selves. The structure of *L. cervina*, from the roe, stag, and elk, presents nothing of this kind; so that the above-mentioned animal may be regarded, if not as a new genus, at least as a transition towards *Strebla*.

3. *Nycteribia elongata*. Belonging to Group I. of Kolenati, with no angular ridges on the thorax, and with the margin of the anterior part of the thorax entire. Colour dark ochreous; legs rather paler. Animal elongated; head small, concealed, with a long, extensible, acute proboscis, covered with long hairs. Thorax ovate, depressed at the lower margin, translucent at the portion near the head, furnished with a few transverse rows of stiff bristles, among which there are some longer spines. Upper surface convex, lower surface nearly flat. Lateral ctenidia of 17 teeth, almost reaching the margin. Legs with very long bristles; femora elliptical, tibiæ clavate, both spinous on the lower surface; tarsus long and slender; claws very thick and spinous.

Abdomen elongate, ovate, with a tuft of spines at the margin of each segment. Colour of the sutures pale yellow. Anterior ctenidium with 45 teeth. Anal segment of the male tolerably broad, with a short forceps and long thin outer horny covers, strongly hairy. Anal segment of the female at the sides with two truncated tubercles, and two rounded ones in the middle.

Length 0·5 millim. On *Nyctophilus Geoffroyi*.

4. *Nycteribia varipes*. Belonging to Group II., with angular ridges and thin tibiæ. Colour pale ochreous. Legs quite pale. Head elongated, thickly clothed with long setæ. Proboscis short, but sharp; vertex with two rows of very long spines standing outwards. Thorax with distinct reddish-brown angular ridges in front, which nearly touch one another. Lower surface finely and densely, upper surface densely clothed with hairs, with a tuft of long setæ. Ctenidia rather distant from the margin of the thorax, 25-toothed; teeth of nearly equal length, with the exception of the outermost.

Abdomen of the female 5-jointed; first segment narrow, second very long and broad, third nearly as broad, but only one quarter as long, the last two narrower; terminal segment with two warts directed outwards at the angles, and two approximated ones in the middle, all furnished with long setæ. Upper surface with isolated long setæ among dense hairs; sides with short fringes; angles of the segments furnished with dense tufts of hairs. Sutures dark-coloured. Ctenidium with 50 teeth, not distinct.

Legs very long; femora elliptical, tibiæ narrow, tarsi long, strong-clawed, finely but densely hairy, with long setæ at the joints; femora and tibiæ of the anterior legs almost truncated and tubercular at the joints, with very small articulations.

Length 0·4 millim. On *Miniopteris morio*.

Sufficiently distinguished from the rest by its broad abdomen. —*Zeitschr. für die Gesammten Naturwiss.*, neue Folge, Band iii. pp. 121–124.

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FOURTH SERIES.]

No. 54. JUNE 1872.

XLIV.—*On two new Sponges from the Antarctic Sea, and on a new Species of* Tethya *from Shetland; together with Observations on the Reproduction of Sponges commencing from Zygosis of the Sponge-animal.* By H. J. Carter, F.R.S. &c.

[Plates XX., XXI., & XXII.]

Among the sponges preserved in spirit at the British Museum which Dr. J. E. Gray wished me to examine with reference to any thing that might remain untold about them, as well as to their future arrangement there, are two glass jars partly filled with specimens, which, but for the presence of spicules, might very well pass for so much wet brown paper torn into pieces and soaked in sandy mud. Notwithstanding this uninviting aspect, however, they claim attention through bearing respectively the following labels, so far as the writing on them can be now made out, viz.:—

"Dredged from depth of 300 faths. Lat. 74½° S. . . . . . Antarctic Exp. Admiralty." And "Dredged in 206 faths. Lat. 77½° S. and long. 175° West. Antarctic Exp. Admiralty."

The fragments in both jars belong to the same species of sponge; and the "locality" being known, there is no doubt that they were dredged up by Captain Sir James Ross during his Antarctic Expedition, which is further proved by the following extracts from that illustrious navigator's book entitled 'A Voyage of Discovery and Research in the Southern and Antarctic Regions during the years 1839–43,' viz.:—

"Feb. 16th. The lat. at noon was 75° 6′ S., long. 189° 04′ W. In the afternoon we hove-to and sounded in 290 fathoms on a bottom of green mud, the temperature at that depth being 32°, while that of the surface was 30°. . . . . The dredge was put overboard for a short time, and many curious invertebrate animals and a small fish taken in it" (vol. ii. p. 195).

No doubt it was on this occasion that the fragments of sponge still preserved in the British Museum were obtained. Rolled over and over by the dredge, probably in a rough sea, and mixed up with the sandy mud of the bottom, it is not extraordinary that they should have passed into the state mentioned. The only part extraordinary is, that at such a time and under such circumstances as those recorded in the book to which I have alluded, the dredge should have been put overboard at all. No one but a cool and intrepid scientific investigator of the highest type could achieve such results as were obtained in this Antarctic Expedition. Well might England be proud of such men!

With this feeling, then, it will easily be conceived that, however uninviting the remnants of this sponge appeared, the fact of their having been obtained when most men would have been making their vessel snug and sailing away from such an inhospitable locality demanded the little exertion which their examination would entail on one sitting quietly at home by his fireside.

Hence they were examined ("overhauled," to use a nautical expression very appropriate here) bit by bit, and carefully scrutinized, with the most repaying results, as will presently be seen.

Among the fragments were observed pieces four inches long; there was evidently a porous surface on one side and a cavernous structure on the other, both like those of *Hyalonema* (*Carteria*, Gray) and *Holtenia*, Wy. Thomson (see figures of the latter in Phil. Trans. 1870, pl. 69 &c.). The spicules belonging to the fragments were of three kinds, viz. acerate, anchor-, and fork-headed. It was therefore evidently a deep-sea *Tethya*. Subsequently tufts of long anchor- and fork-headed spicules were found attached to some of the fragments; and these as evidently belonged to the base of the sponge, being the means by which it was fixed to the muddy bottom. Thus many points presented themselves which led to the conjecture that the sponge must have been in form of body something like *Carteria* and *Holtenia*, which in this respect are nearly identical, —not possessing podal beards of spicules eighteen inches long, like Mr. Kent's noble specimen of *Pheronema Grayi* in the British Museum, dredged up off the coast of Portugal, in the yacht 'Norna,' in 1870, but with short spiculous tufts not more than an inch in length.

Up to this point, then, inference was all that I had to depend on for the original form of this sponge, when, by good fortune, among the mass I found a fully developed ovum or, rather, young *Tethya*, about one-sixteenth of an inch in diameter,

which, when magnified, turned out to be so perfect that it probably is as much a facsimile of the adult parent as a human infant is that of a grown-up man. I therefore wanted nothing further than to magnify this, and with the detail afforded by the "fragments," to give not only the figure and description of the latter, but that of the entire sponge, for which I now propose the name of *Tethya antarctica* (Pl. XX.).

While examining these fragments I also observed that they had acted in the dredge as a kind of "tangle," by having caught up several large foreign spicules, of two distinct kinds, but apparently belonging to the same sponge. There were only these two kinds, which were very numerous, and so long and large that they could be seen and easily extricated with unaided vision. One is, up to this time, a unique form, viz. an anchor-head with *four* arms, and sometimes a fifth—which being a continuation of the shaft, the spicule is hexactinellid. The other is a quaternate or quadrifid spicule, with a cruciform head, whose four arms spread out horizontally and somewhat sigmoidly from the end of a vertical shaft. It is evidently allied to the same form of large cruciform spicule which spreads its long arms over the surface of *Carteria* and *Holtenia*, but differs from these in being covered throughout with a layer of minute or micro-spines, which, in all but the shaft, are accompanied by a great number of large or macro-spines.

Thus, these two forms of spicule being very numerous and unaccompanied by any other foreign forms in the fragments of *Tethya antarctica*, I have assumed that they are respectively the podal and surface spicules of a sponge allied to *Carteria* and *Holtenia*, for which I propose the name of *Rossella antarctica* (Pl. XXI.), in memory of the great antarctic navigator who dredged them up.

I have also found a branched Antarctic sponge belonging to the Suberites, which will be described, with other sponges of the kind, on a future occasion.

Lastly, in a jar labelled "Shetland. J. S. Bowerbank, 52. 3. 12. 70–73," to which is added, in Dr. Bowerbank's blue ink and handwriting, "*Tethya lyncurium*," I found six specimens, viz. two of *Tethya cranium* and four of another species of *Tethya* as yet undescribed; so that the conjecture of Dr. Bowerbank in writing *T. lyncurium* (*Donatia*, Nardo & Gray) was very wide of the mark, and excusable if it had not been for a public museum.

Having learnt by experience that appearances are more misleading among the Spongiadæ than in any other of the lower animals which I have been accustomed to study, from the great resemblance of one sponge to another, I never now am content to decide in this respect until I have actually examined microscopically a bit from the sponge itself presented to my notice. Thus, in examining all the six specimens mentioned, I came upon four, distinctly different from *Tethya cranium*, Johnston, which has been so aptly named and figured with its oviform bodies by this accurate naturalist (Hist. Brit. Spong. &c. 1842, p. 83, pl. 1. figs. 1–8).

From the label on the jar, it is therefore evident that both species inhabit the sea about Shetland, having probably come from the "Haaf Banks;" for Dr. Bowerbank states that he obtained "nearly three hundred specimens" that were dredged up there (B. S. vol. ii. p. 84).

For this new species, which will presently be described, I propose the name of *Tethya zetlandica* (Pl. XXII. fig. 1).

As all the specimens, viz. both *T. cranium* and *T. zetlandica*, are filled with ova in different stages of development, I took the opportunity of mounting some of the more advanced ones in Canada balsam, and found that they possessed the same distinguishing characters which point out the differences between the adult forms of both these species.

Moreover the presence of the ova in different stages of development from a very early period has enabled me to give descriptions and illustrations of a sequence of them, preceded by *zygosis* in the sponge-animals, taken from *Halichondria simulans*, Johnston, in the living state, which thus far seems to point out the mode of sexual reproduction and development in the Spongiadæ generally.

The *zygosis* takes place by apparent union of the "collars" of two sponge-animals, animalcules, or infusoria (whichever name pleases best), so that their "rostra" are brought into apposition just like that witnessed in the *Difflugiæ*, where the mouths of the two tests are brought together by an apparent union of the contained animals. Of course it will be necessary to give a detailed account of zygosis in the *Difflugiæ* to compare it with that of the sponge-animalcule.

For the terms "collar" and "rostrum," see my description and illustrations of the sponge-animal (Annals, 1871, vol. viii. p. 9, pl. 1. fig. 13, *b*).

I shall also at the same time be able to add a few more observations on the development of the spicule.

Tethya antarctica, n. sp. Pl. XX.

Body globular; colour tawny yellow. Surface smooth, interrupted frequently by papillæ, through which the spicules of the interior project in bundles, cactus-like (Pl. XX. figs. 1 & 2). Dermal sarcode cribriform, from the number of minute "pores" in it (fig. 4), with here and there a large circular vent (fig. 2, *c c c*). Summit presenting three or more large vents, which branch off internally into the excretory canal-system (3, *a a a*). Base furnished with tufts of long spicules, anchor- and fork-headed respectively, some of which have their heads in the sponge and their shafts free, and *vice versâ* (fig. 2, *e*). Internally cavernous, arising from a much dilated state of the excretory canal-system, whose extremities are peripheral, where the sponge-structure appears to be densest. Spicules of three kinds, viz.:—1, acerate, very slightly curved, and long-pointed (fig. 5); 2, anchor-headed, of two forms, viz. one with thick arms, hastiform (fig. 7), the other with the arms more expanded (fig. 8); 3, tri-fork-headed, one prong much longer than either of the other two, which are equal (fig. 6). *No* bi-hamates. The first or acerate spicule is chiefly confined to the body, and the two other kinds to the surface, being longest and most numerous at the base. Thus the spicules generally vary much in length. The largest acerate form averages 1-20th of an inch in the adult sponge (fig. 9); and the longest fragment of shaft found with anchor-head attached did not exceed $1\frac{1}{4}$ inch (fig. 10). Generally the longest of these spicules do not appear to have been more than $1\frac{1}{2}$ inch in length. The hastate form of anchor-head appears to be chiefly confined to the body, and the expanded or grapnel form to the free extremities of the spicules of the tufts at the base of the sponge. Size of young *Tethya antarctica* figured 1-16th of an inch in diameter exclusive of the tufts at the base—inclusive of the tufts, 5-48ths, or about 1-10th of an inch long (fig. 1). Size of largest *fragment* of adult sponge 4 inches long.

Hab. Marine; deep sea, in 206 to 300 fathoms.

Loc. Antarctic Ocean, in lat. $74\frac{1}{2}$° and $77\frac{1}{2}$° S., and long. 175° W.

Obs. I have little to add to what has already been stated of this sponge. The description of the form is taken from that of the young one found in the parent, and the details of structure from the adult fragments; so that the whole is almost as complete as if we had had the adult entire. Generally the sponge corresponds to the *Tethyadæ* of which *T. cranium* is the type, modified more or less by a great dilatation of the excretory canal-system, in which it more particularly agrees with *Carteria* and *Holtenia*. It is also tufted at the base for fixture in the mud and sand; but in this it does not resemble these sponges any more than *Tethya dactyloidea*, which not only is similarly tufted at the base, but presents a large vent at the summit, through which the excretory system of canals empties itself (Annals, 1869, vol. iii. p. 17, and 1872, vol. ix. p. 82). Perhaps most of all it is like Schmidt's *Tetilla polyura*, which came from Desterro, on the coast of Brazil; but it contains no bihamates, which makes it differ, I think, from all the other species known but the one from Shetland, about to be described.

I am not able to state if, like the other *Tethyadæ*, its internal structure radiated from a nucleus; but if so, the fragments would lead me to infer that this must have been situated towards the base. Here, of course, our young one does not assist us, as to ascertain this point by its destruction would not compensate our loss of the only entire form of this sponge that we possess.

With reference to the nature of the grains of sand which pervade these fragments, I might here state that they have a lava-like aspect and structure, as if they originally came from the active volcanoes witnessed and measured by Sir James Ross on the adjoining continent.

Rossella antarctica, nov. gen. Pl. XXI.

Large peripheral spicule with quaternate or cruciform head, consisting of four arms radiating at more or less than right angles from the peripheral end of a vertical shaft (Pl. XXI. fig. 1); arms very long, spreading, somewhat sigmoid in their course (fig. 6), round, ending in attenuated extremities, covered throughout with a layer of microspines in close approximation, and here and there large or macrospines, all directed outwards (figs. 1, *a*, *b*, and 4, *c*, *d*), the latter failing towards each end of the arm; shaft also sharp-pointed, and covered with the layer of microspines, but not so distinct, and entirely without macrospines (fig. 1, *d*, *c*); so that, under a low power, the arms appear spined and the shaft smooth.

Podal spicule consisting of a long shaft with anchor-head composed of four recurved arms (fig. 7) and sometimes a fifth, which is in continuation with the shaft, and thus renders the spicule hexactinellid (fig. 8, *a*). Peripheral and podal spicules both visible to the unassisted eye, the largest of the former presenting a shaft about 4½-12ths and each of the arms about 3-12ths of an inch long (figs. 5 & 6). Head of podal spicule 1-20th of an inch broad, and longest fragment of shaft, with head attached, 1½ inch (fig. 10). From the latter having become attenuated towards the broken end, it is probable that, if entire, it would not have exceeded two inches. Length of podal spicule, generally, unknown.

Hab. Marine. Deep sea, in 206 to 300 fathoms.

Loc. Antarctic Ocean, in lat. 74½° to 77½° S., and long. 175° W.

Obs. All that I have to offer respecting this sponge is the description of these two forms of spicules. It might seem strange that I should endeavour to establish a new genus upon them, were it not considered that the *four*-armed anchor-head (fig. 7) is unique, so far as our acquaintance with the Spongiadæ at present goes; that is to say, with the exception of *Acarnus innominatus*, Gray, where there is a fourth arm, but in a totally different kind of spicule (Annals, 1871, vol. vii. p. 273, pl. 17), I know of no other instance. Secondly, the four-armed, spreading, or great peripheral spicule (fig. 1) is so far identical with that of *Carteria* and *Holtenia*, but totally differs from it in being spiniferous instead of smooth. Perhaps the minute cruciform-headed and spined spicules congregated in multitudes along the course of the smooth arms in *Carteria* and *Holtenia* may be represented by the spines on those of *Rossella*. The only question, therefore, is, whether the two spicules belong to the same sponge or to two different sponges; and this seems to be answered by the facts that the two forms are analogous to the anchor-head or anchoring spicule and the great cruciform one of *Holtenia* respectively, and also that both forms are equally and abundantly present about the fragments of *Tethya antarctica*, wherein they have become entangled, to the exclusion of every other kind, except those which belong to the *Tethya* itself. Thus we may fairly assume that they both belonged to some deep-sea sponge which, thus differing from all others yet known, merits a separate genus, with perhaps no more appropriate name than that of "*Rossella*," after the great navigator who dredged them up from the bottom of the Antarctic Ocean.

It is impossible to say how long the shafts of the anchor-headed spicules might have been, although the longest portion that I have found is attenuated at the fractured end; for, although this generally indicates an approaching termination, still the attenuation may or may not be much prolonged. But, judging from the average of specimens found, I should say, as before stated, that the shaft probably did not exceed two inches.

The occurrence of a fifth arm in the direction of the shaft, forming a kind of spike at the end (fig. 8), seems to be too common to be abnormal, and therefore allies this sponge still more to the Hexactinellidæ of Schmidt.

I also found one of these six-armed spicules in which there is an extension of one of the recurved arms to such a degree as to be almost equal in size and length to the shaft (fig. 9, *a*). This, I fancy, *must* be an abnormal form.

In no portions of *Tethya antarctica* that I mounted in Canada balsam, nor in any others examined, could I find the least trace of any of the minute kinds of spicules which characterize the Hexactinellidæ. Then it must be remembered that, although the large spicules of a sponge of this kind might be caught up and preserved by such a "tangle" as the *Tethya* afforded, the small spicules to which I allude would inevitably escape.

Fig. 3 is a more magnified view of the central portion of one of the great cruciform peripheral spicules, here introduced for comparison with the fossil fragment (Annals, 1871, vol. vii. p. 126, pl. ix. fig. 37). It is the only part of this spicule which in the hurly-burly of the waves and currents, would be likely to survive all the rest on its way to become fossilized; and the identity is so great that my conjecture, at the page mentioned, of their having belonged to a "quaternate or quadrifid system, whose parallel is only to be found in *Hyalonema* (*Carteria*) &c." is thus confirmed. That which I supposed to be an enlarged central canal in the fossil is the original shaft, and the external portion (*d*) an additional layer, as evidenced by the recent specimen—thus being only an instance of the common mode of strengthening and enlarging the structures of the Spongiadæ, viz. by the addition of layers to the external surface of the horny or silicified fibre.

Hence, having found fossilized fragments of this system in the Greensand, the Hexactinellidæ cannot be descended from the Ventriculitidæ of the Chalk, as Schmidt's pedigree-table (Atlant. Spong. Faun. 1870, p. 83) would have it, in support of the evolution-theory. But as a "theory" is but a "theory," it is only to correct the mistake and maintain the remaining part until another error is found out, and so on.

I take this opportunity of stating, in modification of what I have said in my "Fossil Sponge-spicules of the Greensand," p. 126 (*op. et loc. cit.*), viz. that I had not been able to find any *hex*radiate spicules in my mounted specimens of *Hyalonema*, that since then I have obtained and mounted other specimens from an undoubted *Hyalonema*, taken off with my own hands, in which *hex*radiate spicules, of *minute* size, are as plentiful as in any other sponge of the kind. Still I maintain that, if *Hyalonema* is to be considered one of the Hexactinellidæ, it must be based upon the presence of these *small* hexactinellid spicules; for the large ones of the periphery, and the minute feathered ones too, there, which appear to be the same in this respect as in *Holtenia*, bear no trace of the sixth ray, that I can see. Indeed the sixth ray, if on one of these large cruciform peripheral spicules, which appear to be intended to bind down the surface smoothly, would, by its projecting outwards, be evidently out of place; and if these spicules are to be considered hexradiate because a little projection of the central canal may be observed where the sixth ray would be if developed, to carry out this principle in the Spongiadæ will be found very inconvenient, if not wholly impracticable. In distinguishing species, which is a purely conventional arrangement, we should select, if possible, prominent features that are easily recognizable, both for practical purposes and to facilitate the study of natural history, there being, comparatively, no limit to minute distinctions, as there is no real line of demarcation in nature, if we do not limit the power to which the microscope should be used in this respect. The infinite mind of Nature does not require them; but the finite mind of man cannot get on without this aid, and still less the "finite purse;" when the more costly, *i. e.* the highest, powers of the microscope are required for their detection.

Tethya zetlandica, n. sp.

Pl. XXII. figs. 1–6 and 11–13 and 14–17.

Conical, globular, or slightly compressed (Pl. XXII. fig. 1). Colour bright grey in spirit. Surface smooth, interrupted by thick-set papillæ irregularly disposed, large and separate (fig. 2, *a*) or small and approximate (fig. 1, *a*). Pores and vents for the most part closed by contraction. Internal structure consisting of bundles of spicules (fig. 13, *b b b*) radiating from an excentric nucleus or point (*a*) to the circumference, where they end respectively in the papillæ of the surface (*f*), imbedded throughout their course in the sarcode of the body (*c c c*), which is charged, in the adult state, with minute ova (fig. 7), and presents, in dilated cavities connected with the excretory canal-system (fig. 14), a great number of pendent seed-like bodies —that is, the young *Tethyæ* (fig. 13, *d d d*); sarcode terminating peripherally in a condensed tough lamina (fig. 13, *e e e*), which forms a kind of cortex to the whole, and, extending upwards on the projecting bundles of the spicules respectively, also forms the papillary prolongations of the surface (*f f f*). Spicules of three kinds, viz.:—1, acerate slightly curved; 2, triforked, with the prongs of equal length; 3, anchor-headed. All these spicules vary in length with their position; the acerate, which are much the shortest, are chiefly confined to the body and internal parts, while the two others chiefly occupy the surface and base, being shortest on the upper part of the body and longest towards the base; all three kinds may be found projecting from the papillæ in variable plurality when the anchors and forks have not been broken off, which is generally the case. There are *no* bihamates. Average length of longest spicule, which is the anchor-headed shaft at the base of the *Tethya*, about 5-12ths of an inch. Size of specimen, viz. fig. 1, about 2 inches high by $1\frac{3}{4}$ inch broad.

Hab. Marine; deep water.

Loc. Sea about the Shetland Islands; Haaf Banks.

Obs. I have assumed that this species comes from the Haaf Banks, seeing that the label on the jar bears the words "Shetland. J. S. Bowerbank," with "*Tethya lyncurium*" written, as before stated, in Dr. Bowerbank's hand, who, in his 'British Sponges,' vol. ii. p. 84, as before stated, observes, with reference to *T. cranium*:—"I obtained nearly three hundred specimens of this sponge from the Shetland deep-sea fishermen, through their agent," part of which, viz. the two specimens of *T. cranium* and four of the species just described, in the jar at the British Museum, I further assume to have belonged to that collection. "*Tethya lyncurium*" (*Donatia*, Nardo & Gray) does not appear to have been yet found north of Connemara Bay, in Ireland, viz. lat. 53° 26′ (Johnston, *op. cit.* p. 85).

T. zetlandica is closely allied to *T. cranium* in most ways. It appears to inhabit the same locality, and sometimes, in like manner, to grow in the cavity or on the stem of *Halichondria ventilabrum*, Johnst. (see illustrations of both species, Pl. XXII.); but it markedly differs from *T. cranium* in two points, viz. in the disposition of the spicules on the surface, and in the absence of bihamates. This is at once seen in fig. 9, where the hoary, shining, asbestine appearance of the spicules of *T. cranium*, arranged in whorls like the hair of the human head, parting from the crown, from which Johnston has aptly named it (*op. cit.* pl. 1. fig. 1), contrasted with the irregular disposition of the same in *T. zetlandica* (fig. 2), at once points out the two species; while the entire absence of bihamates (fig. 9, *c*) in the sarcode (which is pregnant with them in *T. cranium*) is a not less distinguishing microscopic character, in which *T. zetlandica* agrees with *T. antarctica*. And not only, as before stated, are these differences to be seen in the adult forms, but they equally characterize the still unborn *Tethyæ* of the interior in each species (figs. 11 & 12). Thus the spiral twist of the spicules and the presence of bihamates, though all very minute, in the young *Tethyæ* of *T. cranium*, are as characteristic of it as the opposite is characteristic of *T. zetlandica*.

For the purpose of illustration, I have given figures of two specimens of *T. zetlandica*, in one of which the papillæ are large and separate (fig. 2) and in the other small and almost confluent (fig. 1); the latter, as will be observed, has grown on the stem of *Halichondria ventilabrum*: also a figure of *T. cranium* growing in the bottom of the cavity of a specimen of *Halichondria ventilabrum*, from another jar in the British Museum, labelled "*Halichondria ventilabrum.* J. S. Bowerbank, 52. 3. 12. 54."

The reader will at once observe that these are mere outlines of the objects they are intended to represent, and not finished drawings, as the latter would occupy more time than I feel disposed to give them, and are not absolutely necessary for the purpose, since, with the description and these diagrammatic sketches, the general appearance of both species, with their distinguishing characters, can at once be seen and applied.

In the illustration of *T. cranium* may be observed a distinct group of vents (fig. 9, *a*), to which attention is here directed because Dr. Bowerbank in his diagnosis inserts, "Oscula and pores inconspicuous" (*op. cit.* p. 83). But the distinctness of the whorls or spiral lines of spicules (fig. 9, *b b*) must be viewed as diagrammatic, since in the natural state they no more appear than in the hair of the human crown.

I have also added a group of the bihamates magnified (fig. 9, *c*), which are not to be found in *T. zetlandica*.

The word "bihamate," first applied by Dr. Bowerbank to this spicule, does not always meet the requirements of the case, although it is quite as good as any other that has been chosen. The name, however, does not matter, so long as we remember that it is a C- or S-shaped body, of a more or less spiral tendency, with the ends so turned in opposite directions that, if laid on a flat surface, they do not both rest on the same plane; so that, in whatever position the bihamate is, one end is always projecting, ready to catch any thing that may come into contact with it: hence Dr. Bowerbank has placed this form among his "retentive spicula" of the sarcode.

Nature, however, does not always require them for this purpose, as they are absent in *T. antarctica* and *T. zetlandica*, where the sarcode is held together apparently without any thing else of the kind. The habit of assigning a cause for every thing that Nature does more frequently meets with contempt than admiration.

Reproductive Process.

As with *Tethya cranium*, so with *T. zetlandica*; both species, in the adult condition, are richly charged with the small globular and compressed elliptical bodies (fig. 13, *d d d*) first described and figured by Johnston under the designation of "oviform" (*op. cit.* p. 84, pl. 1. fig. 8). Those in *T. cranium* are about 1-24th and those in *T. zetlandica* about 1-16th of an inch in diameter: they are therefore easily visible to the unassisted eye, and hence I have been able to give the outlines of a section of fig. 2 in fig. 13, which is pregnant with them, while, every part having been drawn of the natural size, the reader will, by reference to it, have nearly a facsimile of the object itself. Most of the oviform bodies and many in the *section* only just showing themselves above the level of the sarcode, while others are on their edges, their outlines, of course, are not all of the same size and shape. Whether the compression, which, as will hereafter be seen, is confined to the less-advanced forms, arises from the contracting effect of the spirit on a globular form when fresh, or whether it is natural to these bodies, I am ignorant, having never seen a *Tethya* under these circumstances while *living*.

In Dr. Bowerbank's 'British Sponges,' pl. 25. fig. 343, will be found a monstrous representation of one of these oviform bodies under the designation of "gemmule," which is only surpassed by his description (vol. ii. p. 87), where he applies the term "sexual" to them, and conjectures that one may be the "female or prolific gemmule;" but Dr. Bowerbank had never been able to discover any "spermatozoa" in either!

As this is a kind of physiology which I do not understand, let us go back to the term "oviform" first applied to these bodies by their original discoverer, and see if we can trace them from their earliest appearance up to the complete development of the full-formed young *Tethya*. But before entering upon this subject, it is desirable to premise a description of the sponge-animal from which the ova are first produced, and then the mode of sexual union by which impregnation is accomplished.

Last year I confirmed Prof. James-Clark's discovery of a "collar" round the cilium of the sponge-animal (Annals, vol. iv. p. 1, pls. 1 & 2), and at the same time gave a full figure of this body, which must now be regarded as the animal of the sponge just as much as the polype is regarded as the animal of the coral.

Since then most of my observations on the "ultimate structure of *Spongilla*," in which the animal was first pointed out (Annals, 1857, vol. xx. p. 21, pl. 1), have also been confirmed by Prof. James-Clark in his description and illustration of the American *Spongilla* (American Journ. Sc. and Arts, Dec. 1871, vol. ii.; republished in the Annals, 1872, vol. ix. p. 71, pl. 11, and in the Monthly Microscop. Journ. for March, No. xxxix. p. 104).

Shortly describing the animal, animalcule, or infusorium of the Spongiadæ, whichever appellation may be thought most appropriate, it is, in its passive form, a minute globular cell, apparently filled with granuliferous plasma, bearing a nucleus and two contracting vesicles, provided with a rostrum or projecting cylindrical portion supporting a delicate fimbriated collar, in the midst of which is a single cilium, and, in its active state, will take into its body crude material (that is, particles of indigo) if they be presented to it. The collar and rostrum possess the power of polymorphism; and, when necessary, the whole body can be thus transformed. The latter is about 1-3000th of an inch in diameter in the calcareous sponges, and only half that size in those of the siliceous ones that I have examined; and they are arranged in countless groups on the lining sarcode of the areolar cavities of the sponge.

Of all other animalcules or Infusoria with which I am acquainted, the sponge-animal seems to me to come nearest to *Difflugia*, or to that kind of *Amœba* which throws out its pseudopodia from one part of its globular form in particular (see an illustration of this in 'Annals,' 1856, vol. xviii. pl. 5. fig. 17). Hence it may be inferred that, if among the sponge-animals we find instances of two in apparent union similar to that which is termed "zygosis" among the *Difflugiæ*, we have strong reason for believing that in both instances this kind of union is for the same purpose.

In zygosis of the *Difflugiæ* the mouths of the two tests are brought together by an apparent union of the two contained animals; and if this be watched, the two animals thus united will be observed to flow backwards and forwards into each other's tests, as if their incorporation was as complete as the union of two drops of water; after which they separate, and each betakes itself to its own test.

Of this process Mr. W. Archer, of Dublin, who is probably the highest authority living, from his extensive and actual observation of the nature and habits of these animals, states respecting zygosis:—"Whatever may be the significance of the phenomenon, it is at least one which I have noticed myself in nearly every form of all the genera [of the freshwater Rhizopoda], each individual species always *conjugating* only with its *own* fellow" (Quart. Journ. Microscop. Sc. April 1871, No. xlii. p. 111). I can confirm what Mr. Archer has stated; and in one instance I found *five Difflugiæ* of the same form and species, which is one of the largest, viz. *D. urceolata*, Cart. (Annals, 1864, vol. xiii. pl. 1. fig. 7), all united together by their mouths, after the manner of zygosis. But, whether they be found united in pairs, which is the usual way, or in greater number, they are always, as Mr. Archer has stated, of the *same* species. Neither of us has ever seen two different species of *Difflugiæ* in zygosis, which is not less significant of the act being for sexual reproduction than that the individuals engaged in it are not mere varieties of one species, as some would have it.

I have also long since tried to find out the whole bearing of this phenomenon in connexion with the oviform bodies found in both the *Difflugiæ* and *Amœbæ*, and from time to time have recorded what I have observed, by illustration as well as description, which those who wish to consult my contributions in this respect may find in different numbers of the 'Annals,' viz. in vol. xviii. p. 115 (1856), vol. xii. pp. 30 & 261 (1863), vol. xiii. p. 23 (1864), and vol. xv. p. 171 (1865), since which time I have not returned to the subject. I had hoped to publish a figure, now in my journal, of zygosis in *D. urceolata*, in which every detail was measured and drawn upon the same scale, that the relative sizes of all might at once be seen; but, thinking that this might be indefinitely postponed, on account of my studies having taken another direction, I published the description of it in my last paper on the conjugation of certain species of Diatomaceæ, viz. that in the 'Annals,' vol. xv. above mentioned.

Finding that I could obtain no more knowledge of the process by mere observation of it externally, I tried what the effect of crushing and tearing to pieces a pair of *D. urceolata* (for this is the largest and thus best adapted species that I have found for the purpose) under the microscope, with the following results, which, as a kind of *ultimatum* on the subject, was thus published in the paper last mentioned:—

"Returning, then, to the question of impregnative generation in the Diatomeæ, it seems to me that, being so closely allied to the Rhizopoda in their organization, they might be inferred, by analogy, to follow the same mode of producing an impregnated generation as *Difflugia*. That this mode has been demonstrated, I by no means wish to assert; but observations on the subject, made subsequently to those published in my last communications to the 'Annals,' still further support me in the views therein announced, viz. that the nucleus furnishes the *sperm-*, and some other part of the body of the *Difflugia* the *germ-cells*, which produce the new generation. For in that large species which I have designated *urceolata* in my last communication, and which I have since ascertained to be one of the most persistent and plentiful forms about this neighbourhood, I, last summer, almost invariably found the nucleus (instead of undergoing the change as a whole) to become divided into several spherical cells of equal size, each of

which presented bodies in its interior similar to a brood of cells, which, on other occasions and under similar appearances, I have found to issue in the form of ciliated, monadic, polymorphic Rhizopods. With these also were present a number of much larger round and subround refractive cells, in which a nucleus was present, but very difficult to be seen, owing to the extreme fineness and apparent homogeneity of the material they contained. There were also several starch-grains present; and on many occasions, but on one in particular, a pair of these *Difflugiæ* in zygosis, when crushed in water under the cover of the slide, presented in their interior, besides a great number of the three kinds of cells mentioned, a still greater number of ciliated, monadic Rhizopods, of the sizes of the bodies in the nuclear cells, and a number of small unciliated *Amœbæ*, about the size of the 'refractive cells.' So far, then, only, do I feel justified in stating that this appears to me to be the mode in which the impregnated generation of *Difflugia* is produced; and if it be so, then all that remains to prove it is the evidence afforded by witnessing the actual union of the 'ciliated monadic Rhizopods' with the 'unciliated refractive cells'—an act which, probably taking place within the body of *D. urceolata* in an undisturbed condition, is not likely to be soon seen among its contents when forced out of the test into water by crushing and the pressure of a glass cover" (Annals, 1865, vol. xv. p. 171 *et seq.*).

I have quoted this paragraph at length, not only to show the results of my last observations on zygosis, but to point out what may take place in the sponge-animalcules under similar circumstances, if we can satisfy ourselves that they also enter into this kind of union. But before commencing this part of our subject, it is also desirable to add briefly what I have observed in the oviform bodies of the *Difflugiæ*, which we may assume to be the result of their zygosis.

One thing is always obvious, viz. that the nucleus disappears, leaving the nuclear utricle empty; and the changes which take place in the oviform bodies in *Euglypha* are recorded in the following extract, viz.:—"I have seen the ovule of *Euglypha* in every stage, from its first appearance in the test to the time when it has acquired the power of putting forth rhizopodous prolongations (fig. 31), after which the tests of very small *Euglyphæ* presented themselves in the same basin, which did not appear before the parents had died off and left their ovules to shift for themselves" (Annals, 1856, vol. xviii. p. 230, pl. 5). All this was described and figured in the place just mentioned, more than fifteen years ago.

We are now in possession of the form of the sponge-animalcule as well as that of the *Difflugiæ* and *Amœbæ*. We know that they all possess the power of polymorphism, and take in crude material for nourishment, but that the former differ from the latter in being infinitely smaller, in possessing a cilium, and in living in communities. However, if we view the sponge-animalcules as but an inferior grade of *Amœbæ*, as we view the compound Tunicata as inferior grades of the great separate Ascidians, then the presence of the cilium in the sponge-cell finds its explanation in the fact, according to my observations, that the young *Amœbæ* begin life with a cilium, which is afterwards retracted. (Annals, 1863, vol. xii. p. 48, and 1864, vol. xiii. p. 21, pl. 2. fig. 19.

We have also become acquainted with the phenomenon called zygosis in the *Difflugiæ*, and its probable consequences, including the formation and development of the oviform bodies into forms like the parent. Let us now see how far any thing in the sponges may present itself to us like the latter.

In Dec. 1869, long before I knew any thing, from actual observation, of the form of the sponge-animal, as described by Prof. James-Clark, I had a very small *Halichondria simulans*, Johnston (*i. e.* not more than a quarter of an inch in diameter), under microscopic observation, in a watch-glass with sea-water, for several days; and during this time I repeatedly assured myself of the form and measurement of all its elementary parts, which, with the position of the spicules, were carefully drawn in my journal, upon the scale of 1-6th to 1-6000th of an inch. I have therefore now the most reliable information on this subject, particularly as these observations and drawings were again repeated with similar results on another specimen of the same species in January 1870.

Among these elementary parts there are figures of the conjugation of cells somewhat larger than the sponge-animals of the "groups," but bearing such a strong resemblance at once to the form of the sponge-animalcule among the sponges, and to zygosis among the *Difflugiæ*, that little doubt can be entertained of the latter being identical.

I have therefore selected for publication that figure (8) which best illustrates the facts, as the others, although equally convincing, are more or less complicated with pseudopodial prolongations.

In this figure we observe distinctly the bodies (*a a*) of the two sponge-animalcules in conjugation or zygosis, united by their rostra (*b b*), drawn upon the scale, as just stated, of 1-6th to 1-6000th of an inch. This would give the ordinary size of the sponge-animalcule of the calcareous sponges, which appears to be about double the size of that of the siliceous ones—measurements which at all times, of course, with such small objects, of such a polymorphic nature, and viewed under such circumstances, should only be regarded as approximative.

I have already stated (Annals, *l. c.*) that, among the marine *siliceous* sponges, *Halichondria simulans*, from its hardiness and the apparently larger size of its sponge-animalcules, together with its plentifulness, affords one of the best species for observations of this kind.

Besides the figure of zygosis above described and given in the plate, there are others where the sponge-animalcules are united linearly, like the individual Diatomeæ in the filament of *Melosira*, with here and there a conjugation like that of our illustration. Schmidt has also figured something of this kind in an allied species, viz. *Reniera aqueductus* (Adriat. Spong. 1st Supp. pl. 1. fig. 12). But, with the polymorphic nature of the sponge-animalcule, such diversities of form being unlimited, our present object has been to select that which is most like zygosis in every respect, an almost facsimile of which I figured long ago in *Amœba radiosa* (?) (Annals, 1856, vol. xviii. pl. 5. fig. 17).

Not knowing until last year the form of the sponge-animalcule by actual observation, I only viewed this conjugation as *very like* zygosis in the *Difflugiæ*; but now that I am familiar with the figure and habits of this animalcule, the identity of the process seems to me complete.

Thus having obtained a starting-point for our history of the reproductive process of the Spongiadæ by impregnation, let us revert to the seed-like bodies in the *Tethyæ*, for the purpose of following it up to the fully developed young animal of the Shetland species, with which we are now most immediately concerned.

And taking a portion of the sarcode of *T. zetlandica* (i. e. from fig. 13), it will be found, when torn to pieces in water under the microscope, to be thickly charged with granuliferous cells about 15-6000ths or 1-400th of an inch in diameter (fig. 7). There is, of course, a wide difference between this size and even that of the body of the sponge-animalcule, which may be set down roughly about the 3000th of an inch. But I can recognize with certainty in these spirit-preserved specimens *no* stages between the two sizes; so I must be content to assume that this is an advanced state of the sponge-ovule, whatever its original size might have been.

When further examined, this cell is observed to be filled with nucleated cellules (*c*), each of which is again filled with minute granules (*d*), and in the midst of all an effete (?) nuclear cell (*b*), like that seen in the *Difflugiæ* and *Amœbæ* (see also

Annals, 1863, vol. xii. pl. 3, on *Amœba princeps*)—that is, *without the nucleus.* This cell, again, is exactly like that which I have described and figured as existing so abundantly in *Dercitus niger* and *Stelletta aspera* (Annals, 1871, vol. vii. p. 13, pl. 4), and which therefore now must be regarded as ova.

From the condition of the ovule imbedded in the sarcode, as just described, we go to the seed-like bodies *outside* it, viz. in the dilated cavities of the excretory canal-system, where they are still pendent to the sarcode by a little pedicle which is analogous to the umbilical cord in higher animals (fig. 14), and which, as the young *Tethya* becomes fitted for an independent existence, gradually atrophies until the separation is complete.

Here, although there is every stage to be observed between the least and most advanced ovule in this part of their development, we shall find it convenient to divide them into two groups, viz. that in which the ovule is elliptical, compressed, pear-shaped, and circumscribed by a kind of capsular covering (figs. 14, *b b b*, and 6 & 12), and that in which it assumes a globular form, with undefined spiculiferous border and areolar sarcode (figs. 14, *a a*, and 4 & 11).

In the first instance (figs. 6 & 12) the cellules of the ovule appear to have become broken down into a granuliferous homogeneous sarcode (*c*) charged with minute refractive silicified spheres, which may be the germs of the spicules that are subsequently to appear in the centre of the mass. Those that are now present are all acerate (that is, without heads), and do not reach the confines of the ovule (fig. 5)—which presents a defined margin (*a*) with the shape above mentioned, and in this form is attached to the dilated cavity of the excretory canal-system by the little pedicle mentioned.

In the second instance (figs. 4 & 11) the "granuliferous homogeneous sarcode" has become areolar (*a*); the spicules have greatly increased in number (*b*); heads of different shapes have been and are being added to them; they have burst through the defined margin of the foregoing development, and carried out with them the areolar sarcode into a papillated globular form, in miniature, like that of the parent. Young sponge-animals have in all probability begun to grow in the areolar cavities; and the pedicle of attachment perishing, the little sponge falls loose into the excretory canal-system, through which it is rapidly ejected into its new element, there to find a place of attachment (perhaps again the stem of a *Halichondria ventilabrum*) and finally attain its adult size.

These two descriptions apply to the ovules of *Tethya cranium* as well as to those of *T. zetlandica*; only the spicules in the former are arranged in a whorl from the commencement, and accompanied by the bihamate spicule (figs. 11 & 12), which points of distinction are, of course, absent in the latter.

It might also be observed that, although the one-armed anchor-headed spicules project beyond the rest in the young *Tethyæ* of both species, they do so to such an extent in *T. cranium* as to form a kind of fringe (fig. 11, *c*).

I am not prepared to make any lengthened comparison between these young *Tethyæ* and the so-called "seed-like bodies" of *Spongilla*. At first it would appear that there is not any very great difference between their sizes respectively, the fully developed young *Tethyæ* of *T. cranium* and *T. zetlandica* being respectively 1-24th and 1-16th of an inch in diameter, while the seed-like bodies of the five species of *Spongilla* at Bombay, viz. *cinerea*, *Carteri*, *alba*, *Meyeni*, and *plumosa*, average respectively 1-63rd, 1-29th, 1-30th, 1-47th, and 1-22nd of an inch in diameter, the last measurement being the long diameter of the elliptical form (Annals, 1849, vol. iv. p. 81). But when it is considered that these measurements include the thick crust which surrounds each seed-like body, and that the globule of soft contents is still smaller, that no spicules are yet developed in it, and that it cannot be considered the "fully developed" young *Spongilla* until it has left the capsule, it becomes evident that we are not comparing like with like. In short, the state of the contents of the seed-like body much more resembles the ovule of the *Tethyæ* while "imbedded in the sarcode" (fig. 7) than any other stage of the latter above described. At a very early period the seed-like body of *Spongilla* very much resembles in all particulars the globular body of the sponge-animalcule itself, somewhat enlarged; and when fully formed, its contents consist of a globular cell containing a number of spherical cellules filled respectively with granular matters, among which are many still smaller cells or germs. Thus it closely resembles in this respect the ovule of the *Tethyæ* before it leaves the sarcode to become pendent in the dilated cavity of the excretory canal-system. Hence it now seems to me that we should regard the so-called seed-like bodies of *Spongilla* as true ova, which, like the seeds of plants, are wrapt up in a shell for preservation until such time and circumstances occur as are favourable to their development. As the contents of the seed-like body issue from the capsule, the globular cells and *their* contents respectively appear to pass directly into the globular groups of sponge-animalcules, and the excretory canal-system to be hollowed out, and the horny skeleton and spicules formed, in the intercellular plasma which exists between the globular cells (Annals, 1857, vol. xx. p. 26).

The presence of a capsular covering to the ovum in *Spongilla*, and its absence in the *Tethyæ* and the marine sponges generally, is explained by the drought to which the former may be exposed during subsidence of the fresh water in which it is growing. Thus the masses of *Spongilla* in the tanks of Bombay become uncovered and perfectly dry for several months in the year—a contingency to which the marine sponges can never be exposed; and hence the capsule, instead of being a protection to them, would be in the way of the full development of the ovum, which goes on uninterruptedly from the beginning to the end, when it is ejected into the water in a state of comparative maturity. The contents of the ovum of *Spongilla*, on the other hand, do not reach this state until they have emerged from the capsule and become developed into the young *Spongilla*.

Of course, in a new field like this, to which I have now and then turned my attention for the last twenty years, my views progressively have been somewhat modified—and yet not much, as will be seen by my "Description of the Freshwater Sponges of Bombay," first published in the 'Journal of the Asiatic Society of Bombay,' in 1849, and subsequently reprinted in the 'Annals' of the same year (*l. c.*).

In describing the development of the young *Spongilla* from the seed-like body in the paper just mentioned, it may be observed, at p. 87, that I mention an "intercellular substance," or "semitransparent mucilage," which forms the "bond of union between the cells" of *Spongilla*, that it possesses a power of polymorphism "independently of the sponge-cells, and presents contracting vesicles." All this, too, is figured in the illustrations (pl. 4. fig. 2). Finally, at p. 95 is the following sentence:—"My impression, however, is, that both the horny skeleton and its spicules are formed in the intercellular substance, and not within the cells." This is Häckel's view in 1870; and for this "intercellular substance" he proposes the name of "sarcodine" or "syncytium" (Annals, 1870, vol. v. pp. 112 & 113, "On the Organization of Sponges &c.," translated). No allusion whatever is made to my notice of the same substance &c. in 1849, which probably would have been the case had this naturalist read all that had been written on the subject previously to writing himself. How unlike the old Salmasiuses and Bocharts, &c., who read every thing on their subject and acknowledged it! Has not the age for these master minds passed away amidst the growing desire to avoid every thing that gives extra trouble, even though it may entail inferior work?

The same kind of bodies which Dr. Th. Eimer found in the siliceous and calcareous sponges at Capri, from March to July 1871, and figured, with description, as spermatozoa of these sponges, in the following December (Schultze's Archiv für Mikroscop. Anat. vol. viii. pt. 2, p. 281), I found in *Microciona atrosanguinea*, at Budleigh-Salterton, Devon, in July 1870, and fully described them as such in the following October (Annals, vol. vi. pp. 339, 340)—conjecturally, it is true, because I do not know that any one has yet seen them pass into the ovum of the sponge, which is thus still wanting to confirm the otherwise well-assumed fact. My description is unaccompanied by illustrations; but the figures in my journal, from which it was taken, are identical with those of Eimer, and therefore the description too.

The "thread-cells" which Eimer figures from the Renieridæ &c., at p. 283, *ib.*, I have not yet seen.

I could have wished that Eimer had alluded to my description of October 1870 instead of quoting Häckel's account of mine and Prof. Huxley's figures respectively (published in the 'Annals,' in 1854 and 1851) of spermatozoa in the sponges, as explained by Lieberkühn, whose identification of the latter with a flagellated infusorium is now shown by Eimer's figures to have been most unfortunate—and as regards my own, doubtfully given from the first (in 1854, and contradicted in 1858) as spermatozoa, equally unjust; for although probably not the spermatozoa of *Spongilla*, there can be no doubt that they really belonged to it, and, by their habits, could not have been the infusorium mentioned by Lieberkühn. In short, had Lieberkühn read my description as well as seen the figures, he would not have suggested this explanation.

Eimer states, in his "Addendum," that Häckel has also now seen spermatozoa in both the siliceous and calcareous sponges (Jenaisch. Zeitschrift, vol. vi. pt. 2).

Development of the Spicule.

While the opportunity was afforded of tracing the development of the ovule generally in the two *Tethyæ* mentioned, it will not seem unlikely that I should have endeavoured to find out something more of the development of the spicule than is stated in my "Ultimate Structure of *Spongilla*" (Annals, 1857, vol. xx. p. 23); but I could not, so far as its earliest and primary form is concerned (that is, the simple acerate one), although I have been able to do so as regards its arms or appendages. It should be understood, however, that I am not going into the whole of the development of the spicule now, as I am accumulating material for a separate paper on this subject.

In the development of the young *Spongilla*, I, of course, had nothing to deal with but the acerate or primary form of the spicule, as this is the only large form in this sponge; but in the young *Tethyæ*, as will have been seen, there are arms to many of the spicules, resulting in the development of several different forms, the chief of which, and that which is peculiar to the young *Tethya*, is the one-armed anchor-headed spicule.

To resume shortly what I have already stated in this respect:—the development of the ovule commences with the cell of cellules &c. *in* the sarcode; then follows the breaking down of all these cellules into a granular mass of plasma, of an ovoid shape, appended by a pedicle to the *outside* of the sarcode, in a dilated cavity of the excretory canal-system; then a few acerate spicules appear in the centre of this, together with many minute spherical refractive granules, apparently of a siliceous nature; lastly, the granular plasma becomes areolar, the spicules greatly increase, and heads of various forms develope upon their peripheral ends, among which the one-armed anchor-headed one mentioned is not only the most numerous, but, as before stated, extends somewhat beyond the circumference of the young *Tethya*, now become globular. It is to this form, which appears in all stages of development, that my attention has been chiefly directed; and from it I am able to add a little more to the development of the spicule than I have already given.

The four representations under fig. 16, Pl. XXII. are intended to furnish a series of forms illustrative of the development of this one-armed anchor-headed spicule, which, of course, will apply to all other developments of the same kind of form: that of *a* is, of course, assumed, since, before the end of the shaft begins to be inflated, there is no indication of what it is to be, beyond a linear acerate form. I have drawn it as *open* at the ends, though I am not certain if this state always precedes the inflation, as it is frequently seen in the simple acerate spicule. In *b* we have the inflation of the head, which undoubtedly precedes the formation of the arm, together with a terminal expansion of the central canal in a compressed cellular form. Our figure *c* shows the first budding of the arm and the extension of the central canal which leads to it branching off *below* the terminal compressed expansion; while *d* not only shows the full formation of the arm, but that of the one-armed anchor-headed spicule generally, attended by a frequent occurrence, viz. the budding of another arm, *e*. All

these figures are drawn to the same scale, viz. 1-24th to 1-600th of an inch, whereby they furnish facsimiles equally magnified of the objects they are intended to represent. Fig. 3 is the head of an average anchor-spicule taken from the base of the *adult* form (fig. 1) and magnified to the same scale. It not only also shows an extension of the central canal beyond the branches given off for the arms, but points out the relative sizes of the adult and fœtal spicules of this kind, when compared with *d* of the following figure.

There are other spicules in the young *Tethya*, especially fork-heads having one, two, or three arms; and these are represented under fig. 17: *a* is one-armed, analogous to the one-armed anchor-head just described; *c* has two arms, and is the most numerous form in the young *Tethya* after the one-armed anchor; *b* is the three-armed form, which is scantily present, like the three-armed anchor-head, *d*; while *e* is the acerate form. I need hardly add that the other ends of all these spicules are single-pointed.

Thus the development of *the* arm is always accompanied by an extension of the central canal of the shaft. But there are other additions to the spicule, viz. spines &c., which are not always so accompanied, as may be seen by reference to fig. 4, Pl. XXII., where they may be observed to have been added to the outside of the shaft after the latter had been formed. Hence, in this instance, it is not the extension of the central canal which determines the ultimate form of the spicule, but some external agency, which adds to and modifies the external form of both the horny and silicified fibre, as well as the spicules. That this should be easily effected on all sides in the midst of the sponge, where these parts are enveloped in the intercellular sarcode, may be easily conceived; but it is not easy to conceive how this takes place in the long spicules of *Hyalonema* and *Holtenia*, unless they grow, like hairs, by additions to their proximal extremities, or the sarcode creeps out over them to their ultimate terminations.

Still, we are dealing here with the developments of the spicule *after* the shaft has been formed, and not with its earliest appearance, to which I can add nothing more than I stated in 1849, *l. c.*, viz. "My impression still is, that both the horny skeleton and its spicules are formed in the intercellular substance, and not in the cells." But how they come into being I know not, any more than the "Preacher," who, 3000 years ago, wrote:—

"As thou knowest not what is the way of the spirit, nor how the bones do grow in the womb of her that is with child;

even so thou knowest not the works of God who maketh all" (Ecclesiastes, xi. 5).

Undoubtedly the power which developes the ovum, and causes it to pass into the new being, acts without brain and organs of sense. It is a power which pervades all nature, and is infinite. Hence, as our brain and organs of sense are secondary products with a finite power, we can never comprehend the infinite one. So that all idea of ever finding out how things come into existence or grow may as well be abandoned. We can see a crystal as soon as it is formed, but the highest magnifying-power does not enable us to see it come into existence or increase in size. As familiar instances of this power, we might perhaps mention the return of the messenger-pigeon direct to its home, the bee to its hive, the young cuckoos to the land of their parents, &c. But the instances are infinite, as the power is unknown; like that of the mind itself, we only recognize it by its manifestations. It is called "instinct," and is regarded by most as a kind of inferior intelligence; but it can see without eyes and reason without a brain, better than we can do with either. In short, it is nature unbounded, of which man is but a finite imitator.

So also in investigations with the microscope, it seems to me highly unphilosophic to speak without modification of the "structureless jelly," to wit, of an *Amœba*, or of the absence of a cell or layer round this animalcule or any body of the kind, because it is not demonstrable to our senses. The leg of a *Euplotes* is probably as complicated in its muscular apparatus as that of a crab-claw, yet it is as transparent and apparently structureless as glass. The texture of a cell- or surface-layer may be infinitely delicate or infinitely dense. There is no difficulty in calling it such under the latter; and it would be unphilosophic to deny its existence in the former. There are, no doubt, textures in the Spongiadæ that loom, as it were in the misty distance of development, which in higher animals can be recognized by the coarsest sense; but in the former condition we should only speak of them as such, and not with that certainty that we would of the latter. The atoms which make up the complicated and beautifully formed body of a *Euplotes* rush about before us, under the microscope, as a whole, with the appearance of being as tough and compact almost as a crab. But let death occur, and the phenomenon called "diffluence" will immediately succeed, in which the atoms fall asunder like a bunch of iron-filings held together by magnetism, when the latter is suddenly withdrawn. Lastly, both motion and change of form may be infinitely slow or infinitely rapid. We could not see either in the *Amœba* were it not for the magnifying-power of the microscope, nor in the heavenly bodies, were it not for their great size and great distance. Hence we cannot comprehend this infinity, and should only speak of these phenomena as they appear to our finite organs of sense, modifying our assertions by our equally finite reason, in all philosophic humbleness. I have been induced to make these remarks because I have lately observed a tendency to speak more decidedly in microscopic inquiries than our powers justify.

EXPLANATION OF THE PLATES.

Plate XX.

Fig. 1. *Tethya antarctica*, n. sp.; fully developed young one, natural size.

Fig. 2. The same, lateral view, magnified to the scale of 1-48th to 1-1800th of an inch: *a*, summit; *b*, base; *c c c*, vents; *d d d*, papillæ of surface supporting spicules; *e*, tufts of spicules projecting from the base; *f*, two very long anchor-headed spicules projecting from the side.

N.B. The greater part of the anchor-heads have been broken off.

Fig. 3. The same, end view of summit, magnified to the same scale, showing three large vents, which branch off internally into the excretory canals: *a a a*, vents; *b b b*, papillæ of the surface supporting spicules.

Fig. 4. The same, full-grown specimen; portion of dermal sarcode, showing the pores and spicules of the surface: *a a*, pores; *b*, spicules. Scale 1-48th to 1-1800th of an inch.

Fig. 5. The same, form of acerate spicule.

Fig. 6. The same, form of triforked spicule; one prong much larger than the other two, which are equal.

Fig. 7. The same, form of anchor-headed spicule of the body.

Fig. 8. The same, form of anchor-headed spicule of the tufts at the base.

N.B. All these are adult forms, drawn to the scale of 1-24th to 1-1800th of an inch.

Fig. 9. The same, real average length of largest acerate spicule.

Fig. 10. The same, real length of longest portion of shaft, to which the anchor-head remained attached.

Plate XXI.

Fig. 1. *Rossella antarctica*, nov. gen.; large cruciform peripheral spicule, showing:—*a a a a*, the four arms, covered respectively with a layer of large and small (macro- and micro-) spines; *b*, continuation of adjoining arm; *c*, shaft or vertical arm, covered with a layer of microspines only; *d*, continuation of same, to show form of free extremity. Scale 1-48th to 1-1800th of an inch.

N.B. In this figure the arms are truncated, to meet the size of the plate, and drawn straight instead of sigmoid, for convenience. See the natural form in figs. 5 & 6.

Fig. 2. The same, lateral view, to show the position of the arms relatively to that of the shaft. All truncated to make the figure smaller.

Fig. 3. The same, central portion, drawn to a larger scale, viz. 1-24th to 1-1800th of an inch, to compare with the fossil one, fig. 37. pl. 9, vol. vii. p. 126, Annals, 1871: *a*, shaft or vertical arm; *b b b b*, horizontal arms; *c*, central canal; *d*, subsequent layer added to the original shaft.

Fig. 4. The same, portion of a horizontal arm much more magnified, showing the original shaft, the spiniferous layer, and the relative size of the macro- and microspines: *a*, original shaft; *b*, additional or spiniferous layer; *c*, macrospines; *d*, microspines.

Fig. 5. The same, lateral view, nat. size.

Fig. 6. The same, to show sigmoid curve of horizontal arms and straight shaft, nat. size.

Fig. 7. The same, podal (?) spicule, showing portion of shaft and anchor-or, rather, grapnel-head, consisting of four recurved arms.

Fig. 8. The same, hexactinellid form, in which the shaft is continued on into a fifth arm (*a*) or straight spike.

Fig. 9. The same, hexactinellid form, where one of the recurved arms (*a*) is prolonged after the manner and length of a shaft. Abnormal form?

N.B. These three figures are all drawn to the scale of 1-48th to 1-1800 of an inch.

Fig. 10. The same, longest portion of shaft found with anchor-head attached, nat. size.

Plate XXII.

Fig. 1. *Tethya zetlandica*, n. sp., attached to the stem of *Halichondria ventilabrum*, Johnston, nat. size: *a*, papillæ, small and closely approximated; *b*, stem of *H. ventilabrum*.

Fig. 2. The same, nat. size, half the specimen: *a*, papillæ, here large and separate.

Fig. 3. The same, anchor-headed spicule of the base of fig. 1, to show, *a*, the continuation forwards of the central canal towards the point. Scale 1-24th to 1-6000th of an inch.

Fig. 4. The same, fully-developed young one, nat. size, viz. 1-16th of an inch in diameter.

Fig. 5. The same, magnified about 16 diameters, showing:—*a*, areolated sarcode; *b*, spicules, chiefly one-armed anchor-headed, of the form given in fig. 16, *d*.

N.B. This must be viewed merely as a diagram. It would be almost impossible to give a facsimile of this beautiful object with all its detail on this scale.

Fig. 6. The same, earlier stage: *a*, defined margin of the ovule; *b*, granular plasma; *c*, spicules, now few and all acerate or without heads, showing that the acerate is the fundamental form of the spicule.

N.B. The same remark applies to this figure: it must be regarded as a diagram. To have introduced a shade for the "granular plasma" would have confused the whole.

Fig. 7. The same, still earlier stage of the ovule, viz. while it is imbedded in the sarcode, now about 1-400th of an inch in diameter: *a*, cell-wall; *b*, nuclear cavity (?); *c*, nucleated cellules; *d*, nucleated cellule, more magnified, showing contained granules.

Fig. 8. *Halichondria simulans*, Johnston; two sponge-animalcules in zygosis?: *a a*, bodies of sponge-animalcules respectively; *b b*, their necks or rostra in conjugation.

Fig. 9. *Tethya cranium*, Johnston, attached to the stem of *Halichondria ventilabrum*, Johnston, nat. size: *a*, group of vents at the apex; *b b*, lines indicating the disposition of the projecting spicules of the surface winding round the summit, like the crown of the human head; *c*, form of bihamate spicules with which the sarcode is charged; *d*, stem of *H. ventilabrum*; *e e*, part of cup of same.

Fig. 10. The same, fully developed young one, nat. size, viz. 1-24th of an inch in diameter.

Fig. 11. The same, magnified about 16 diameters, showing:—*a*, areolated sarcode; *b*, spicules, chiefly one-armed anchor-headed, disposed in a whorl; *c*, extension of anchor-headed spicules beyond the periphery of the young *Tethya*; *d*, minute bihamates.

N.B. The same remarks apply to this and the following figure as to figs. 5 & 6. Note the disposition of the spicules in a whorl, and the presence of the bihamates as distinguishing this species from *T. zetlandica*.

Fig. 12. The same, earlier stage: *a*, defined margin of ovule; *b*, granular plasma; *c*, spicules, few in number, and all acerate or without heads, already disposed in a whorl; *d*, bihamate spicules.

Fig. 13. *Tethya zetlandica*, vertical section of fig. 2, about two-thirds of nat. size: *a*, nucleus; *b b b*, bundles of spicules radiating from the centre of the nucleus to the circumference of the *Tethya*, where they end in the papillary projections of the surface; *c c c*, sarcode filling up the intervals between the bundles of spicules, charged with the ovules, fig. 7; *d d d*, young *Tethyæ* (magnified in figs. 5 & 6) in dilated cavities of the sarcode connected with the excretory canal-system, fig. 14; *e e*, condensed layer of sarcode forming the cortical layer of the *Tethya*; *f f*, papillary prolongations of the same extended up upon the projecting ends of the spicule-bundles.

N.B. All parts of this figure are of their natural size.

Fig. 14. The same, diagram of dilated cavity of sarcode connected with excretory canals, showing pendent position and forms respectively of the young *Tethyæ*, figs. 5 & 6; also openings of the excretory canals: *a a*, fig. 5; *b b b*, fig. 6; *c c c*, openings of excretory canals.

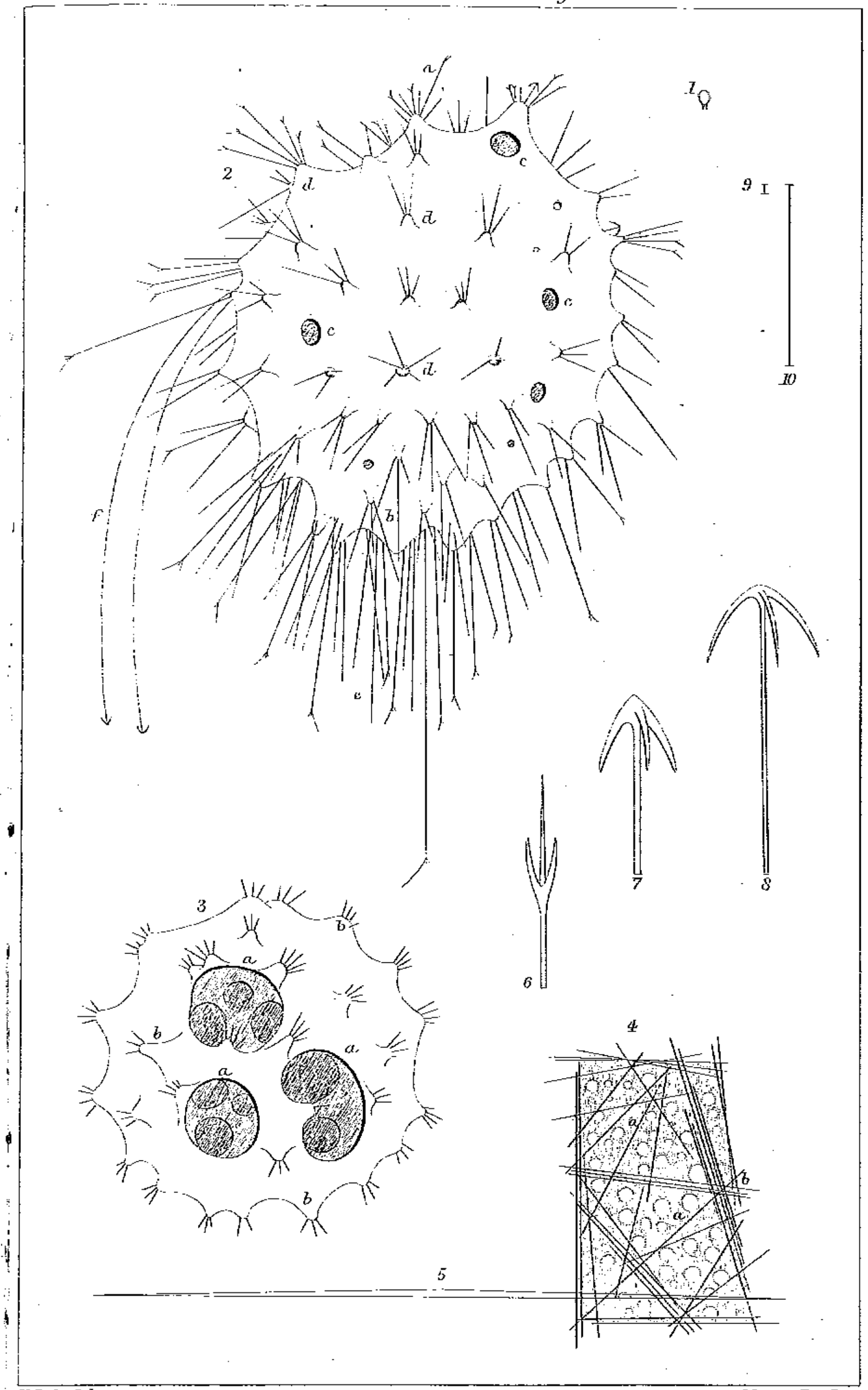
Fig. 15. The same, three young *Tethyæ* attached to one pedicle.

Fig. 16. The same, four figures showing the development of the one-armed anchor-headed spicule, viz.:—*a*, simple shaft; *b*, the same with end inflated; *c*, showing the budding of the "one arm;" *d*, the arm fully formed; and *e*, the bud of a second arm. Scale 1-24th to 1-6000th of an inch.

Fig. 17. The same, other spicules of the fully developed young *Tethya*, fig. 5: *a*, one-armed forked spicule analogous to the one-armed anchor; *c*, two-armed forked spicule; *b*, three-armed forked spicule; *d*, three-armed anchor-headed spicule; *e*, acerate spicule.

Of course, the ends of all these spicules, which are not represented, are single-pointed.

Budleigh-Salterton, Devon.
25th March, 1872.



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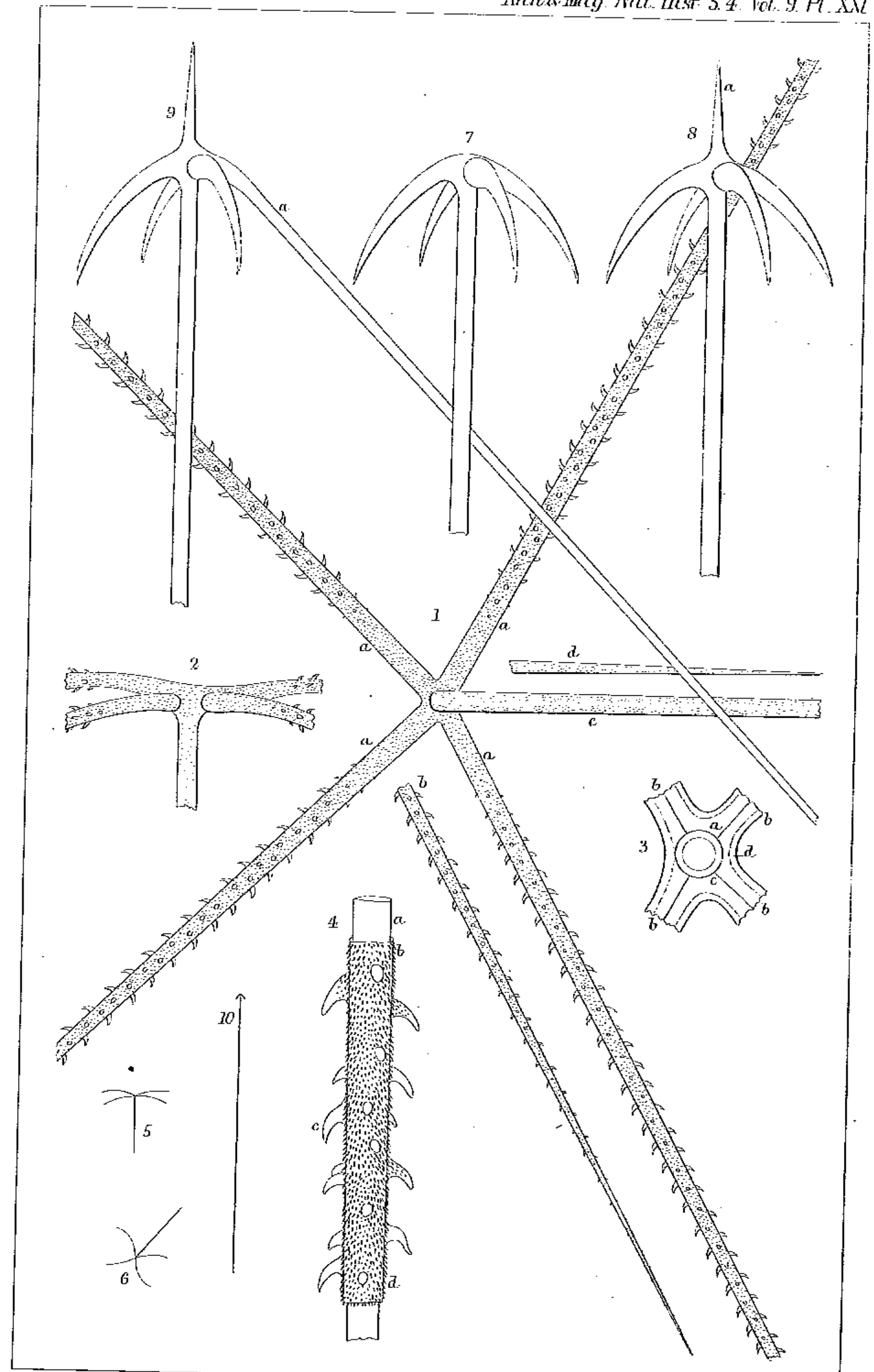

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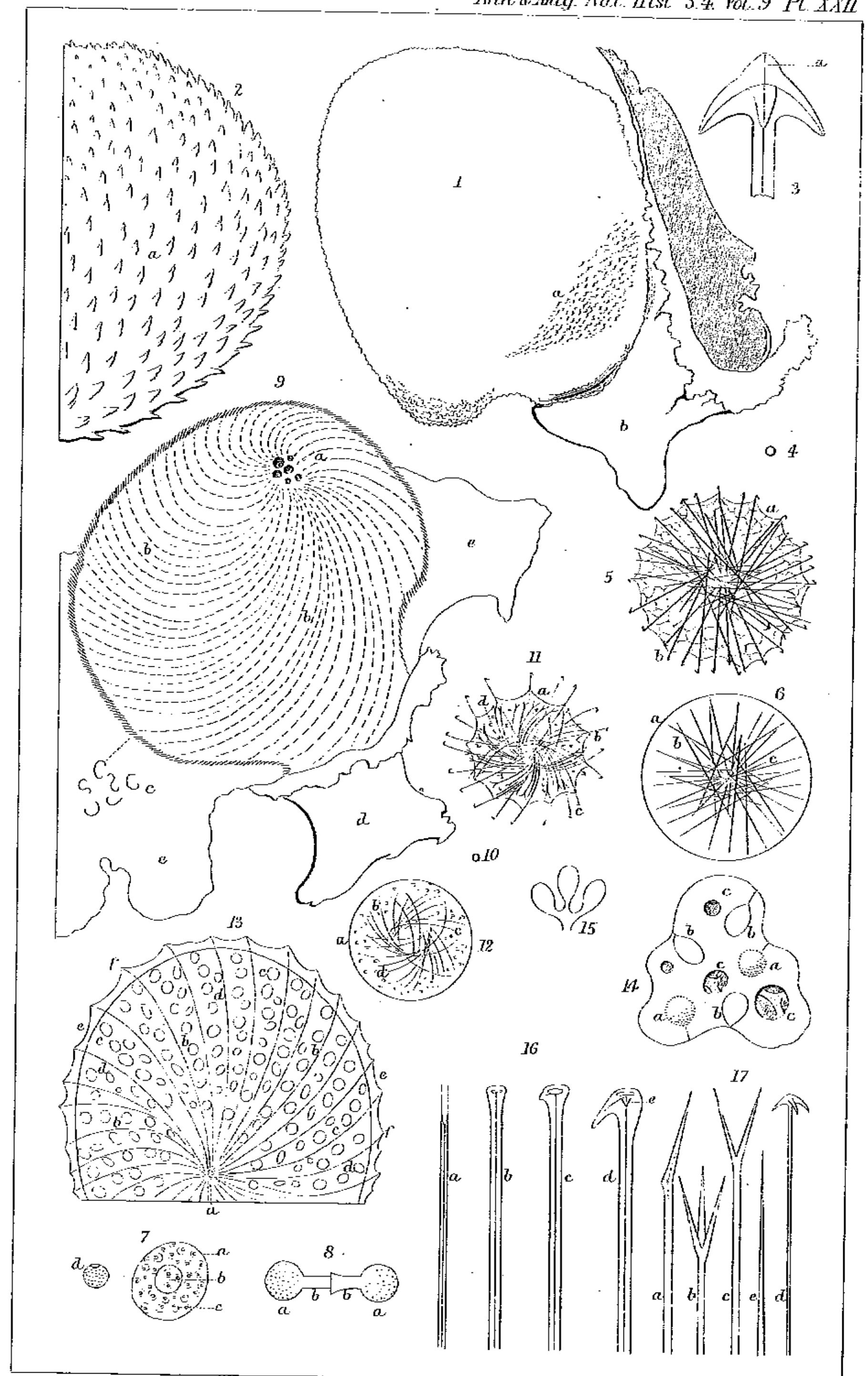

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