is occupied, as usual, by an internal pith, terminating at the origin of the bell by the evolution of the hydra ; for wherever the

inorganic parts were sufficiently diaphanous, a hydra has always appeared to be connected with the pith. Here the animal is contained entirely within its transparent bell, which is wide and capacious, in proportion to the dimensions of the body, and from hence it ascends to display from 24 to 30 deeply muricate tentacula over the edge. The neck and head are very long, within which the stomach is seen descending quite to the bottom, and the mouth appears above, generally contracted, in a hemispherical form ; but sometimes dilated like a cup. This is a very timid animal. It retreats suddenly within, from complete expansion, and crouches down to the bottom, where it is clearly exposed in its diaphanous habitation.—Figs. 2, 3.

The branches of many specimens are deeply indented by from five to nine whirls, at the forking of the limbs from each other : and similar whirls indent the twig immediately under each bell. But numbers are not so distinguished ; they bear no such whirling ; whence I am disposed to infer, that there are species or varieties with which I am not yet familiar. These whirls do not constitute a spiral ; nor does any part of the product relax as a spring or screw, which might be inferred from the descriptions of naturalists. I have never witnessed anything of the kind among zoophytes. All that I have seen are either simply flexible or they are rigid.

This coralline is of great luxuriance. Before a young specimen had rose an inch, it bore 56 hydræ. One, nine inches high, bears above 1200. All are of light grey colour. The product is white in its origin or earlier stages ; smaller subjects remain so. Their formation is by divergence in the same plane ; but the formation of adults is by branches, springing from around the stem, and shortening as higher above the root.

The decaying extremities of adults are sometimes regenerated, when new twigs together with the hydræ are perfectly white. Now the extreme tenuity of the bell completely exposes the progress of the included embryo. When matured here, as well as when recovered in perfection from the sea, the animal proves of delicate nature, surviving but a short time.

Soon after its decay, the bell falls also, which proves the inconsis-

tency of assuming this part of the organization as a permanent characteristic.

Vegetation.—As already alluded to in the history of other Sertularia, the natural configuration of this species is disturbed by a vigorous renovating extremity coming in contact with some solid substance, such as the side of the vessel containing it. Now, there is no room allowing the alternate origin of branches from the circumference of the stem, during ascent, if that be the mode of its growth. All issue from the outside of the stem, which is climbing in adhesion. From each side of a stem of the same diminutive proportions as the adhering shoot, a branch is generated. Such branches appear as mere spines in this adhering vegetation. The higher extremity of the vegetation does not itself flourish; but a little lower, a spine shoots out, of which the summit soon enlarges with a bell and hydra. At this juncture, the extremity of the vegetation having advanced somewhat higher still, without flourish, a new spine, a little lower than the top shoots out, which speedily enlarges above with a bell, wherein a second hydra is developed. Thus the second hydra is midway between the first and the ascending extremity of the vegetation. Next, while the two are flourishing, a spine shoots out of the twig, bearing the first or *lower* hydra, forking with it and flourishing likewise; meantime the same succeeds in relation to the second or *higher* hydra—the stem in adhesion still continuing its ascent. By this process the lateral vegetation, by means of branches, enlarges the expansion of the new production generated of the adhering shoot; but it is not to the same extent as the vertical vegetation.

The progress of this Sertularia, adhering thus by a shoot in contact, is sometimes rapid. A new hydra has been brought to maturity in 48 hours, from a point where a spine was previously imperceptible.

The originating stem ascending in this manner advances a line in 30 hours, or about an inch in eight days.

The extremity of such a regeneration as now described having reached the side of a vessel, it ascended by adhesion, and dispersed lateral branches, also in adhesion during its ascent. In about a month 62 spines, bells, and hydræ were generated, whereof 30 sprung from the stem, the

rest from the branches. All were entirely new. The reproduction had rose 30 lines, yet its energies were not exhausted, as shewn by farther advances.

Here, after ten spines had been generated, an eleventh shot from the stem on September 20,—next day the hydra was about to flourish. A needle had then forked off it, and hydræ from both were displayed on the 22d. The hydra from the needle decayed in 24 hours. That from the spine subsisted three or four days. The twelfth hydra, mature also on the 22d, decayed in three or four days; so that the animals originating from the reproduction had little permanence.

Propagation.—From anything yet said on this subject, it seems questionable whether the precise mode whereby the *Sertularia dichotoma* perpetuates its race is sufficiently explicit. Perhaps it may be found to bear more than one kind of vesicle.

On rare occasions I have seen numerous ovate vesicles borne by this *Sertularia* among the bells containing living hydræ, and in the proportion of about one to thirty of the latter. Their position is no farther peculiar, than in being seated on the upper side of the branches; and they are generally empty, as if having fulfilled their purpose. When present, their numbers on a branch sometimes amount to eight or ten.

These vesicles are of a grey or a greenish colour. When prolific, they contain twelve or more dull grey corpuscula, each with a dark central nucleus, and all as if compressed together.—Pl. XLI. figs. 4, 6. They are void of any resemblance to the corpusculum in the vesicles described of the other *Sertulariæ*, developing from a globular form, and escaping as an active planula from the orifice of the vesicle.

When the contents of that now in question approach maturity, some internal motion is betrayed towards the summit of the vesicle; the tips of the tentacula of an included animal protrude; then stretching farther, they clasp convulsively, as if to free the body within. After much apparent exertion this is gradually accomplished, but instead of the accustomed planula, we next behold a creature allied to the *Medusa*, which has escaped from its prison.

At first I could scarcely credit the truth of so unusual an occurrence;

one presenting such a remarkable deviation from the nature of the progeny discharged by the vesicles of the various Sertularian tribes. But I was unable to recognise any error, either in the previous existence of the Medusa within the vesicle, or in its liberation from it. I have seen the same repeated several times, though at distant intervals; the last occasion being in July 1840, when a number of vesicles happened to be under observation, all of the same character.

One Medusa at the very bottom of a vesicle had there developed prematurely. It was distinctly observed clasping the tentacula below, while its escape from above was precluded by the intervention of others still immature.

The vesicles in progress, full and empty, are represented figs. 4, 5, 6, 7.

When originally observing this animal, before ascertaining its origin, I had bestowed the name *Tintinnabulum* on it, from its resemblance to a hand-bell; and I believe that its general aspect will justify such an appellation. It is of some importance to find familiar objects for illustrating those unknown. The body resembles a minute watch-glass, half a line in diameter, bordered by a pendent marginal fringe of about 23 muricate tentacular organs issuing from an enlarged root, and nearly as long as the diameter of the disc. A central prolongation below corresponds to the proboscis of the Medusa, which is thus seen while the animal suspends itself in equilibrio among the water. When reversed, it appears like a crest on a convex surface. Four lines with enlarged extremities, diverge from the base of the proboscis; likewise four lines at right angles seem present above.—Figs. 8, 9.

The animal is whitish or almost transparent. It swims by jerks, or bounds like the various species of Medusæ, from collapse of the body, perhaps aided by the tentacular organs. It pursues all directions, rising, falling, or remaining stationary in equilibrio. Like a group of the *Medusa bifida*, these creatures narrowly resemble a flock of minute birds wending their course through the expanse of the firmament.

This animal courts the light.

In the progress of evolution they rise upwards in the vesicle, and in as far as I could discover, the tentacular organs protrude first, in which

if I be right, a correspondence appears between their developement and that of the *Medusa ocilia*. But I should desire an opportunity of repeating this observation. Considerable exertion seems requisite for liberation, and many perish in partial protrusion. All having quitted the vesicle, an opaque columnar substance, with an enlarged summit, remains.

The life of these creatures is transient; they disappear insensibly, or they fall to the bottom of their vessel, where they die. The longest period I have been able to follow them was nine days, when they still rose a little amidst the water.

During March and some subsequent months of summer, numerous colonies of the *Tintinnabulum* have been produced in different years from such vesicles as above described. No other animals have ever issued from them.

The figures given by *Ellis*, Plate XXXVIII. fig. 3. B. and by a later author, Mr Lister, in the Philosophical Transactions, Vol. cxxiv. Pl. x. as of young hydræ escaping from the vesicles of the *Sertularia dichotoma*, are quite unintelligible by me. No doubt it is possible, however improbable, that the ovum in the vesicle of a *Sertularia* may relax as a planula; that a spine may originate from the planula if retained long enough, and then a hydra. But all this is adverse to the ordinary course of nature.

If the accounts of the two authors now named could be reconciled to any facts that have occurred to me, I should conclude that it is the *Tintinnabulum* they have seen escaping from the vesicle of the *Sertularia dichotoma*.

A series of accurate observations on multiplied specimens has still to determine the real distinctions of the *Campanularia dichotoma*, the *C. geniculata* and *gelatinosa*.

PLATE XLI. FIG. 1. *Sertularia dichotoma*.

2. Hydra and bell, front.
3. Hydra and bell, profile.
4. Portion of a branch with a hydra and vesicles, showing their relative proportions.
5. Portion of a branch with immature hydræ still in their cells, and a hydra in retreat, *a*.

PLATE XLI. FIG. 6. Prolific vesicle. Here the contents, as in others, are in a double row.

7. Tintinnabulum or Medusa quitting the orifice of the vesicle.
8. Tintinnabulum at large, reversed.
9. Tintinnabulum in plane.

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

§ 2. SERTULARIA (CAMPANULARIA) VERTICILLATA. — PLATE XII. FIGS. 1–8.—Although the young of this product be sufficiently numerous and easy to be obtained, nor of difficult preservation, its rarity as an adult, in any places I have resorted to, forbid conjectures regarding both the dimensions and the luxuriance which it may ultimately reach.

For many years I was induced to consider the species as consisting of no more than a single hydra in its bell, sustained by a stem; that in this simple form it originated, flourished, and decayed. As such, it should have attracted the notice of preceding naturalists, especially from its size, being one of the largest campanulate hydræ in the Scottish Seas.

In a better stage it has occurred to me as an erect stem, with one or two subordinate branches, but nothing more. However, others have had it in greater luxuriance.—Pl. XII. fig. 1.

This zoophyte rises above two inches high by a short stem, composed of aggregated tubuli, and with an obtuse summit. Branches originate at a large angle from the stem, bearing campanulate twigs and hydræ, in sets of four, five, or six. The twig is faintly whirled, sometimes so indistinctly as to be scarcely perceptible; and the bell is of excessive tenuity. This is in the form of what is called a Chinese bell, having a plain or serrate lip, for both are undoubtedly seen, without denoting a species obviously distinct. It may constitute a variety.

The hydra rises within the bell to display above 30 muricate tentacula.—Fig. 2. But when fully extended, these lose their muricate aspect under the microscope, then resembling articulated organs with several very short obtuse spinous processes from the origin of each articulation. The animal seems to be capable of exercising some slight influence over the twig.

The inorganic parts are of faint greenish-yellow colour; the hydra of



Portularia Campynularia Dichotoma.

a fine ruddy hue—which seems partly dependent on the food or the season. Those highest coloured are always single specimens, that is, consisting of a single bell and hydra, when their numerous long tentacula recurving over the lip might be supposed in alternate arrangement, or almost a double row, which is somewhat the character of the preceding subject. In this state the zoophyte is like a beautiful flower.

The central pith of the twig seems susceptible of contraction and extension by the rise and retreat of the hydra, if it be not an optical illusion. Perhaps something analogous to muscular powers may belong to such minute products.

This zoophyte is generally meagre; but it is embellished by the spreading of the hydra over its delicate bell. In most of the Sertularian tribes, the sheath, denticle, or cell, constituting an inorganic part for reception of the hydra, remains permanent, but here the bell always falls on the decay of its tenant. The two are mutually dependent on each other. There is a striking contrast between fig. 1, a specimen in vigour, and one where only a number of vacant twigs remain.—Fig. 8.

That specimen was embellished by about 100 hydræ with their transparent bells, 70 being on the main stem, and 30 on the branch. All were in the highest vigour, some in ample developement, displaying their lively action, others rising cautiously to spread over the lip of their dwelling, or clasping the tentacula, and suddenly crouching down in retreat below. But their decay was rapid. In 48 hours from the first enumeration when obtained, the whole were reduced to 36, distributed in equal proportion on the stem and on the branch. In another day only 6 remained; on that which followed no more than one. Most of the bells had also fallen.

Thus had an hundred living beings perished on the fourth day after vigorous animation.

Meantime from the same reproductive energies residing in other species, many of the vacant twigs which had previously borne animals were extending, and speedy regeneration ensued. A long clavate enlargement of the growing twig unfolded as a new hydra with its bell.

Thence it is evident that decay of the bell should be concomitant on the decay of the hydra. It is part of the arrangements of Nature.

In this manner five hydræ were generated on the main stem between May 2 and 6, and seven on the branch between May 2 and 7. But the branch becoming limber, proved in total decay on May 29.

After the stem had been sundered near the root, a shoot rose from the remaining stump, which bore a hydra in eight days.

A twig from the sundered portion having come in contact with the glass vessel containing it, extended and generated subordinate parts. Thirteen hydræ were generated from them in eighteen days, and one additional in the course of a month. The period of their subsistence was usually two or three days.

Three shoots had descended from the extremity of another sundered stem, each extending half an inch in nine days, and then bearing a hydra. Their length having doubled in a week, one bore two, and each of the others three hydræ, all vigorous.

Thus there are generations both by ascent and by descent, because a prolific shoot rose from the preceding stump; and prolific shoots descended from the lower end of the section.

These facts may be compared with what is said of the *Sertularia fascis*, and of others.

Considering the position allotted to this product by modern systematists, the mode of its propagation merits notice.

It is seen that the preceding species of the *Campanularia* or *Sertularia*, the *dichotoma*, discharges a number of minute Medusæ. The present species bears a prolific ovoidal vesicle, exactly resembling a Florence oil flask, with a long tubular neck and circular orifice. Vesicles of this kind, interspersed irregularly with the twigs on the stem, have occurred in May and in July.—Fig. 3. Instead of Medusæ, they contain three or four planulæ, which are very conspicuous within; figs. 4, 5, and escape when mature, as white, fleshy, and a little flattened, fig. 6.

The rarity of the product has opposed my further investigation of the history of these creatures. If they truly belong to the same genus as the *Sertularia dichotoma*, it would be strange to find one of them propagating through the medium of a Medusa, and the other through that of a planula.

Specimens of the *Verticillata* appear of finest quality in their earliest

stage, when dispersed as single hydræ, or when the zoophyte consists of very few. They are numerous scattered over shells, founded on *Ascidie*, or rooted on other products; these are always larger and their colour more vivid.

From their frequency in the single state, together with the rarity of adult and luxuriant specimens, the naturalist receives a useful warning against presuming on the ultimate aspect of any zoophyte. Likewise, on finding nothing but the twigs or pedicles of fallen bells, interspersed with vesicles, as in fig. 3, which very shortly follow them, he will perhaps deem the *Campanularian* form too equivocal a characteristic of the species.

PLATE XII. FIG. 1. *Sertularia (Campanularia) verticillata*.

2. Hydra displayed from its bell.
3. Vesicles interspersed with twigs of fallen bells.
4. Prolific vesicle.
5. Prolific vesicle.
6. Planula.
7. Bell with a serrate lip.
8. Regenerated portion, having lost the hydræ and bells.

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

§ 3. SERTULARIA (CAMPANULARIA) DUMOSA.—PL. XXVI. FIGS. 22–25.
—The narrow resemblance of this product to common furze, when viewed by the naked eye, had induced me to name it *Sertularia Ulex*, before having been aware of its distinction otherwise.

Though now enrolled by some authors with the *Campanulariæ*, its structure is very different from that of the two preceding species.

It appears, like many, under some modification; but it does not seem to grow in much luxuriance wherever I have sought it.

The *dumosa* rises two or three inches, by a short stem, subdivided meagrely into boughs and branches, with a slight incurvature.—PL. XXVI. fig. 22. Long inverted, transparent, conical cells, not bells, issue from around the boughs and branches, their opposite orifices being about a line asunder. They seem disposed in pairs, that is, one opposite to the other,

in some specimens, but less definitely so in others. The cell is sessile or without the intervention of any pedicle or twig connecting it to the stalk.—Fig. 23.

The hydra is well exposed through the sides of its transparent cell, when the body is discovered as originating immediately from the internal pith of the stem, or branch whereon the cell is sustained. It is of much smaller diameter than the cell, tapering regularly downwards, and ascends to display from eight to fourteen deeply muricate tentacula. This great irregularity of the number occurs on the same specimen.—Fig. 24. There is likewise a difference in the form of the cells, from which those of the same specimen are not exempt. But it is most conspicuous on the comparison of several.—Fig. 25. The lip of the bell is even. The general aspect of the adult hydra is greenish-yellow. Vivid grass-green distinguishes the hydra itself and all later accessions. The cells are of the faintest yellow, older formations are brown.

Probably the hydra is regenerated. In its progressive advances it is seen in a long clavate shape, through the side of the cell, with some enlargement of the pith at the point whence it originates.

Short shoots frequently issue from each extremity of a section, which, if vigorous, bear hydræ, but if feeble, they extend irregularly and prove abortive.—Fig. 24, *a*.

It seems a general law with the greater part of the Sertularian tribes, that hydræ shall develop from all vigorous vegetation conveying the pith. But nothing animated comes of what is feeble and irregular.

Nevertheless, the precise order of the new subsidiary parts is disturbed on the contact of such vigorous vegetation with solid substances. A section of this Sertularia had generated a shoot an inch long, which in seven weeks had run in adhesion along the bottom and up the side of a vessel. Three cells with hydræ sprung from the horizontal portion on the bottom; and one, which was abortive, from that on the side. These four would have stood in pairs, nearly opposite, had the stem been free. Now the whole rose from the upper side only. Long shoots, bearing cells with hydræ, were at the same time vegetating from the lower extremity of other two sections.

Thus, hydræ are generated from descending as well as from ascending parts of the *Sertularia dumosa*. I know not whether this may be found a feature more peculiar to zoophytes with a compound stem.

PLATE XXVI. FIG. 22. *Sertularia (Campanularia) dumosa*.

23. Portion shewing the form of the cells: hydræ in decay.

24. Portion with the hydræ displayed. This is the extremity of a branch. Vegetating shoots, *a*.

25. Portion of another specimen, with cells and hydræ.

All these figures, except 22, are enlarged.

§ 4. SERTULARIA (CAMPANULARIA) SYRINGA—*Creeping Bell Coralline*.—PLATE XII. FIGS. 9, 10.—I find some difficulty in identifying this product with what learned authors distinguish by the same name. The accompanying figures may be a guide to the truth.

In certain respects the *syringa* falls within the characters assigned to the genus *Campanularia*, but not in others.

It always occurs, in as far as I have seen, as a parasite, ascending other zoophytes like a slender thread, bearing cells with hydræ.

To the naked eye, the cells are like so many spines of horn colour, but seldom contain living animals, which perhaps indicates their delicacy. They are of a long and somewhat campanulate shape, with an even lip, rising on short pedicles, from the stem or thread, with about four whirls. The pedicles originate at a considerable distance from each other. The hydra protrudes a long, slender, transparent body, crowned by about 16 muricate tentacula. That number has been ascertained as the complement of several. I have not observed any of the hydræ with only eight tentacula, which is, in fact, a very rare characteristic of any of the marine hydraoid zoophytes. I do not deny its existence, however. Such a number of *muricate* tentacula may be rather incidental than general.

The whirls are occasionally very distinct; but I have never been able to ascertain that they are in a twisted form or arrangement.

As the bell or cell does not fall on losing the hydra, its relation to the animal seems different from that of some species of the *Campanularia*.

PLATE XII. FIG. 9. *Sertularia syringa* investing both sides of a section of the
Sertularia dichotoma.

10. Hydra and empty cells of another specimen.
Both figures are enlarged.

§ 5. SERTULARIA ARCTA — *The Crowded Sertularia*. — PL. XLII.
—Much hesitation may be entertained regarding the correct position of this product, which is apparently allied to some intermediate genus approaching the investing *Flustræ*. But the Ascidian hydra of the *Flustra* itself, denies its reception there: neither, for the same reason, can it be confounded with the *Alcyonidiæ*, to which, in perfection, it bears some analogy; for here the zoophyte is hydraoidal. Leaving its precise place, for the present, the product is now introduced merely for the convenience of associating it with other hydraoids.

It is generally found as a small, irregular, flattened mass, seldom of regular figure, seated as a parasite on the angles formed by uniting branches of the *Sertularia falcata*. The dimensions and the shape are alike various. Sometimes it is six lines by two, if of an oval figure.—Pl. XLII. fig. 1; but rarely appearing so symmetrical.—Fig. 2.

In as far as I have yet observed, this mass consists of a single stratum of long, curving, tubular cells, crowded closely together.—Figs. 3, 4. Where best exposed, as on the margin, the curvature is most conspicuous, that of some, there exceeding a semicircle.—Fig. 4.

A hydra with eight muricate tentacula occupies each cell, stretching much beyond its circular orifice, but offering nothing else remarkable. The complement of tentacula may be rated at eight, though some individual hydræ have ten.

This product is not common; it has never occurred to me otherwise than as a parasite; and it may be readily overlooked.

Propagation.—Here, as in many preceding species, the perpetuation of the species is effected through the medium of a planula, such as is peculiar, under some modification, to that which is the origin of zoophytes, whose hydræ are provided with muricate tentacula. This animal appears

in October and November. It is very minute, not extending the third of a line, of vivid green colour, and at first of the wonted habits, form, and aspect.

But instead of being generated within a pod or vesicles as others from the hydraoidal Sertulariæ, its matrix consists of a congeries of cavities or compartments, as seen in the surface of the mass.—Fig. 5. An aperture being discovered in the middle of each after the planula has been discharged, we may presume that no more than one is contained in a compartment.—Fig. 6.

These animals are extremely numerous ; at least 150 quitted a specimen during the last days of October and the beginning of November,—all concentrating soon in a watch-glass.

When fresh and vigorous they are not distinguished by any noted peculiarities, nor until in early preparation for the usual metamorphosis.—Fig. 7. But important changes ensue as this advances, and they are such as I have not witnessed in any other of the tribe. When the planulæ are about to remain stationary, the body becomes round and deeply annulated, exhibiting a number of prominent segments, like the whirling lately described as indenting the stems and branches of zoophytes. Then they have much the appearance of minute green leeches, excepting in the rings, their vivid green colour being still preserved.—Fig. 8.

In a short time one end of the planula forms an enlargement, while the other is elongating.—Figs. 9, 10. A bud swells above, fig. 11, which rising as a long cell, shews an internal hydra under different aspects in progressive evolution.—Figs. 12, 13, 14. At length the whole organic structure being perfected—the animal is completely unfolded.—Fig. 15.

As the hydra advances, two rings enlarge the body near the root, and the origin of the head, which afterwards disappear on the attainment of greater maturity. The lower extremity of each subject seems affixed below ; the higher rises in a clavate form.

The concentrated multitude, fig. 15, in as far as can be observed, does not consist of so many hydræ incorporated together, or united to any common substance, in such a manner as to be compared, for example, to the *Flustra*, all seem to be only in approximation.

The planula becomes motionless in about eight or nine days after quitting the matrix ; and other seventeen or eighteen elapse before evolution of the hydra. Therefore this Sertularia reaches perfection in about twenty-six days after the planula escapes.

When the whole planulæ of a specimen have forsaken their compartments, the mass affording them, previously of a green colour, is now converted to grey. After the concentrated nascent hydræ disappear from their cells, those in their decay seem to leave the bulbs at the root, as bearing considerable resemblance to the mass of compartments.

All the preceding details apply to objects which are very minute.

No corresponding mode of propagation among zoophytes has hitherto occurred to me ; and although the subject of repeated observation, it is sufficiently interesting to merit further inquiry.

PLATE XLII. FIG. 1. *Sertularia Arcta*.—The Crowded Sertularia.

2. Another specimen.
3. Margin of the same.
4. Margin of Fig. 1.
5. Surface of a mass of compartments.
6. Portion of the same, showing the orifices left by the escape of the planulæ.
7. Planulæ.
8. Planulæ metamorphosing.
9. Nascent Sertulariæ from the Planulæ.
10. Nascent Sertulariæ advancing.
11. Nascent Sertulariæ in further progress.
12. Nascent Sertulariæ with the hydræ protruding from the cell.
13. Nascent Sertulariæ far advanced.
14. Nascent Sertulariæ.
15. Nascent Sertulariæ, originating from the planulæ, now come to maturity.

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



Actinaria - Actis

ASCIDIAN ZOOPHYTES.

Our attention has been hitherto directed principally to those Zoophytes whereof the living tenant, if not to be absolutely identified with the structure and habits of the hydræ of the fresh-waters, or with that above described of the sea, certainly offers many essential points of correspondence.

There are some other products equally meriting commentary, whose animals, more elevated in the zoological scale, exhibit an organic frame of greater apparent importance and complication, as if to discharge certain higher functions.

But it cannot be affirmed that superior benefit is derived from the multiplication and arrangement of such organic structure, or that functions of greater utility are performed, than what are effected amidst the simplicity of humbler beings. The vital principle is neither stronger, nor is it of longer endurance; it is not less the subject of casualties; the perpetuation of the race is not less dependent on the circumstances wherein they are placed; while the portion occupied by the others of simplest form to our apprehension, is uninterrupted in the distribution of the animated universe.

Human comparisons of perfection, therefore, are rather relative than positive. None but the CREATOR can judge justly of the degree of perfection allotted to his creatures.

Scientific observers having devoted themselves to investigation of a rude and shapeless animal product, the *Ascidia*, generally more like a lump of inanimate matter, than a being endowed with vitality, they there found a most curious and interesting internal organization, veiled by the coarsest exterior. Now was a structure revealed, elevating this rude mis-

shapen mass far above many creatures whose symmetrical parts and ornamental aspect were calculated to invite admiration.

The general correspondence of some of the internal structure of the *Ascidia*, with that of the animated tenants of an extensive tribe of zoophytes, suggested a distinction, whereby the latter should be denominated ascidian, while the former, whose properties we have discussed, should be characterised as hydraoids.

Although, in the strictest definition, this denomination, *ascidian*, might be rejected for animals so different in various important features, it proves a convenient distinction. Naturalists will find many facilities in its adoption; besides the meagreness of language itself compels us to admit much, especially for avoiding circumlocution, which would be otherwise rejected.

Farther, it is impossible to assume every trivial characteristic assigned by each transient, or even each permanent observer, to the favoured subject of his studies as a distinctive feature whereon some leading division of the animal kingdom shall repose. Nor will such projects, now too common, perhaps, prove lasting auxiliaries to science, until the learned coincide completely on those to be held decisive.

Herein, I conceive, more intimate knowledge of individual species, that which is only to be gathered from the preservation of individual specimens, is requisite, than we have yet attained. Therefore we cannot dispense with endeavouring to procure the multiplication and the corroboration of facts. No doubt this costs the sacrifice of time and trouble, but the reward is durable.

In regard to the ascidian zoophytes, I shall abstain from attempting to detail the anatomical structure of their minute inhabitants, which has been done so well and so satisfactorily by others. It is always of difficult detection and demonstration in the living specimen, nor to be otherwise accomplished than by simple inspection, when transparency of the dwelling and of the integuments of the creatures exposes the interior,—an opportunity very seldom offered. On considering such an obstacle, invincible in many, I cannot but remark that a degree of precision sometimes appears in the representation of internal organization, which seems to be deduced



Bellularia (Metania) Loriculata

rather from presuming what the internal parts ought to be, at least in certain respects, than from truly discovering what they are. The resemblance presented is only a modification, of which the skilful microscopician may convince himself; yet we cannot deny that it may approach the fact.

For satisfactory elucidation of the structure and history of some Ascidian zoophytes, let me refer the reader to the very copious memoir of an intelligent author, Dr Farre, in the *Philosophical Transactions* for 1837, together with the useful abstract and illustrations by Dr Johnston, in his general treatise on British Zoophytes. In the former, the anatomy of several species is distinctly explained; and a few notices relative to the propagation of the respective genera, all accompanied by numerous figures.

Perhaps the subject of the ascidian zoophytes should be introduced with some more special commentary on the form and the habits of the *Ascidia* itself. But independently of their combination with a foreign substance, which I have not seen in any of the *Ascidia* proper of Scotland, the tenants of that substance are, not real *Ascidia*, being only participants in certain analogies, nor these of a very intimate kind.

No greater apparent difference can separate two animals of opposite genera than the external character of the *Ascidia proper* and the *ascidian* zoophyte. The former resembles a mass of mere inanimate matter, commonly rooted to the same spot or substance, which it is incapable of quitting. It scarcely betrays the rudest indication of any propensities or instincts. All its changes, alterations, and actions are confined to an almost insensible enlargement of the body from the absorption of water, slight dilatations of its orifices for the reception and discharge of muddy matter. The rigidity of the body of the majority of the *Ascidia* restrains either its distention or contraction. Their whole sensations seem more obtuse to external impressions than those of most living creatures. Hence are their habits and configuration so little calculated to invite notice; nor until stripped of the coriaceous exterior covering, is the curious internal structure laid open to the beholder. Hence also is almost all that has been said of the ascidian tribe confined to anatomical formation.

As I shall probably resume a few general observations on the *Ascidia* in a subsequent section, the reader may be here referred to the ample in-

formation on both the simple and compound genera, contained in the works of M. Savigny and M. Milne Edwards, together with the notices by Mr Lister in the *Philosophical Transactions* for 1834.

Whoever views the *Ascidian* tenant of zoophytes, will be forcibly impressed with the noted difference of its whole appearance, nature, and habits, from those of the animal just referred to. It is full of life and vivacious activity, readily quitting that retreat wherein its numerous tender flexile organs are temporarily contracted, for security. The gentlest touch, even modifications of the intensity of light, are sufficient for the display of acute sensations. It can manifestly exhibit its apprehension of danger and its conviction of safety. Its numerous parts are shewn in rapid motion, as if in quest of sustenance, and the exercise of some of the vital functions may be occasionally discovered, while its most prominent organization is subject to continual and instant changes.

Thus the nature of the product is very different, it is almost directly opposed to that of the *Ascidia* proper.

The inorganic portion, that is the polyparium, foundation or dwelling of some *Ascidian* zoophytes, admits of narrow comparison with that of the hydraoidal race. Possibly on a very comprehensive view, a parallel might be found in the majority. But others, in this country at least, present much variety both in form and substance; and we seem as yet to be in absolute ignorance of the real connection or relation of the different parts with each other.

The elements compounding that portion and the arrangement of the parts, seem more numerous. These elements, to consider them generally, are membranaceous, gelatinous, or calcareous: they appear in flattened surfaces, elevated in tubular cylinders, rising in lobate masses, or in a foliaceous form, besides assuming fistulous shapes not remote from those of the *Sertularia*.

From this variety naturalists have endeavoured to frame a vocabulary or a kind of descriptive nomenclature, significant of the form of the dwelling, combined with the structure of the tenants. But the obstacles to their design, so excellent and so laudable in itself, prove almost insurmountable. Until common consent shall determine what is to be held a

sufficient distinction, one class of observers can be hardly expected to sacrifice the features assumed, as predominant to those which are favoured by another. Hence the perpetual vacillation, which renders it preferable to admit some conventional term, even though less appropriate, for there cannot be an equal desire for its alteration.

On this principle, I shall refer to the tenant of the ascidian zoophytes, in much the same signification, as to the *hydra* of the preceding tribes, and also by the name of *hydra*. I am not insensible that, by such a latitude, I stipulate for a license beyond the strictness which definition would allow, but that will prove more than compensated by the advantage of avoiding circumlocution; nor does it involve the reader in the slightest perplexity. Besides, it obviates that intertexture of words meant to render an intricate compound expressive, though, in truth, they tend to enfeeble and confound each other. The simplicity of definitions from name and character, preserved by such skilful authors as Linnæus, accustomed to contemplate the grand scale of the animal world; and of Otho Frederic Müller, viewing it in ample detail, merits modern observance.

The tenant of the *hydraoid* zoophytes is comparatively a simple animal; its internal organization, as that of the hydra, if consisting of various parts, seems very little understood. The tenant of the *ascidian* zoophyte, where the cellular partition and integuments admit, is seen to be of more complex structure, and by the same means we discover much diversity in their nature.

While the ascidian hydra is quiescent, the transparence of some zoophytes shews it contracted in the cell, doubled on itself, the tentacula compressed together, and the orifice of its habitation closed. As it rises to display its parts, the orificial membrane above is carried upwards, along with the body, and dilates as the body unfolds, like the inverted finger of a glove, turning outwards. Now, it may be observed, that the body of the tenant is attached below, by ligaments regulating its rise and descent; that the orificial substance of the cell is a continuation of its external integument, and is carried up from its union with the animal, until the closed pencil of tentacula can display themselves. As the hydra sinks below, the same skin drawn downwards, closes as an operculum over it, when the

summit of the cell becomes a conical or an ovoidal prominence. It is difficult to render this intelligible without inspection of living specimens.

Now, the hydra reposes in absolute quiescence. Next, when rising to display itself, a percussive action is exhibited by the expanded tentacula, as if they were inflicting blows on something in their vicinity. The neighbouring visible particles are attracted apparently by a vortex, and tossed about among them. Then, also, it is discovered by microscopic aid, that the surface of each tentaculum, instead of presenting mere inequalities or the muricate character, distinguishing that of the hydraoid zoophytes, is bordered on each side by numerous cilia, or short and stout hairs: that the particles coming in contact with them are transmitted along the border, upwards or downwards, or from one to another: and that they are finally absorbed in the central mouth of the animal.

But this ciliated structure is to be recognised, in general, only under favourable conditions, and by optical instruments of superior power and quality. The effect, indeed, may be often seen while the cause is unknown, insomuch that reputable observers, either from their own defective vision, or ignorant of the proper means of assistance, have denied the presence of the cilia ascribed to such hydræ by more successful naturalists.

Since Dr Fleming directed the notice of observers to the functions of the *Cilia* of zoophytes, others have assigned an important office to those occurring on many different animals. The reader will peruse with much interest the article *CILIA*, by a learned anatomist, deeply versed in the history of the lower tribes, *Dr Sharpey*, Professor of Anatomy and Physiology in University College, London, composed for the Encyclopædia of Anatomy and Physiology.

Doubtless, that creative power devising the wondrous structure of animals, assigned some definite use to all their organs; but I know not that these are yet completely disclosed to naturalists.

In many such products, a distinct view of the hydra itself is obscured by the intervention of neighbouring parts: and the minute inspection of some is impracticable.

I shall now proceed to offer a few general remarks on several genera and species of the ascidian zoophytes, in as far as they seem to me to merit



Cellularia (Notamia) Sericulata

observation. Sometimes they are separated by very slight distinctions; the names proposed for them are so various, that every one must waver greatly in their adoption, nor can I pretend to determine which is preferable. Much remains to be done in this respect, both in gaining additional knowledge of the genera, and in the significance of the formation and nature of the species, to sanction the appellative more peculiarly applicable. If selecting one, it is by no means for the purpose of derogating from the correctness of another.

§ 1. CELLULARIA (NOTAMIA) LORICULATA—*Coat of Mail Coralline*.—PLATES XLIII., XLIV.—This product occurs in large, thick massy tufts, several inches high, and several inches across, so dense and confused, that its peculiar structure must be ascertained from smaller specimens. I regret that my inability to procure those of considerable dimensions of suitable form, though an abundance of others may be had, compels me to leave the best illustrations for a supplementary Plate. A few other subjects are under similar circumstances; some of the Sertulariæ were sought for above ten years before obtaining specimens for the most satisfactory representation.

The *Cellularia loriculata* generally assumes somewhat of a conical figure, whence the longest parts diverge from the lower half of the stem; they shorten upwards, and terminate almost in a point or obtuse vertex. This seems the natural configuration; and even when luxuriance and bushiness restrain the regular shape, wherever the extremities are free, they are so distinguished.—Plates XLIII., XLIV. figs. 1, 2.

I have not observed the root of the adults of circumscribed or definite form, farther than as a scale of very small diameter. The stem for some short distance above it exhibits irregular articulations, which are not evident in every specimen.—Fig. 3. Alternate branches with their subordinate parts, the whole tending to the same general formation, originate from the stem, fig. 4. enlarged. The cells, very low, scarcely projecting from the level where situated, have an elliptical orifice; they are arranged nearly in pairs, opposed back to back, from which peculiar feature, Dr

Fleming, a *practical* observer, proposes to institute a genus *Notamia*, expressive of it.—Plate XLIV. fig. 5.*

Some analogy may be found between the general arrangement and form of the parts of zoophytes unconnected by genera. The cells of the *Loricularia*, an *ascidian* zoophyte, for example, are in such a position that their tenants protrude in opposite directions. Nearly the like is seen in the *Sertularia pumila*, an *hydraoid* zoophyte, where the orifice of the cell is considerably elevated.—Plate XXVI. figs. 15, 16.

A large specimen of the *Loricularia* is composed of numerous principal and subordinate tufts, each of which would occupy a cone of smaller diameter in proportion below than fig. 1.

The hydra is minute, lively, and active, almost transparent, or dingy white; it seldom protrudes from its dwelling, which has scarcely any perceptible margin. When doing so, twelve is the usual number of tentacula displayed. Some have fourteen. The hydræ rarely occur alive; and observations can be made only on the merest fragments, from intervention of the numerous parts. The tentacula have a percussive faculty, and the hydræ vanish in a moment.

If these creatures have any reciprocal connection, the means whereby they are united is undiscovered. Probably the cells from which they protrude in opposite directions, are separated by thin parietes peculiar to the successive pairs disposed on the twig. But owing to the inconvenient interception of the observer's view, from the multitude of parts, he is exposed to much embarrassment in obtaining such a position as to allow satisfactory delineation of the living specimens.

Dark umber-brown distinguishes the lower parts of this zoophyte; a shade of which, together with dingy white, pervades the remainder. New accessions towards the extremities are pure white. Some specimens present a more luxuriant and richer aspect from speckling; perhaps owing to the numerous hydræ that have perished in their cells.

The substance of the product partakes of a calcareous nature.

* It would be highly beneficial to science, were Dr Fleming to complete his useful work on *British Animals*. His definitions are so clear, explicit, and applicable, as to stamp authority on the volume already published, and to prove it the result of correct observation and laborious research. No one could be better qualified for the task.



Sellularia (M.) Loriculata

PLATE XLIII. *Cellularia (notamia) loriculata*—Coat of Mail Coralline.

PLATE XLIV. FIG. 1. Specimen growing from a portion of sponge.

2. Branch.

3. Stem.

4. Branch.

5. Twig with cells.

6. Twig with hydræ.

All the preceding figures, except 2, are enlarged.

§ 2. CELLULARIA REPTANS—*Creeping coralline*.—PLATE XLV.—This is a product whose curious, determinate, and elegant formation, eluding the unaided vision of mankind, can be discovered only by microscopic means. What idea can we entertain of the Power that planned and executed such a wonderful species of architecture—so many edifices—such an arrangement—together with the inhabitants that occupy them! Here is presented a vast colony of living beings—all dwelling in peace—no one interfering with another's safety. In the marvellous field of the animated universe, every step unfolds some novelty arousing our admiration of the works of the creation.

This zoophyte is generally established on others, especially on the *Flustra foliacea*. It rises an inch in height, by a very short stem, and diverges as much into subordinate parts, all tending to dichotomous formation, or each cleaving in two.—Pl. XLV. figs. 1, 2.

The stem and all the rest of the parts are clothed with a double row of cells, in alternate arrangement. Their orifice, nearly level with the surface, is elliptical, and their higher extremity guarded by two or three short spines. A lively ascidian hydra, with twelve tentacula, inhabits the cells, but exposing so small a portion of the body that its nature and form are to be rather presumed from analogies, than described and demonstrated. The tentacula are slightly recurved: they are endowed with a percussive faculty: particles are attracted, tossed about and repelled, by the hydra, which retreats instantaneously within its dwelling. The whole product is of a dark brownish-yellow: the portion of the animal exposed

is very pale, almost colourless: but the opacity of the cells precludes a satisfactory view of their contents.

Some specimens appear speckled red.

The vegetative faculty of specimens, though abortive of animals, seems to be denoted by numerous slender prolongations, scarcely grosser than hairs.

Many minute beings seek shelter among the multitude of cells, from whence they either issue forth occasionally, or are dislodged by the impurity of the water.

Besides its foundation on the *Flustra foliacea*, this *Cellularia* establishes itself on the external surface of various shells, or it finds a safe and convenient nidus within some, such as those of the mussel and oyster, when empty.

The specimen represented, being perfect, was selected from among many.

PLATE XLV. FIG. 1. *Cellularia reptans*—Creeping Coralline.

2. The same, enlarged.

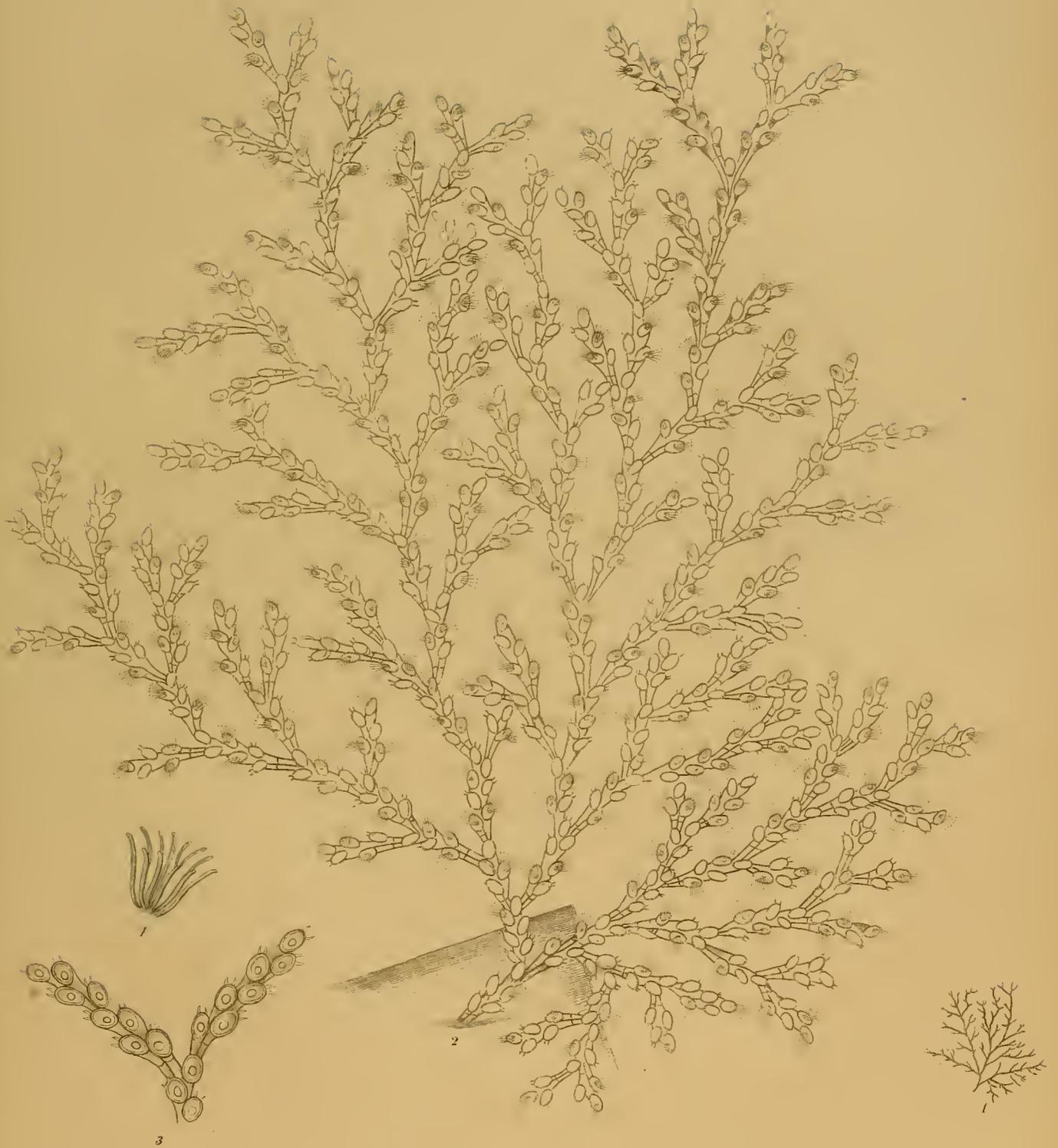
3. Aspect and arrangement of the cells, enlarged.

4. Portion of the hydra which is exposed, enlarged.

§ 3. *CELLULARIA FASTIGIATA* (*SERTULARIA FASTIGIATA*, *Linnaeus*).—
PLATE XLVI.—It is often very embarrassing to determine the identity of species, or whether a certain subject before us may not be a mere variety.

Spite of all precautions, I feel very sensibly that I have been sometimes misled by appearances; whence, if our arrangements shall be guided by the structure of the inorganic parts, when life has fled, I believe that they will afford greater facilities than the animated subject.

We can readily account for embarrassments resulting from the minuteness and frequent indistinctness of the organs of zoophytes: from the alteration of their relative position by age and increment, that elusory characters are necessarily assigned to many, from different observers having assumed younger or older specimens; the barren or prolific: that various portions of the same specimen, where common features peculiar to



Gelularia Reptans

each, have been taken : that absolute identity of features, in fact, does not exist ; or remains to be unfolded. All this must conspire to embarrass one observer, when in quest of what has been described by another, to say nothing of the difficulty of distinguishing accidental from natural vegetation, the influence of the seasons ; and especially as we have yet to learn those periods of the year when, in preference to others, our enquiries regarding particular points—such as the multiplication of individual species, may be profitably directed.

Unless in instances comparatively few, I cannot but conclude that we are still insufficiently acquainted with numerous important facts and distinctions, those to be the basis of undeviating authority. Thus, instead of pronouncing the identity of species, which no doubt would simplify our treatise, it is, meantime, better to keep them apart until obliterating equivocal by positive characteristics. Should this be practicable, the present zoophyte can be easily conjoined with the subject of the fifth paragraph, as the fourth is purposely interposed.

This species has been denominated a *Sertularia*, a *Flustra*, and a *Cellularia*, by different authors. It rises two inches or more in height, by a short stem, sustaining a bushy and somewhat globular head. Several principal boughs subdivide into branches, which multiply in subordinate parts. The older portion is of an umber colour, the extremities being lighter, and, if new, they are white. A fine and entire specimen bears much resemblance to an aged tree in miniature, whereof there is a slight convergence above and an expansion from below.—Pl. XLVI. fig. 1.

The structure of this product, in detail, approaches the dichotomous formation, or cleaving of the principal into two subordinate parts. But it is somewhat irregular in respect to different portions, as will be seen from fig. 2 to 7, inclusive.

Cells are ranged on one, and occasionally on both sides of the subordinate parts ; but here also without uniformity.—Figs. 3, 4. A large cylindrical or slightly tapering spinous process prolongs the exterior edge of the cell, whose presence may denote perfection : though it is absent in some specimens apparently entire.

The parts are irregularly articulated, but no precise relation is to be

discovered between the articulations and the cells ; there is no definite correspondence in number or extent.

A hydra, with a pencil of 16 or 18 tentacula, rises within, to display them from the orifice of the cell, which is so transparent as to expose its almost colourless, long, tapering body, affixed by ligaments to a remote point below, figs. 8, 9. One or two fine vermilion ovular substances are contained in the body of many, rising and falling along with it. Their nature has not been explained.—Fig. 4. Numbers are free of them. The hydra is alike lively as others, clasping its tentacula together when displayed, exercising them in percussive action, with all the peculiarities distinguishing the vigorous tenants of ascidian zoophytes.

The stem should consist of aggregated tubuli, to judge by the shoots sent forth of the extremity, when sundered. At least 15 filamentous prolongations issued downwards from a section, ultimately extending much farther in proportion than represented in fig. 10, and adhering to the vessel wherein deposited. Meantime the opposite extremity was vigorously regenerating hydræ within, and the avicularium without the cells.

All the higher parts are regenerated, as may be seen from different specimens, in various stages, where the colours are contrasted. The regenerations are of the palest grey, almost or entirely white.—Figs. 5, 6, 7.

This product occurs at an early period as a single stalk, not a line in height, with its hydra displayed. Another hydra is generated, in the next place, on the same side, and then a third still higher. The final modification and arrangement of the parts belong to a later era.

A white, opaque globule rested on the orifice of several cells of a specimen obtained in the beginning of March, during survivance of living hydræ on other parts. Active avicularia, of which more particularly hereafter, were also dispersed over it.—Fig. 11.

Specimens are frequently stained with red patches. If any be at first pale, they become soon deep coloured : the hydræ are found dead, and the avicularia motionless. Those thus distinguished are very beautiful.

The parts intercept each other so much, and are so numerous, that the smallest fragments only can be taken for microscopical observations.

This zoophyte is always rooted on solid substances. It is not common.



Cellularia fastigiata

PLATE XLVI. FIG. 1. *Cellularia fastigiata*.

2. Portion shewing the arrangement of the parts.
3. Portion with hydræ.
4. Portion with hydræ, shewing the formation of the cells :
also the distribution of the avicularium.
5. Higher portion regenerated.
6. Higher portion with regenerated hydræ and avicularium.
7. Higher portion regenerated with hydra.
8. Hydra.
9. Hydra.
10. Section generating descending shoots.
11. Section with hydræ, globular substance on the cells, and
avicularia.
12. Avicularium in repose.
13. Avicularium active.

All the figures except the first are enlarged.

§ 4. CELLULARIA CILIATA—*Ciliated Coralline*.—PLATE XLVII.—None of the numerous tribe of Corallines can exceed the symmetry, elegance, and beauty of this interesting product waving amidst the waters. The singularity of its parts and proportions, seem to have originated with the vigorous efforts of a sportive organic nature.

The general appearance of the Ciliated Coralline is a minute and nearly circular fan, sustained by an undulatory stalk, with a slight recurvature from its weight and expansion.—Pl. XLVII. fig. 1.; fig. 2. enlarged.

It seldom surpasses nine lines in height, and is somewhat less in divergence. At a considerable distance above the root the stem cleaves into two boughs, each of these into two branches, and every branch into two parts. Thence the arrangement is strictly dichotomous, or by successive cleaving in two.—Figs. 3, 4. An harmonious and admirable symmetry results from this simplicity, and the subdivision advances still farther, though the ultimate distribution of the minuter component parts becomes indefinite.

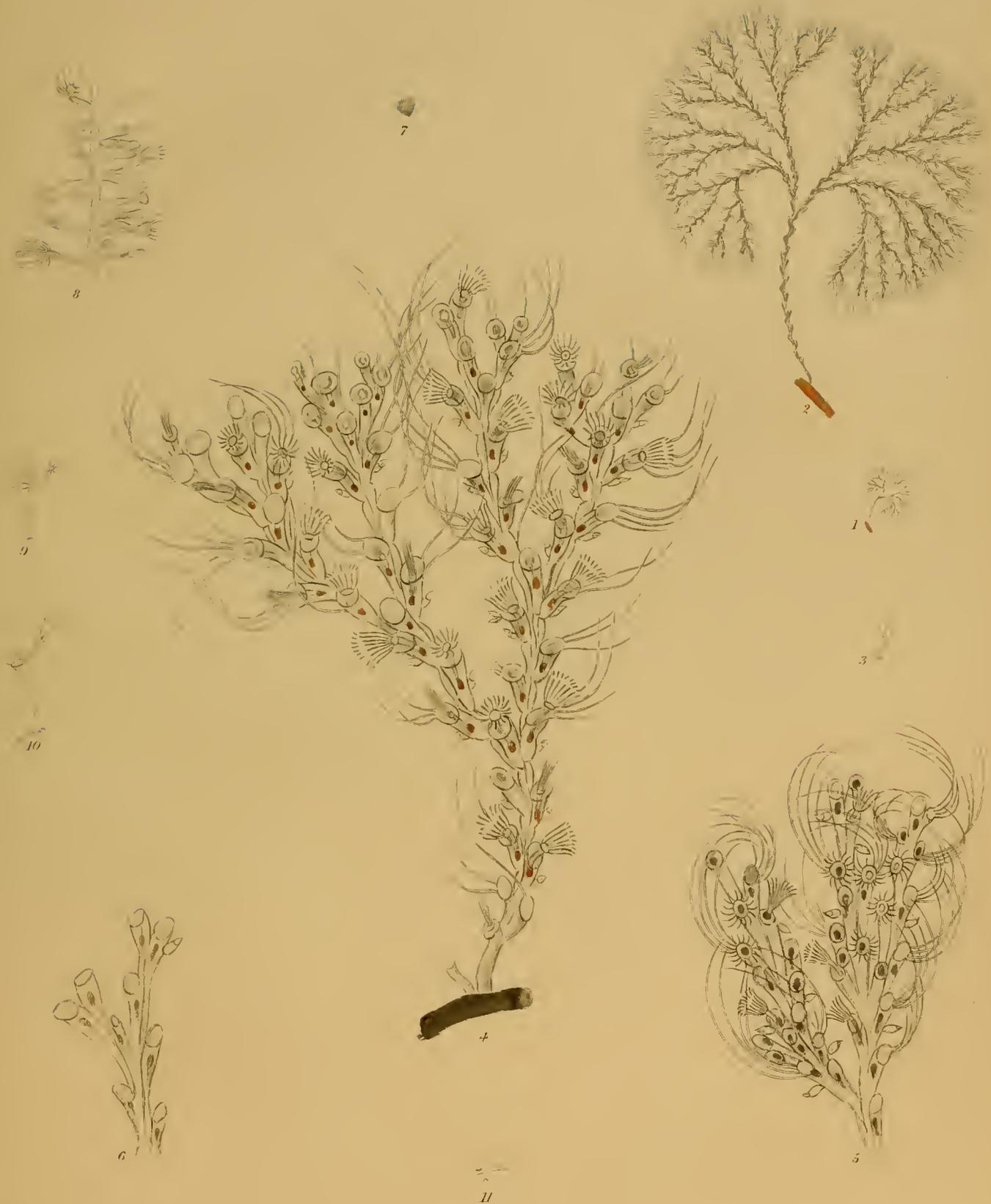
Each of all the multitude of parts is bordered by a double row of cells in alternate arrangement. The orifice of the cell is elliptical, and

guarded by five incurving spines of extraordinary length, originating from its upper margin.—Figs. 4, 5. So great a profusion of long, slender, delicate needles, combined with their peculiar form and position, impart a soft and silky aspect to the whole product, which, to the eye, resembles the minutest fern.

The length of the spines equals six, ten, or even twelve times the diameter of the orifice of the cell. They are longest and more multiplied towards the extremity of the branches, where their accumulation and crossing intercepts a distinct view of the adjacent parts. Those below are commonly impaired; and the length and number of those above are frequently irregular, either from natural or accidental causes. However, the true complement of each cell may be rated at five.

An ascidian hydra of corresponding nature with the others described in this chapter inhabits the cell. It is colourless, or of the faintest grey, provided with from 12 to 14 rather flattened, slightly recurved, ciliated, and percussive tentacula. But the animal is so vivacious and so restless, as to render inspection by the microscope very inconvenient, and it altogether disturbs that stillness which is essential for the study of the artist. Therefore to obtain complete and perfect delineation of all the parts is impracticable; interception, and motion combined with their multiplicity, are perpetual obstacles. An opaque reddish or brown ovular substance appears in the body, rising somewhat along with its ascent in the cell. Many vacant cells also contain a dark globular substance at the bottom. Several authors are disposed to conclude that what is thus seen as a residuum, is the body of the hydra remaining permanently after death. But I have not understood that in either case the nature of the substance is sufficiently ascertained. Hydrea, no doubt, sometimes die in retreat, nevertheless their soft and perishable organs, for the most part, waste away imperceptibly.

White corpuscula, very minute, and some of larger dimensions, have been produced in vessels containing specimens of this zoophyte in August and December. They swim actively, and in most respects resemble those described in the next paragraph. One which admitted of closer inspection, proved opaque under the microscope, of soft appearance and variable



Scleraria siliata

form. Some were like an obtuse-angled parallelopiped, apparently provided with a ciliated apparatus below, in front. It was difficult to attempt following their history. Stationary globules have been likewise observed among the parts of specimens, but numberless interceptions prevented a distinct view of them.—Fig. 7.

In early stages the product exhibits a singular formation, as may be seen in various nascent specimens, which originated on each side of the stem of a different zoophyte.—Fig. 8. A second long cell seems belonging to the first, both apparently guarded by a greater number of spines than peculiar to maturity.—Figs. 9, 10.

The root is formed of forking radicles.—Fig. 11.

Many avicularia, which are extremely minute and transparent, border the different parts of this Cellularia.

PLATE XLVII. FIG. 1. *Cellularia ciliata*—Ciliated Coralline.

2. The same enlarged.
3. Branch.
4. The same enlarged.
5. Branch of another specimen.
6. Portion showing the arrangement of the cells.
7. Corpusculum.
8. Nascent Cellularia in different stages.
9. Nascent Cellularia further advanced.
10. Nascent Cellularia still farther advanced.
11. Root.

All the figures of this Plate, except figs. 1 and 3, are enlarged.

§ 5. CELLULARIA AVICULARIS—Bird's-head Coralline—PLATES XLVIII. XLIX.—I refer to this subject with considerable hesitation. It has rather appeared to me a different species from the *Cellularia fastigiata*, but the point must remain open for discussion.

Ellis, in Plate xxxviii, wishes to identify the "Bird's-head Coralline," fig. 7, with a preceding species, represented by him Plate xx. fig *a*, A. But the latter is either the *fastigiata*, or the subject of this paragraph; while the former, fig. 7, seems the *Flustra Murrayana*.

In those places to which I have had access, the product here named *Cellularia avicularis*, has always grown as a parasite on the *Flustra truncata*, a foliaceous zoophyte. I do not recollect observing it elsewhere, which shews either that the same conditions are favourable to both, or favourable to the particular kind of development then attained by the *avicularis*.

In studying zoophytes, it is necessary to reflect, that development is much governed by situation, which has the greatest influence both on dimensions and perfection.

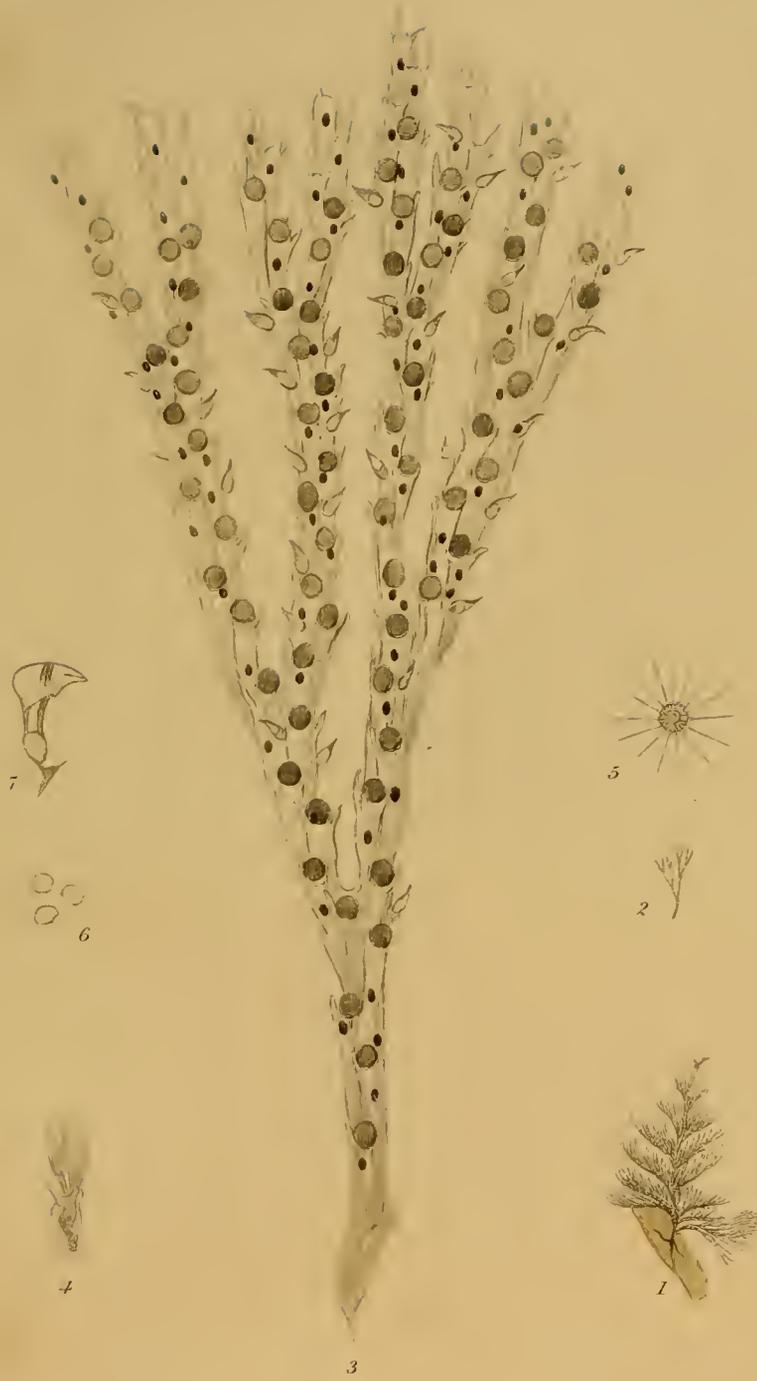
On the leaf of the *Flustra truncata*, this product assumes somewhat the form of a pine or larch, rising above an inch in height by a short stem, around which the boughs are disposed, rather in a spiral arrangement. The second originates a little above the first or lowest, a third still higher than the second. All shorten in proportion as higher, with a slight incurvature of both the interior and exterior parts towards the stem, so that the whole form of a perfect specimen is conical.—Plate XLVIII. fig. 1. XLIX. enlarged. But this is not alike definite in smaller specimens. All the subordinate parts terminate in a cell, which, in perfection, seems to be guarded by three marginal spines. Some have two, many only one. Possibly three form the complement. The root runs superficially over the *Flustra*, secured by four radicles.

As in the *Fastigiata*, the dichotomous configuration and relative position of the parts must be sought for more conspicuously by the aid of the microscope.—Plate XLVIII. figs. 2, 3.

A lively ascidian hydra with 14, 15, and, I believe, sometimes 16 tentacula, inhabits the cells.—Figs. 4, 5. Numerous brown ovoidal corpuscula remain in those which are vacant; and a spherule rests on the orifice of many, also vacant, where there is no room for more. This is brownish, or paler and thinner as if empty.

A number of *Avicularia* bordered the branches of the specimen.—Plate XLVIII. fig. 1, such as described in the following paragraph. They appeared smaller than ordinary, and were at first motionless, though displaying sufficient activity two days after.—Fig. 6.

Dingy yellow, brown, red, and grey are agreeably contrasted in the various parts of the product.



Gelularia Aricularis

Several minute, white, opaque corpuscula, probably gemmules, appeared in different vessels receiving the specimen. They were solid and consistent, obviously soft, as shewn by slight alterations of the shape. Under magnifiers of considerable power, the body proved more cubical and obtuse than spherical, begirt by numerous short cilia in rapid motion. Two hairs or spinous processes, much longer than the cilia, apparently originating below, came in view from certain positions of the animal. The corpuscula move swiftly, shooting in a moment beyond the field of the microscope.

Fine specimens of this zoophyte are rare.

PLATE XLVIII. Fig. 1. *Cellularia avicularis*.

2. Portion shewing the dichotomous formation.
3. The same enlarged.
4. Hydra, profile.
5. Hydra, front.
6. Avicularium.
7. Corpuscula or gemmules.

All these figures, except figs. 1, 2, are enlarged.

XLIX. FIG. 1. of Plate XLVIII. enlarged.

Perhaps the *Flustra Murrayana*, subsequently described, might be appropriately introduced here, from some apparent kindred to the preceding subject. But it is of more foliaceous texture; and, as frequently said, this treatise being only a collection of detached memoirs, not a system, any particular zoophyte may receive its proper place when it becomes sufficiently familiar to observers.

A very indefinite section seems to result from such a character as *Cellularia*.

§ 6. AVICULARIUM.—PLATES XLVI. Figs. 12, 13; XLVIII. Fig. 6.—The subject of the preceding paragraph has received its specific name from the presence of a singular organic body, which cannot fail to attract the notice of all observers. Its position and nature prove the source of much embarrassment, together with the peculiar and unaccountable motions which it exhibits.

Perhaps the Avicularium may be ultimately found a generic character. In as far as I know, it belongs chiefly, if not exclusively, to the genus we have left, as instituted by later naturalists, the Cellularia, and hence connected with the ascidian hydræ. We find it on the *ciliata*, the *fastigiata*, *avicularis*, just described, and the *Flustra Murrayana*. All with cells guarded by spinous processes.

Much obscurity hangs over the true nature of the Avicularium. But it is obviously of animal organization, and endowed with spontaneous motions.

From its external position and utter dissimilarity to the rest of the product where affixed, we should at first sight deem it a parasite; nor can we discover any immediate connection between it and the living tenant of the zoophyte.

The Avicularium is always seated on the outside and about the middle of the cell. I have never seen it otherwise. Also, if the leaf of the zoophyte be composed of a longitudinal series of parallel cells, it is borne on each margin of the leaf, or on one margin only.

This organization, presents the strongest resemblance, in extreme miniature, to a bird's head, as denoted by its name; nor is the comparison much impaired even by powerful magnifiers.

It then seems to consist of three distinct principal organs, first a basis *a*, founded on, or incorporated with the cell; next a head *b*, connected with the basis; and, in the third place, a lower mandible *c*, demonstrating the most lively action.—Plate XLVI. figs. 12, 13, *a*, *b*, *c*.

In quiescence, the whole is like the head of a bird with the bill closed. In activity, the lower mandible opening, folds back with a very wide gape. Another joint apparently connects the head with the basis, wherein the neck moves as in a socket. The bill opens and closes frequently; the spectator would say, for the purpose of absorbing some extraneous matter, too minute or too refined for detection by human sense.

The motion is of two kinds, the whole *avicularium* bending backwards and forwards; when the head sometimes reclines as far back in proportion as seen of a bird reclining its head between its shoulders. The other motion is merely the opening and closing of the lower mandible, widely gaping, and continuing thus, but stationary, when the whole zoophyte has perished.



Zellularia Aricularis

These movements are sometimes so lively, that notwithstanding the excessive minuteness of the Avicularia, the agitation of several at once, proves very inconvenient for microscopical observation. Though numerous on a specimen, not above one individual has been seen on any single cell. In itself it is semitransparent. Farther than already described, no subordinate parts have been detected. Whether they exist, must be inferred from future discovery of its real nature. Meantime, we must allow that much embarrassment attends all attempts to account for the presence of these objects. Are they parasites affixed immovably to a certain spot? Are they an integral part of the zoophyte? What relation do they bear to the cell or to the hydra? Such points are of no easy solution. For a long time, I was induced to conclude the Avicularium a parasite—for there are animals, like the lepas or barnacle, and some other cirrhipedes, whose parts are incorporated with wood, rocks, or shells. I cannot believe that it is connected with the hydra, from finding it seated and active on the side of those cells wherein there are none. Nevertheless, it is an integral part of the zoophyte, in so far as being generated along with new or reproducing portions. This, indeed, does not exclude the character of a parasite; for I have understood that those infesting the larger animals, sometimes occur in the fœtus.—Pl. XLVIII. fig. 6.

Without following the progress of the Avicularium, it could not be recognised from any resemblance between its earlier and later stages. At first, it appears as a convex or hemispherical knob, crowning a cylinder. While still farther advanced, it remains of imperfect form, triangular and of light grey colour. Symmetry is afterwards attained.

Many were regenerated or reproduced on portions of the *Cellularia fastigiata*.

A few remarks on a flexible organ sometimes issuing from the *Cellularia scruposa*, are meantime reserved.

PLATE XLVI. FIG. 10. *Avicularium*, quiescent.

11. The same in activity; basis, *a*; head, *b*; mandible open, *c*.

XLVIII.

6. *Avicularium*.

These figures are enlarged.

CLUSTER OR SOCIAL ASCIDIAN ZOOPHYTES.—PLATES L., LI., LII.—
The definite figure, number, and arrangement of the parts, have enabled naturalists to detach a few zoophytes from the general enumeration, and to unite them in lesser sections.

One of these has been constituted by Dr Fleming, under the name *Valkeria*, which other authors incline to preserve, as sufficiently expressive.

This, in a more extensive sense, comprehends those zoophytes with cells approximated in groups or clusters, inhabited by an ascidian hydra with eight tentacula: to which may be conjoined some with similar tenants, but numerously arranged in rows on the different inorganic parts.

By a remarkable disposition of Nature, masses or clusters of animals belonging to the same product are generated at considerable intervals, without any intermediate channel obviously connecting them.

But the more distant cluster, being of later evolution, and the cells nearest to the preceding being the larger and more mature, affords some presumption of the vital principle of the one being derived from the other developed before it, and conveyed by a secret communication.

Here the skeleton seems to participate more of the substance of that of the Tubularia and of the Pedicellaria than of the skeleton of the Cellularian race.

As one leading feature of this section is the number of tentacula belonging to the hydra being definitely eight, the *Imbricata*, *Cuscuta*, and *Lendigera*, fall properly within it: and the same characteristic distinguishing the *Spinosa*, will sanction its annexation. My observations on a few of these, also with eight tentacula, are not sufficiently mature for a separate paragraph.

§ 1. VALKERIA IMBRICATA.—PLATE L.—The naturalist in commemoration of whose name this genus is instituted, was a clergyman of the Church of Scotland, established at Moffat, a village in the county of Dumfries, celebrated for the medicinal wells in its vicinity. These have been very long in great repute for alleviating various distempers, and are now much resorted to, especially in the summer season. Having been sent



Talkeria subricata

thither for a serious infirmity, in early youth, I recollect the natural productions likely to stimulate my juvenile curiosity, which were displayed in the threshold of Dr Walker's dwelling. The Chair of Natural History, which is among the later academical institutions in the University of Edinburgh, becoming vacant, Dr Walker was appointed to fill it. On his demise, the present worthy and learned Professor Jameson, whose useful labours have contributed so effectually towards the advancement of science in Scotland, was chosen to succeed him.

The *Valkeria imbricata* rises erect, about two inches in height, by a short stem, and then subdivides into slender boughs, waving slightly, with branches in alternate arrangement on their opposite sides, originating from the convexities.—Pl. L. fig. 1.

Masses or clusters, composed of a double row of cells, wind spirally up the surface of the skeleton, at irregular intervals. This peculiar order is distinct in their earlier stages, but with the increment and accumulation of cells, the spiral progress, and the disposal of the cells in pairs, become less evident; it is gradually obscured, and finally lost.—Fig. 2.

The cell, of ovate form, is occupied by an ascidian hydra, with eight ciliated tentacula. The cilia are stout, and very conspicuous, as their successive action is exhibited, fig. 3.

As the cell is connected with the body of the ascidian hydra, whether by ligaments below, or by the union of the margin above, it undergoes a great modification with the position of its tenant. When the latter is displayed, the cell is extended: when in retreat doubled on itself, the cell becomes ovate.

The stem seems tubular. Its extremities are obtuse. But neither the surface of the stem nor that of the cell is smooth.

Finer specimens exhibit numerous subordinate parts, of which the most remarkable are the clusters of cells. One an inch high, bore between 60 and 70 such clusters, with their hydræ. Another, an inch and three quarters high, had 19 clusters on a single branch. The former specimen spread about an inch. But, in studying the subject in detail, it is better to select more meagre specimens, where the multiplicity of parts does not intercept the view.

The clusters are generated and formed after a singular manner. One may consist of sixteen or twenty cells, winding in pairs up a branch in a slight spiral direction. As the vegetation of the obtuse extremity of the branch advances, the clusters originate on it in prominences still lower and nearer the root. The first or lowest pair of cells is the largest; the other pairs, in winding up the stem, diminish gradually to extreme minuteness. Thus did one series exhibit 8 pair or 16 originating cells: another 3 pair only, being probably in an earlier stage. As they advance, they become greenish or yellowish to the eye, and on approaching maturity, the included embryo becomes perceptible.

The subsistence and maturity of a lower cluster seems to be essential for the propagation and evolution of a higher cluster. This may afford room for speculation, whether the vital principle is not awakened in the germ of the hydra, or whether some deposition of elements, to be thus brought to maturity, be not effected by the vigour of the parts, as the vegetative power advances the stem whereon the new series shall originate.

Besides the groups dispersed on this product, in various numbers, sometimes a straggling single cell may be seen.

A yellowish or greenish colour pervades the whole zoophyte. The clusters are yellow: the cell transparent, its tenant faint yellow, as is evident while contracted within.

The product appears as a parasite, or rooted independently on solid substances.

I am informed that it is abundant in some of the Scottish Seas. But I have never found it so. On the contrary, it has been rare.

PLATE L. FIG. 1. *Valkeria imbricata*.

2. The same, enlarged.

3. Hydra, enlarged.

§ 2. VALKERIA CUSCUTA.—*Dodder Coralline*.—PLATE LI. FIGS. 1, 2.—Another cluster-zoophyte, much more common than the preceding, appears as a very minute pendulous chain, of a greyish colour to the naked eye. I have never seen it erect, its slenderness and flexibility, indeed, being



Valkeria bascula, 1.2. *spinosa*, 3.3.

such that it cannot sustain itself unsupported ; whence, it either hangs as a parasite from other marine substances, or stretches along the surface of shells.

The stem, no thicker than a human hair, extends sometimes an inch and a half in length. It is smooth and tubular, seldom with any branches ; though specimens do occur with several, and then they diverge to right and left.

Numerous clusters of from six to eight or ten ovate cells are implanted on the stem and branches, at intervals, and occasionally with considerable regularity. The cells may be also seen in pairs, when one cell is on each side of the stem. Here the clusters are more numerous, and in nearer approximation to each other, than in the species above described.

An ascidian hydra, with eight ciliated tentacula, occupies the cell, which, like the other, is prolonged on its protrusion.

This zoophyte is commonly of dingy white or greyish colour.

The specimen represented did not exceed half an inch in length.

PLATE LI. FIG. 1. *Valkeria cuscuta*, magnified.

2. Hydra magnified.

The reader will find some interesting remarks by Dr Fleming, in the Memoirs of the Wernerian Society, vol. iv. p. 485, Pl. xv.

§ 3. VALKERIA LENDIGERA—*Nit Coralline*.—PLATE LII.—The name *Syrinx* or *Pan's Pipe*, would have been more characteristic than any hitherto given to this zoophyte, from the intimate resemblance of some of its parts to that instrument,—presuming the species now described to be identified with that of preceding naturalists.

I am aware that it is proposed to institute a new genus *Serialaria*, which shall include the species before us. But as this seems to have been done in ignorance of the nature of the hydra belonging to it, and the general features being common to what the *Valkeria* may comprehend, perhaps its true place is very near to this section, and may be included here.

The *Syrina*, *Pan's Pipe*, or *Lendigera*, consists of a very slender stalk, from which a meagre distribution of boughs and branches originates irregularly. At certain intervals, also, irregular enlargements are seen on the various subordinate parts, but so minute, that their general form is scarcely to be recognized as definite by the eye. The whole product is about two inches high, expands as much, and is of faint dingy yellow.—Pl. LII. fig. 1 ; fig. 2, enlarged.

Under the microscope, the indefinite enlargements on the subordinate parts, are found to consist of a double row of cylindrical cells, with an obtuse summit. Though generally described as in a double row, their real arrangement is in partial alternation, the convex side of one being applied to the opposite recess formed by the union of two, somewhat like the position of two rows of cells in a honeycomb. Few having attended to this, most probably has given rise to the proposed genus *Serialaria*.

Fourteen or fewer cells, compose a group or alternate double series. The number in the group diminishes towards the extremities of the parts. But the greatest number is not limited to fourteen : some groups containing more. The cells of the series shorten as they ascend, because the lower cells come first to maturity. The disparity, however, is less evident among the older of the series, though very conspicuous among the younger or higher. Their origin and increment corresponds with what is seen in the cells of the *imbricata*. Larger specimens of the zoophyte bear 50 or 60 groups. The sustaining stalk extends beyond the farthest group by prolongation, preparatory for new accessions. From vigorous vegetation the obtuse extremities sometimes adhere to whatever they reach.

The intervals between the groups are bare and transparent. But the surface of both the stalk and the cells is speckled.

An ascidian hydra, with eight tentacula, inhabits the cell, which rises in active evolution, like the others, carrying up the convex summit of the cell along with it. The orifice of the cell is connected with the margin of the body, so that, in the rise and fall, they are in continual dependence. A row of specks seems to traverse the middle of the tentacula. Buoyant particles are tossed about among the hydræ, and when received by the mouth in the centre, their deglutition becomes sensible, from trans-

3

1



2



5



4

Dalmania Lendigera

pearance of the body, which is scarcely darker than the surrounding element.

This product is founded either independently on shells, or it grows as a parasite on other zoophytes. It is frequently so closely interwoven with a variety of matter, as to render the extrication of specimens entire a very difficult task.

I have never seen the cells of any specimen ranged in a straight line as a single series, nor otherwise than alternately.

- PLATE LII. FIG. 1. *Valkeria lendigera*.
 2. The same enlarged.
 3. Another specimen.
 4. Arrangement of the cells, enlarged.
 5. Hydra enlarged.

§ 4. VALKERIA SPINOSA.—*Silk Coralline*.—PLATE LI. FIGS. 3, 3.—This is a fine and elegant product, of the most delicate texture. It rises several inches in height, bounded for the most part by what might be the form of a narrow cylindrical vessel, containing a living specimen. But the parts are so numerous, so minute, and intercept the view of each other to that degree, that only a very small section can convey their figure and arrangement under the microscope.

All have a slight incurvature towards the slender stem: their extremities terminate in prolongations like thorns.

This is not a cluster or social zoophyte, however: for numerous single, long, ovate, transparent cells, stand in a row on one side of the subordinate parts. As the higher are of smaller size than the rest, probably they come to maturity successively, like some of the preceding. Sometimes there are eight or ten in a row.

The cell is occupied by an ascidian hydra, with eight long transparent, ciliated tentacula, alike quick and lively in its motion with others of its race. But it is extremely timid and reluctant to shew itself. The shape of the cell alters much by its retreat, becoming somewhat irregular, and smaller towards the orifice. It is rarely to be obtained alive. Per-

haps the same may be said of all the more minute hydræ, for they must be very readily affected by transitions of site, or the alteration of temperature. When withdrawn from the water, the largest specimen merely resembles a quantity of wet moss.

The natural colour is grey, with the faintest tinge of pink.

It occurs in great profusion, and sometimes many of the hydræ are alive and vigorous.

Specimens were kept from the end of September until the beginning of January, when the vessel, a tall narrow jar, being emptied of its contents, at least 50 minute specks were seen adhering to the sides on replenishment. They tended to an elliptical form, and several exhibited small white projections. A very minute hydra, with eight tentacula, afterwards sprung from one of them.

PLATE LI. FIGS. 3, 3. *Valkeria spinosa*. Extremity of a branch, enlarged.

This is a single extremity, cleft down the middle, to obtain room for it on the Plate.

NOTE.

There is commonly much irregularity in the position of single cells, of pairs of cells, or of masses and clusters of them, even in all subjects. Certainly this denotes a great inequality of the vital forces. It might be expected that in genera and in species uniformity should prevail, whereas only analogies are presented, and, for the most part, those but of a remote or general character.

The preceding genus, *Valkeria*, embraces ascidian hydræ with eight ciliated tentacula. Another genus of ascidian hydræ, but with *ten* ciliated tentacula, is proposed under the name of *Bowerbankia* or *Lagenella*.

Considerable general resemblance appears between the hydræ and cells of these two. But more minute and accurate examination may prove their difference in other points, though the number of tentacula coincides.

Two species, if I be not mistaken, both with ten tentacula, inhabit

the Scottish seas, but, from having had very few, I can say little regarding either.

Dr Farre proposes here to constitute a genus *Bowerbankia*, including two species, the *repens* and the *densa*. But in Dr Johnston's opinion, the characters specified are scarcely sufficiently definite to justify the distinction between them. However it seems well founded.

1. *Bowerbankia repens*.—PLATE LIII. FIGS. 1, 2, 3.—The general character of this product, in as far as I have seen it, participates somewhat of the nature of the *Valkeria cuscuta*, in the appearance of the stem and distribution of the cells.

A slender stalk rises slightly above the surface of old shells, or runs irregularly over it.—Plate LIII. figs. 1, 2. From this there originate single cells, and cells in pairs or in clusters, the whole irregular in position and number.—Fig. 3. The cell is occupied by an ascidian hydra with ten tentacula. Being apparently identified with the hydra of the following species. farther commentary on it is unnecessary.

This zoophyte is dingy white.

2. *Bowerbankia densa*.—PLATE LIII. FIGS. 4–12.—The general aspect of this species is somewhat diversified. It invests other marine substances as a parasite, sometimes totally overspreading them, with rather a mossy appearance. But I have not observed its form confined by any such definite outline as will admit its reference to familiar objects, which may be seen from two specimens represented of their natural dimensions.—Plate LIII. figs. 4, 5. Accumulated hydræ cover the surface invested.

A magnified view of the upper portion of fig. 4, is given fig. 6; and a transverse section of fig. 5, also magnified, in fig. 7. The whole seems an accumulation of single cells.

The body of the hydra protrudes very far. The cell is much altered; while the animal is in retreat, it is long, with an ovoidal summit, which stretches upwards as the hydra rises to display ten active ciliated tentacula.

From the great protrusion of the body, and the transparence of the

integuments, modern naturalists have followed Dr Farre in assuming this creature as a type for illustrating the structure of ascidian hydræ.

The specimen fig. 5, exceeded 18 lines in length, and 2 in diameter, while the animals were quiescent. Owing to their extraordinary multitude, no part whatever of the substance invested was visible among them. It was studded by the interspersions of numerous yellow corpuscula. But I could discover none in the body of those hydræ manifesting vigorous animation, though one was contained in each cell of many where the tenant had decayed.

Here it may be remarked, that when certain ascidian hydræ lose their vigour, the organic portion wastes away, leaving behind it a long obtuse hollow cone, containing fertile ova. It is in a similar cone of the preceding species, fig. 3, that an ovum appears. In the present species the precise position was obscured. But in the other, there is a remarkable correspondence with the nature of the *Alcyonella stagnorum*. When corpuscula or gemmules were discharged from the zoophyte under discussion, I failed in observing how they escaped. But a most accomplished *practical* naturalist, *M. Van Beneden* of Louvain, while giving the anatomy of the hydra at large, in his *Recherches sur les Bryzoaires*, shews the termination of the oviduct under the root of the tentacula. I deeply regret that my very recent acquaintance with only some of this learned Professor's valuable and interesting works, has prevented me from availing myself suitably of many useful observations, which I can no otherwise repair than by earnestly recommending their perusal to those desirous of real information.

Though I did not observe how the ovum was discharged, nor whether as such, or as an active corpuscular gemmule, for this might have preceded my inspection, I found it of ovoidal form, truncate behind, and begirt by cilia. It was also apparently heavy, solid, and consistent. Several escaped during the course of observation from the specimen figs. 4-6, on July 14, the day after it was obtained, fig. 10. Among these one, fig. 9, was much occupied about a slender hair in the watch-glass containing it; sometimes adhering, sometimes searching around, and evidently betraying what any indifferent spectator would have pronounced its animal nature. Num-



Georbanksia

bers of such corpuscula continued to be discharged for above a week. Two of these escaping previous to July 17, were then adhering to the watch-glass, and in an early stage of metamorphosis, fig. 11.

As the metamorphosis and supervening increment are perfected and advancing respectively, the form of the nascent hydra is clearly exposed through the transparent integument. The body is then seen to be attached by a number of ligaments to the bottom of the cell, and the pencil of the tentacula approaching the summit, where the parts shall relax to allow display of the whole by protrusion on maturity. Descent of the intestinal canal from the stomach, and its return upwards in conformity with ascidian organization, are very distinct, fig. 12. Here is a yellow substance resembling an ovum at the bottom.

All the cells of this zoophyte are originally separate as those of the *Sertularia arcta*.

When the corpuscular gemmules come to affix themselves to some slender substance, and there undergo their metamorphosis, the bases of the generating cells are opposed to each other.

Neither of these two species has been of frequent occurrence in Scotland, but skilful naturalists seem to have found abundance elsewhere.

PLATE LIII. FIG. 1. *Bowerbankia repens*

2. The same enlarged.
3. Portion magnified.
4. *Bowerbankia densa*.
5. Another specimen.
6. Upper portion of fig. 4 enlarged.
7. Section of fig. 5.
8. Hydra.
9. Corpusculum or gemmule.
10. Group of corpuscula.
11. Corpuscula metamorphosing.
12. Nascent hydra from a corpusculum.

All the figures of this plate, except figs. 1, 4, 5, are enlarged.

Whatever new names, whether original, modified, or altered, are found in this volume, they must be regarded as mere temporary and provisional substitutes, liable to such correction as expedient.

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