## 4. On *Hyalonema mirabile*.

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(Plates IV. & V.)

*Hyalonema* was named and described by Dr. J. E. Gray in the Society's 'Proceedings' for 1835, p. 63, from a specimen sent from China to the India House in London, under the name of the Glass Plant, and subsequently in a paper published in the Society's 'Proceedings' for 1857, p. 279, entitled "Synopsis of the Families and Genera of Axiferous Zoophytes or Barked Corals." The author designates it as a Coral, and describes it as follows :—

"Family 1. Hyalonemadæ.

"Coral subcylindrical, rather attenuated, and immersed in a fixed sponge. Axis in the form of numerous elongated, slender, filiform, siliceous fibres, extending from end to end of the Coral, and slightly twisted together like a rope. Bark fleshy, granular, strengthened with short cylindrical spicula; polypiferous cells scattered, rather produced, wart-like, with a flat radiated tip.

"1. Hyalonema, Gray.

"The character of the family.

"1. Hyalonema mirabilis. B.M.

"*Hyalonema mirabilis*, Gray, Syn. B. M. 1830, 118.

"*Hyalonema sieboldii*, Gray, Proc. Zool. Soc. 1835, 63; Dana, Expedition, 642.

"Japan (*Sir Hans Sloane; Siebold*).

"The Coral, as it is usually seen, consists of three distinct portions of very different texture and appearance—the axis, bark, and the sponge."

The author then proceeds to describe each of these parts in detail, and in page 282 he writes, "The sponge to which it is attached has no real connexion with the Coral, except as affording it the means of support, and is of the common structure." And subsequently he states it as his opinion that "There can be no doubt, after the examination of the two specimens in the British Museum, one in my own collection, one in Paris, and several in the Leyden Museum, that the bark evidently belongs to the axis, and that this Coral is a true Zoophyte, and not a sponge covered with a parasitic Zoophyte, as it is regarded by M. Valenciennes (see Milne-Edwards, British Corals, 81)." In the first sentence quoted the author asserts that the sponge *is* a part of the Coral; in the commencement of the following paragraphs he decidedly denies the connexion existing between them; but I presume that the latter is the real opinion of the author. In the 'Annals and Magazine' for October, 1866, Dr Gray corrects

his former opinion that *Hyalonema* belonged to the "Barked *Alcyonaria*," and announces his belief that it should be arranged with the *Zoanthidæ*.

In the Society's 'Proceedings' for 1864, p. 265, M. Barboza du Bocage, Director of the Museum of Natural History at Lisbon, has described a specimen of *Hyalonema*, which was found off the coast of Portugal, near the mouth of the River Sado. This specimen does not appear to have had any portion of a basal sponge appended to it. The author designates the protuberant organs on the coriaceous coat of the spiral column as polypes; and describes what he conceives to be a row of twenty tentacles around the central orifice, and a second circle within the first one of conical elevations which appear to him to be rudimentary tentacles, which he describes thus: —"Les tentacules sont de forme triangulaire, comprimés des deux côtés, à bords parfaitement lisses, et à pointe mousse et arrondie. Ceux du premier rang sont plus larges à la base; et leur bord antérieur est plus convexe, et en forme de bourrelet arrondi."

The author subsequently obtained two other specimens of the same species, and described them in the same work for November 1865: in p. 663 he writes:—"Quoique l'hypothèse du parasitisme des polypes soit aujourd'hui en faveur, soutenue qu'elle est par de grandes autorités scientifiques, les résultats de mes observations sur les spécimens du Portugal me semblent plus favorables à l'hypothèse contraire." The author then proceeds to give the reasons for this conclusion under five separate heads.

The observations of M. Barboza du Bocage do not throw much light on the subject of the disputed nature of *Hyalonema*; and the proofs he offers under five separate heads go rather to prove the spongeous nature of *Hyalonema* than its polypiferous nature. In no. 1 he merely states that no spongeous base has been found on the Portuguese specimens; but this may also be stated of the greater number of specimens from Japan. He also states, in no. 2, that the corium polypigerum in one specimen from Portugal envelopes the whole of the axis entirely, from the smallest extremity, for two- or three-fifths of its length. And this is just the condition of the specimen, supposing its lower portion to have been enveloped by a basal spongeous mass, as is the case with the most perfect specimens from Japan; and the gradual diminution in the size of the oscula (polypiferous orifices of the author) is quite in accordance with their characters as oscula of an extended cloacal appendage to a sponge of such a structure. In no. 3 the author describes the structure of the corium polypigerum, or coriaceous bark of Gray, in terms which apply equally well to the similar parts of *Hyalonema mirabile*, in which siliceous spicula are also abundant, intermixed with extraneous particles of sand; but the intermixture of the latter would greatly depend on its local surroundings while living. In no. 4 the granulated appearance of the surface of the corium is described as "due to the presence of an infinite number of regular spicula dispersed in masses and bristling with points." And in no. 5 he states that each polype is sustained by a siliceous structure of filiform spicula, disposed

longitudinally, and at equal intervals on the internal sides of the cavities.

Thus under the last two heads we have a description of forms of siliceous spicula and modes of their disposition in perfect accordance with well-known spongeous organization; and in truth the whole of the author's descriptions of the Portuguese specimens are strongly in favour of their spongeous nature, both as regards the material of which the spicula are composed, as well as in their mode of disposition on the outer surface of the corium or bark, which is in perfect accordance with the external defensive systems so frequently observed among sponges.

No specific characters of *Hyalonema lusitanicum* are given to distinguish it from *H. mirabile*; and it would not at all surprise me if, upon a further knowledge of the characters of the former, it were to prove to be the same species as the latter; no forms of spicula are given to enable us in the slightest degree to separate the one from the other.

Other naturalists have published works on *Hyalonema*—Prof. John Frederick Brandt of St. Petersburg in 1859, Prof. Max Schultze in 1860, and Dr. Leidy of the United States; but as I have not seen the specimens described by these authors I shall confine my observations to the type ones of the genus in the British Museum and others which I have had the opportunity of closely examining. The opinions of the authors who have written on these subjects vary considerably from each other; but none of them, I believe, entertained the idea that *Hyalonema* was neither more or less than a sponge in all its parts.

In 1860, while searching for new forms of spicula and other structural peculiarities of the sponges to assist me in the construction of a systematic nomenclature by which the species might be described, as plants are in botanical science, I became acquainted with the specimens of *Hyalonema* in the British Museum; and in the course of a minute examination of the one with the basal mass of sponge I found numerous forms of siliceous spicula which I had not before seen, and which I afterwards figured and described in the 'Philosophical Transactions of the Royal Society of London' for 1862. Figures 3, 4, 5, and 6 in plate 31, and figures 12, 20, 30, 34, 35, 36, 37, and 38 in plate 36, are all from the specimen in the British Museum; and the result of this examination of the specimen was a strong conviction that the whole of the parts formed but one animal, and that it was truly a sponge. This conviction I published in the third part of my paper "On the Anatomy and Physiology of the *Spongiadæ*," in the 'Philosophical Transactions of the Royal Society' for 1862, p. 1113; and as the description of the genus given by Dr. Gray applied only to a part of the animal instead of to the whole of it, I deemed it necessary to enlarge the generic characters so as to embrace the whole of the most important parts of its structure, in the following manner:—

"Skeleton an indefinite network of siliceous spicula, composed of

separated elongated fasciculi reposing on continuous membranes, having the middle of the sponge perforated vertically by an extended spiral fasciculus of single elongated and very large spicula, forming the axial skeleton of a columnar cloacal system."

I did not attempt any description of its specific characters, as my object at that time was the description of generic characters only. I now propose entering fully upon the consideration of the minute structures of every part of this complicated and curious animal, and to endeavour to give such descriptions of them as may serve to distinguish it as a species from any other of its congeners.

HYALONEMA MIRABILE, Gray.

Sponge.—Massive, sessile. Surface even. Oscula mammilloid, more or less elevated; terminations depressed, corrugated in radiating lines, numerous, dispersed over the surface of a single central elongated cloacal column projected from the middle of the sponge upward; dermis of the cloaca coriaceous, thick, composed of two layers—outer layer arenaceous, inner layer spiculous; spicula acerate, and cylindro-cruciform, apically or entirely spinous, various in size and proportions: axis of the column a single large spiral fasciculus of very long fusiformi-acerate spicula, each extending from its base to near its apex; spicula asperated near the base. Skeleton lamelliform; spicula fusiformi-acerate, long and slender, apices obtusely terminated; or fusiformi-subcylindrical. Defensive spicula:—external inflato-fusiformi-acerate, hemispinous distally; spines ascending. Internal defensive spicula spiculated cruciform; spicular ray ascendingly and entirely spinous; cruciform rays spinous. Tension spicula inflato-acerate, long and very slender. Interstitial spicula attenuato-rectangulated, hexradiate, large and small; and fimbriated multihamate birotulate, in two systems: the primary one very large and stout; hami cultelliform, fimbriated at the base of the inner surface; shaft cylindrical, entirely tuberculated, tubercles stout; spicula dispersed. The secondary system:—spicula smaller than those of the primary one; hami very long, apices nearly meeting; neither fimbriated nor cultelliform, congregated. Interstitial spicula cylindro-cruciform, terminally or entirely spined; radii short and very stout; spines conical, acute, and very large. Retentive spicula quadrihamate, minute; hami simple, elongate, attenuated.

Colour, undetermined in the living state.

*Hab.* Japan.

Examined in the dried state.

The most perfect specimens I have seen are that in the British Museum (which has the long spiral cloacal column immersed in the basal mass of the sponge to very near its proximal extremity, as represented in the Society's 'Proceedings' for 1857, plate IX., Radiata), and two smaller ones now exhibited (see Pl. IV. figs. 1 & 2). For the loan of the first of these I am indebted to my friend Capt. C. Tyler, and for the second to the kindness and liberality of my friend Mr. Henry Lee. One other specimen in a similarly perfect state

of preservation is in the collection of the Bristol Museum. Numerous other specimens are now known, of which the spiral cloacal column alone has been preserved by the Japanese fishermen who took them; and of such specimens I have had nineteen in my possession. Of these, five had none of the coriaceous dermis around the spiral column. Three specimens from the collection of my friend Capt. Charles Tyler had portions of the basal mass of sponge closely adhering to the proximal end of the column, and one of these three has every appearance of having been accidentally withdrawn from the original basal mass of sponge some time previously to its being taken by the Japanese, as there is, about $\frac{3}{4}$ of an inch above the proximal end of the spiral column, a small bulbous mass of the sponge remaining, nearly an inch in length (Pl. IV. fig. 1). This small mass has secreted a new thin brown dermal membrane, which is continued upward for about an inch, closely surrounding the spiral column. It then throws out ten or twelve of the mammiform oscular bodies in the course of about another inch of its progress upwards, the remainder of the spiral axis being in a denuded state. The membrane surrounding the bulbous mass of sponge and that closely embracing the spiral column above it are continuous and identical in structure, thus affording unmistakeable evidence of their forming parts of one and the same animal. The specimen represented in Pl. IV. fig. 2 has the spiral column enveloped by the corium from its junction with the distal end of the basal sponge for about 2 inches upward, but it does not enter its substance. The dermal membrane of the sponge is entirely wanting.

Two of the nineteen specimens had their distal terminations entirely covered by the coriaceous dermis of the column; and several of them had the thinning off of the proximal extremity of the dermis of the column at the point of its junction with the thin dermal membrane of the distal end of the basal mass of the sponge; so that between the whole of the specimens there is no part of the entire sponge which is not duly represented.

The basal mass of the sponge in the British Museum collection is of a compressed massive form; it is $5\frac{1}{2}$ inches in height, $3\frac{3}{4}$ inches in width, and nearly $1\frac{1}{4}$ inch in thickness; the total height, including the cloacal column, is 20 inches. The base of the spiral axis of the cloacal appendage is at or near the base of the sponge; and it passes thence in a vertical direction through its substance, emerging at its distal extremity. The surface of the spongeous mass has every appearance of having been smooth and even.

The great cloacal organ and its oscula are exceedingly interesting in their structure. While the spiral axis of the cloaca is surrounded by the basal spongeous mass, it has no dermal investment of any kind; but as soon as it emerges from its distal extremity the thin dermal membrane of the sponge is continued over the surface of the column, and gradually thickens in its course upward, until it assumes the form of a stout coriaceous investment, and it then becomes composed of two distinct layers, the outer one being thickly studded with grains of sand and other extraneous substances, which do not

appear to touch each other, but are separately enveloped by keratode in the manner that is so prevalent in the genus *Dysidea*, Johnston. The inner layer has few such adventitious matters imbedded in it; but in place of such material there are numerous cylindro-cruciform and other siliceous spicula dispersed throughout its whole length. From this thick coriaceous dermis the oscula are projected abundantly; they are dispersed over its surface without any appearance of order. In some specimens they are nearly uniform in size, seldom exceeding about a line in height, while in others they vary in that respect to a very considerable extent. In one specimen in my possession a few only are as short as a line, while others vary from 6 lines in height to scarcely an elevation of the apex of the organ above the dermis of the cloaca. The apical terminations of these organs also vary considerably; they are more frequently slightly oval than circular, and in many instances they are quite as much oval as those figured by M. Barboza du Bocage from his *H. lusitanicum*, described in the Society's 'Proceedings' for 1864, p. 264.

I cut off the corrugated apical portion of several of these oscular bodies and mounted them in Canada balsam: the outer surface in most of them was so thickly studded with closely adhering grains of sand that no part of the dermal surface could be distinctly seen; but in some the central orifice was partly open, and the radiating structure was more than usually distinct. In these specimens it was apparent that the radiating ridges within the outer surface do not extend from the circumference to the centre, but only to the outer margin of a central circular membrane with concentric lines of minute corrugations. These structures, therefore, have every character of contractile organs, supplying the place of muscles, so as to enable the animal to open and close the oscular orifice at its pleasure. Within the outer portion of the apex of the osculum, at about the distance of one-third or one-fourth of its diameter, there is situated a second membranous diaphragm, of much less complicated structure than the outer one. This also was not entirely closed; the inner margin of this membrane also exhibited a series of numerous concentric corrugations, forming a flat circular band around the orifice, from the outer margin of which lines of thickened membrane radiated towards the outer margin of the organ; and they gradually expanded laterally, uniting and forming the extreme circumference of the perforated diaphragm, thus exhibiting a series of contractile membranes for the opening and closing of the inner diaphragm in a similar manner to that of the outer one. The radial lines of the inner diaphragm do not correspond with those of the outer one, and they are not so numerous. The apical and the inner diaphragms are connected by a circular series of dissepimental membranes, the planes of which are at right angles to the upper and lower diaphragms; so that the internal aspect of this complicated valvular structure bears no very distant resemblance to the dissepimental structures of many seed-vessels of plants, supposing sections at right angles to their axes to have been made. Sections of this valvular structure in its natural condition are represented in Pl. IV.,

fig. 3 representing a view of the interior of the distal portion of a section through the middle of the valve at right angles to the central axis of the osculer tube, by direct light; fig. 4 represents the proximal diaphragm of the same specimen mounted in Canada balsam. The action of these two valvular diaphragms appear to be more or less independent of each other; and the radiating motive fibres, comparatively few in number and very different in their structure from those of the apical valve, are readily visible in their natural condition when immersed in water or Canada balsam. This is not the case with the motive organs of the more complicated apical valve, which are deeply immersed in the substance of the apical diaphragm, and which cannot be displayed until the internal dissepimental structures and the membrane above, which covers them, are removed by the action of a solution of caustic potass for about eight hours—Brander's solution one part and distilled water three parts being of about the required strength. When these impediments have been removed, the series of motive fibres present a very interesting appearance. The whole consists of numerous spindle-shaped fibres, one end of each being attached to the outer circumference of the corrugated apical area, and the other end to the inner circle of the same part, leaving a circular inner area of transparent membranous structure, the middle of which has the natural orifice of the osculum in its centre, usually in a closed and puckered condition. This parallel radial series of motive filaments, represented in Pl. IV. fig. 5, is doubtless not in its natural condition, the action of the potass having probably increased the motive filaments to two or three times their natural diameter; so that, when in this state they are forced by pressure or other means through the outer orifice of the osculum, they may have been very readily mistaken for tentacula. The radial motive fibres in the specimen under consideration appear to consist of a strong external membrane filled with dense amber-coloured keratode, apparently the same substance as that of which the corium is composed. The inner membrane, covering the under surface of this radial series of fibres, is apparently a much more delicate tissue than that of the dissepiments of the valvular structure beneath; and the fragments disrupted by the action of the potass are crowded with minute elongated spiral cells; but these cells are not peculiar to this portion of the membranous structures of the corium, as I have found them also in parts of that organ which were not connected with the osculer tubes. Their position, immersed deeply in the sarcodous membrane lining the inner surface of the apical valve, and closely covered by the distal end of the dissepimental structures, and also completely immersed in the sarcodous membrane of the inner corium, would seem to indicate them to have some other office in the economy of the animal than that of urticating organs as suggested by Prof. Max Schultze.

In the membrane forming the inner diaphragm, and in the parietes of the tubular part of the osculum, there are frequently found cylindro-cruciform and other spicula of the same description as those imbedded in the inner corium. These peculiar forms of spicula

imbedded in such large quantities in the latter tissue might, by a great stretch of imagination, be thought to have been selected from other extraneous matters around and thus appropriated; but this solution of their presence in the valvular structure of the supposed polype, deeply imbedded in its sarcodous membranes, is certainly inadmissible. In the valvular structures they are in a position in which secretion alone can account for their presence; and their appearance under such circumstances incontrovertibly connects them with the corium on which the so-called polypes are based; so, in like manner, their abundant presence in the inner corium, and still more profuse occurrence in the basal sponge, connects the corium and basal sponge unmistakeably together. We have therefore, by means of these peculiar and very striking forms of spicula, a sequence of proof of a most conclusive character that the whole of the structures present in the most perfect specimens of *Hyalonema* are parts of one and the same animal.

Professors Brandt, Bocage, and Max Schultze, in their respective papers on *Hyalonema*, believed that they had detected tentacula within the heads of the oscular projections; and the former two have each figured what they regard as those organs with powers of about 4 or 5 linear. The figures of the supposed tentacles of the first and second named authors differ exceedingly; and if each be correct, their supposed polypes cannot belong to the same genus. The former author does not seem to have much faith in the reality of what he depicts, as in the description of the figure 8. tab. 2, in his work, he writes, "quoad tentacula expansa idealis." I have no doubt that by soaking the oscular projections in a solution of caustic potass, and by pressure or a little clever manipulation on the softened and half-destroyed tissues of the valvular structure within them, their motive fibres, which pass inward from the inner surface towards the central diaphragm, may be loosened and withdrawn from the apical orifice, and so disposed by pressure or otherwise as to readily deceive an observer whose mind was previously occupied by a foregone conclusion.

I am well acquainted with the polype-cases of *Zoanthus couchii* in the form of *Dysidea papillosa*, Johnston. They are stout open tubes, composed of sand cemented together by animal matter, and they have nothing within them like the elaborate keratose valvular apparatus that we find in the distal ends of the oscular projections in *Hyalonema*; in fact their apices are permanently open when the polypes, their former occupants, are destroyed. Nor have they at any time any appearance of tentacles upon them. Those organs at all times appertain to the soft retractile polypes, and not to the polypidoms that they inhabit. It has been suggested that *Hyalonema* really consists of the basal spongeous mass, the spiral column of spicula, and the inner sheath that surrounds it; while the outer sheath is a parasitical Zoanthoid Coral. But a careful examination of the two sheaths surrounding the column affords such evidences of the identity of their structures as to forcibly negative this supposition.

The peculiarities of the structures of these oscular organs somewhat resemble those of the inhalant organs of *Geodia Barretti*, described and figured in the 'Philosophical Transactions of the Royal Society' for 1862, pl. 32. figs. 3, 4 & 9*a*, pp. 788, 792, 794, and also in 'Monograph of British Spongiadæ,' pl. 19. figs. 301, 302, and pl. 28. f. 354*a*.

The spicula forming the spiral column of the sponge are the longest organs of this description that I have ever seen. They are composed of numerous concentric layers, and are very similar in their structure to the large spicula in *Tethea cranium* or *Euplectella aspergillum*, Owen. The asperation of the bases of the spicula is usually produced by a partial desquamation of the concentric layers, apparently for the purpose of giving the base of the column a stronger adhesive power to the central mass of the sponge. In form they are identical with those of the skeleton fasciculi of the basal mass of sponge, but vastly enlarged in their size and proportions to adapt them to their own especial office in the economy of the animal. The normal condition of these spicula is that of smooth cylinders; but when immersed in the basal mass of the sponge, and also in the lower part of the corium, they undergo a remarkable alteration in shape, assuming very frequently the form of the well-known structure of the hairs of the Bat. In this case the alteration in form is effected by the projection of a series of thin superposed layers of membrane following each other, and secreting silex rapidly and increasingly as they advance, until, each having progressed about the space of 4 or 5 diameters of the central spiculum, they terminate abruptly with a strongly denticulated margin. The silex intervening between the external coat of these coronated masses and the surface of the axial spiculum is not composed of concentric layers as in the latter, but it is as solid in appearance as a mass of glass, as represented (Pl. V. figs. 16, 17).

These curious forms may be seen deeply moulded in the substance of the lower part of the inner corium in which such spicula have been imbedded. This singular structure is apparently to endow that portion of the spiculum with greater prehensile powers than could be obtained by a more or less amount of desquamation of the proximal portions of the spiculum.

The curious cloacal column of this sponge is not without a parallel in the history of the *Spongiadæ*, as in the British genus *Ciocalypta*. In *C. penicillus* we have a series of cloacal columns projected from the basal mass of the sponge, each of which has a central axis of spicula connected together in a longitudinal direction, which extends from the base to the apex of each of the columns. A rather stout dermal membrane envelopes each of them, but is not closely adherent to the central axis as in *Hyalonema*; on the contrary, it is supported from contact with it by a series of short stout pedicels of spicula, the bases of which are immersed in the central axis, and their apices radiate in every direction, forming at their junction with the dermal membrane a most effectual support to it. The spaces between the central column and the dermal membrane, when seen by the aid

of the microscope, closely resemble a beautiful and elaborately constructed Gothic crypt. In this sponge the oscula are simple orifices, not projecting beyond the dermal membrane as in *Hyalonema*. But the same purpose prevails in both descriptions of cloacal organ, that of discharging the fæcal matters at a distance from the inhalant surface of the sponges. A section of one of the fæcal columns of *Ciocalypta penicillus* is represented of the natual size in the 'Philosophical Transactions of the Royal Society of London' for 1862, pl. 73. f. 4; and a magnified view of a portion of the same column is represented by fig. 5; and also in 'Monograph of British *Spongiadæ*,' vol. i. pl. 30. figs. 360 and 361.

Elongated cloacal projections from sponges are by no means uncommon organs. In large specimens of *Halichondria panicea* and several other British species of sponges such organs are frequently put forth; but in these cases the distal extremity is always open, and the production of these organs are the exception, not the rule: but the contrary is the case in the British genus *Polymastia*, very similar in its skeleton-structure to *Alcyoncellum*, Quoy et Gaimard (*Euplectella*, Owen, Trans. Zool. Soc. Lond. vol. iii. p. 203).

In *Polymastia mammillaris* (*Halichondria mammillaris*, Johnston) there are frequently on a single specimen from forty to fifty of these cloacal organs, springing from a sponge about 2 inches in length and breadth and not $\frac{1}{2}$ inch in thickness, but attaining 1 inch in height, with a diameter of rarely more than 2 lines, the distal terminations being always closed; the minute oscula are dispersed on all parts of the cloaca, as in the corresponding organ in *Hyalonema*. Other British species of the same genus approach still closer to the form and peculiarity of *Hyalonema*. In *Polymastia spinula* the basal portion is exceedingly thin; and the cloacal projections, seldom exceeding two in number, are about an inch in length, being in height at least twenty times the length of the thickness of the basal sponge.

In a third species of the same genus (*P. bulbosa*) we have a still closer approach in form to *Hyalonema*, the basal mass of the sponge being bulbous, in the form of a small onion, with a single long slender cloacal tubular appendage crowning its summit, with a length rather greater than the height of the bulbous mass beneath it (Monograph of British Sponges, vol. ii. p. 61). The structure of the column of *Hyalonema*, considered as a sponge, is not so anomalous as it at first appears. In truth it is only one of several varieties of such cloacal appendages, all of which approximate closely to each other in form. In *Polymastia* we have the cloacal organ hollow and closed at its apex, but supported by an external network of siliceous spicula, with the oscula dispersed over its surface. In *Euplectella aspergillum*, Owen, the skeleton is very similar to that of *Polymastia*, with the difference of the oscula being congregated at its distal extremity. In *Ciocalypta* the cloacal organs closely approximate to those of *Hyalonema*. Their parietes are thin, like those of *Euplectella*, Owen, with a central axis of spicula supporting the organ in an erect position; in *Hyalonema* the spicula composing the column are exceed-

ingly long and comparatively few in number, and do not appear to be connected with the parietes of the organ; while in *Ciocalypta* they are short and very numerous, and the axis is connected with the sides of the cloaca. Thus, when we consider the spiral column and its delapidated dermal coating alone, as it is usually received from the Japanese, and without reference to the basal mass of sponge belonging to it in its natural condition, the species presents an exceedingly anomalous appearance; but when the entire animal is considered and compared with other sponges, the anomaly is dissipated, and it is seen to present very few anatomical and no physiological differences from a numerous series of well-known sponges.

The dermal membrane of the basal portion of the sponge in the British Museum has been nearly entirely destroyed, a few fragments only remaining *in situ*. It appears to have been thin, pellucid, and aspiculous, or with a few adventitious spicula attached to its surface. The numerous inflato-fusiformi-acerate external defensive spicula do not appear to perforate it in the natural condition of the sponge; but the fragments of the membrane *in situ* were so small as scarcely to allow of speaking on this point decisively.

The spicula of the skeleton are exceedingly variable in length and proportions, and are often curved to a very considerable extent, or they are flexuous; and amongst them there are occasionally found exceedingly large fusiformi-acerate spicula, the diameters of which are equal to that of six or seven of the ordinary spicula of the skeleton; and at irregular intervals we find very large attenuato-rectangulated hexradiate spicula, which probably served to connect the flakes or layers of the skeleton together (Pl. V. fig. 1 *a*).

I found but one small group of the external defensive spicula *in situ*; but this was exceedingly characteristic. The spicula (Pl. V. fig. 5) are very numerous and closely packed together in parallel lines, and they are apparently projected about half their length beyond the outer surface of the mass of the skeleton. These spicula represent the shaft of an attenuated rectangulated hexradiate spiculum, with the inflation at about the middle of the shaft, whence the four lateral radii of that form of spiculum would spring. But the striking peculiarity of their structure is the mode of their adaptation as external defensive spicula, by the projection from all parts of the distal half of the shaft of numerous small spines at ascending angles of about 20 degrees to the long axis of the spiculum; while on the proximal half of the spiculum there is rarely even the rudiment of a spine to be detected. The central inflation of the spiculum is usually projected beyond the external surface of the mass of the skeleton. A secondary series of defensive spicula are projected from the surface of the mass of the skeleton, and these consist of spiculated cruciform spicula ascendingly and entirely spinous. They are also exceedingly numerous, their cruciform bases all being nearly in the same plane, and their spicular radii nearly parallel to each other, the apices reaching to about the central inflations of the large external defensive spicula. These secondary external defensive spicula are in reality the internal defensive spicula of the sponge. They are perfectly novel in their

form, and are of a complicated and very interesting structure. They consist of a short stout cruciform base, with a long spicular ray ascendingly and entirely spinous, projected at right angles from the centre of the basal radii. The spines on the spicular ray are similar in form and mode of disposition to those of the external defensive spicula, but very much longer in proportion to the size of the spiculum, frequently exceeding in their length the diameter of the shaft on which they are based (Pl. V. fig. 6, and fig. 1 *b in situ*).

The radii of the cruciform bases are also slightly spiculated towards their apices. They are thickly distributed on the fasciculi of the skeleton, and frequently equally so on one side of the interstitial membranes, probably that which forms the surfaces of the interstitial spaces, and they are especially abundant near the exterior of the sponge.

The four basal radii appear firmly cemented to the membrane—but not immersed in its substance, as they do not appear to leave their impression when removed from it, nor do they bring any portion of the membrane away with them.

In some part of the tissues these spicula are very much modified in form. In ordinary cases we find the basal radii short and stout, and not more than a fourth or a fifth of the length of the spicular ray; while in other cases the basal rays are very nearly as long as the spicular one, the only difference in their structure being that the latter is very strongly spinous, while the former have the spines comparatively very slightly produced.

The interstitial membranes, when not covered with spiculated cruciform spicula, are often abundantly furnished with long slender flexuous acerate tension spicula, with a central inflation indicative of their being an incipient condition of either rectangulated hexradiate or rectangulated triradiate forms; and the latter one occasionally is found among them (Pl. V. fig. 7).

The interstitial spicula of this sponge are very numerous, and exceedingly various in size and form. They are of three very distinct descriptions:—first, rectangulated hexradiate, large and small (Pl. V. figs. 8, 9); second, fimbriated multihamate birotulate (Pl. V. figs. 2, 3); and third, cylindro-cruciform (Pl. V. figs. 10, 11, 12, 13, 14).

The first of these forms abound immediately beneath the apparent line of the dermal membrane in the large basal mass of the sponge; the greater portion of them are large, and they are disposed with a considerable approach to regularity, and amongst them there are frequently groups of the smaller variety of this form (Pl. V. fig. 8). They are also rather abundant near the basal portion of the spiral column of the cloacal system of the sponge, and they are found more sparingly dispersed in all parts of the basal mass. Generally speaking the whole of the six radii are fully produced; but occasionally pentradiate forms are found.

The second form or fimbriated multihamate birotulate spicula are generally found dispersed amid the interstitial tissues of the large basal mass of the sponge. There are usually not more than one or

two together; but occasionally they occur in groups of ten or twelve, without any approach to a definite arrangement (Pl. V. fig. 1). These spicula are comparatively large and stout. They have eight rays at each end of the shaft, the two groups of radii curving towards each other to such an extent that each forms the half of a regular oval figure, the opposite apices being separated to the extent of about the length of one of the radii. Each ray is in form like a double-edged obtusely pointed knife bent near the handle in the direction of a line at right angles to the inner surface of one of its flat sides; and each ray is strengthened and connected with the shaft of the spiculum by a stout curved web of silex, which extends from a little below the inner surface of the ray to a point on the shaft about opposite to its middle. The edges of each ray are also slightly curved inward (Pl. V. fig. 2). The smaller or secondary system of birotulate spicula differ somewhat from the larger ones in structure. They are not fimbriated at the base, as those of the larger ones are, nor have the radii the same distinct cultelliform figure (Pl. V. fig. 3). Their position in the sponge is also different. The larger ones are always irregularly dispersed; while those of the smaller system are usually congregated in considerable numbers around the large skeleton-fasciculi, their direction being coincident with the axial line of the fasciculus (Pl. V. fig. 4); a few, comparatively, are dispersed, but this mode of position appears to be rather the exception than the rule. The shaft is cylindrical, and has short stout tubercles dispersed over all its parts, and the radii are so long in their proportions that the opposing apices very nearly touch each other.

The third form of interstitial spiculum, the cylindro-cruciform one (Pl. V. figs. 10, 11, 12, 13, 14), appears to appertain more especially to the cloacal system; they are found abundantly dispersed near the inner surface of the coriaceous dermis of the spiral column of the sponge; but they occur in by far the greatest number between the basal portion of the spicula of the spiral column, and in their immediate neighbourhood, intermixed with the large hexradiate spicula of the interstitial tissue of the great basal mass of the sponge; and at the top of this mass the spiral column is surrounded by a profusion of them.

The radii are short and very stout in their proportions, their length varying from twice to five or six times their own diameter; and the four rays are frequently of different lengths. They are profusely covered with large, stout, more or less conical spines, and especially so at their distal extremities. In all these characters they vary to a considerable extent even in the same group. They appear to be more matured in the basal portions of the sponge than in the coriaceous dermis of the spiral column; in the latter position they are frequently represented by short, stout, entirely spined cylindrical spicula (Pl. V. fig. 10); but between this rudimentary state and the completely cruciform spiculum specimens may be found in every intermediate stage of development. Occasionally a spiculum may be found with a fifth ray, indicating that the cruciform spiculum is in truth only a modification of the regular hexradiate type of the inter-

stitial spiculum (Pl. V. fig. 14). The occurrence of this peculiar form of spiculum in the inner surface of the coriaceous dermis of the spiral column, and also dispersed amid the tissues of the basal mass of the sponge, unmistakeably connects the two as portions of the same individual.

The quadrihamate spicula are a variety of form that I have not seen before. The hami are comparatively very long and slender. They are exceedingly minute, requiring a linear power of at least 700 to define them well. They are irregularly and rather sparingly dispersed on the interstitial membranes (Pl. V. fig. 15).

From the few patches of sarcode remaining attached to parts of the skeleton, it is probable that it has been both dense and abundant. The fragments preserved are of a deep amber-colour.

It is probable that there are more species of the genus than the one described above, as among the material brought up from 2200 fathoms by the soundings in the Indian Ocean, from the 'Herald,' I have seen three distinct varieties of form of multihamate birotulate spicula of a very similar size and character to those found in *H. mirabile*, but with such structural variations as to indicate their origin in different species.

The internal structures of this sponge are strongly indicative of carnivorous habits. The loosely constructed reticulated skeleton would readily admit of the entrance of small annelids; and when once within the precincts of the sponge their escape would be almost impossible. The powerful cultelliform radii of the fimbriated birotulate spicula entering their bodies would securely hold them as prey; and every writhing effort they made would contribute to their destruction by a succession of impalements on the spiculated rays of the numerous spiculated cruciform spicula around them, bleeding them to death from numerous punctured and lacerated wounds for the nutrimentation of the sponge; and it will readily be seen that every one of these elaborately constructed organs that I have described are admirably adapted to the purposes that I have assigned to them.

I cannot agree with Dr. Gray in considering *Hyalonema* as allied to either the *Gorgoniadæ* or the *Zoanthidæ*. We know of no compound polypidom, among the *Coralliidæ* or *Zoanthidæ*, or any other division of Zoophyta, in which there is any approach to the secretion of a siliceous skeleton. In all of them, however varied the form may be, that part of the animal is either purely keratose or kerato-calcareous, while in *Hyalonema* the whole of the skeleton is siliceous; and this fact alone should have served to distinguish it from *Gorgonia*. I do not know of any zoophytes which have tentacula upon the polype-cases instead of upon the retractile polype; and in *Zoanthus* their position is undoubtedly upon the latter-named part of the animal. The form of the oscular mamillæ on the spiral cloacal appendage of the animal is very like the polypidom of some *Gorgoniæ*; but this similarity is not enough to justify the assumption that it belongs to that tribe of zoophytes, especially as, in *Pachymatisma Johnstonia* and other sponges, we find

the oscula simulating the forms of the polypidom of many species of *Gorgonia*.

The genus *Grantia*, with its calcareous skeleton, affords perhaps among the *Spongiadæ* the nearest approach to the structure of the *Gorgoniadæ*; but there is no possibility of confounding these sponges with any known species of that group; while, on the contrary side of the question, the basal portion of *Hyalonema* is nearly assimilated by the peculiarities of the structure of its spicula with the genera *Alcyoncellum*, Quoy et Gaimard, and *Dactylocalyx*, Stutchbury; and the singular cloacal appendage projected from the midst of the sponge has its physiological and, to a certain extent, its anatomical parallel in our British genus of sponges, *Ciocalypta*. That the long spiral spiculous extension, or cloaca, of *Hyalonema* is intimately connected with, and forms a part of, the skeleton of the sponge cannot reasonably be doubted after a careful examination of the large specimen in the British Museum, in which it will be seen that the skeleton of the basal portion of the sponge enters between, and embraces the long fibres of, the spiral organ, without the intervention of any part of the thick sandy cortex. This dermal coat in the British Museum specimen is in good preservation for several inches in length above the spongeous mass at its base; but not a vestige of it remains within the mass, nor is there any space between it and that portion of the spiral column passing through it that serves to indicate that it had ever been present in that position; on the contrary, the sponge embraces the base of the column closely and completely. But if any further evidence of their organic connexion were needed, we have it abundantly furnished by Capt. Tyler's specimen (represented in Pl. IV. fig. 1), in which it is seen that the dermal membrane of the small mass of basal sponge is continued from its distal end up the column, and that it is from this continuous membrane embracing the spiral column that the protuberant oscula are given off. In the specimen represented by fig. 2. Pl. IV. the distal end of the basal sponge and the proximal one of the corium are coincident in their terminations, and it is distinctly observable that no part of the corium enters the basal mass of sponge.

I have not seen the specimen of *Hyalonema mirabile* in the Bristol Museum; but I am informed by my friend Capt. Charles Tyler, who has seen it, that it has a basal mass of sponge very like that of the British Museum one. From portions of the basal mass of the Bristol Museum specimen, presented to Capt. Tyler at the time of his inspection of it, I have obtained precisely the same forms of spicula that exist in the basal portion of the British Museum specimen. I have before stated that, among the specimens in the collection of my friend Capt. C. Tyler, there were three of the spiral columns that had portions of the basal mass closely adhering to them; and on microscopically examining these portions of the sponges they were found to agree in their organization in every respect with the structures obtained from the two larger and more perfect specimens of the sponge, and also with that represented by fig. 2. Pl. IV. No reasonable doubt can therefore be entertained that these specimens

are all of the same species, and that the basal mass and the spiral cloacal organ are truly parts of the same individual.

The external mammillated coriaceous dermis of the cloacal system in the dried condition closely embraces the spiral column of spicula, but I could not detect any organic connexion between them. It is probable, from its reticulated structure in some parts, that there was a considerable intervening space between the spiral column and the external envelopment while in the living state, and that the present condition is due to the contraction of the coriaceous coat while drying.

## DESCRIPTION OF PLATES IV. & V.

### Plate IV.

Fig. 1. *Hyalonema mirabile* in the cabinet of Capt. Charles Tyler, having a small basal mass of sponge covered with the dermal membrane, which is continued up the spiral column, and from which protuberant oscula are put forth. Natural size.

Fig. 2. A specimen of the same species of Sponge presented to me by Mr. H. Lee. The basal mass of sponge is without the dermal membrane, but having the commencement of the corium corresponding with the distal end of the spongeous mass. Natural size.

Fig. 3. A section at right angles to the long axis of one of the osculer organs, just below the corrugated terminal disk, exhibiting a view of the interior of the upper portion of the dissepimental form of the complicated valvular structure within the apical termination of the osculer tube. The central membrane containing the natural orifice is slightly involved, showing on its outer surface a portion of the sand imbedded. By direct light, magnified 50 times linear.

Fig. 4. The lower portion of the valvular structure of the same section, showing the inner diaphragm, or valve, with its motive filaments. The valve partly open, and its membranous structure having a cruciform spiculum imbedded in its substance at *a*. By transmitted light in Canada balsam, magnified 50 times linear.

Fig. 5. The apical termination of one of the osculer tubes cut off immediately beneath the corrugated apex, after maceration in solution of potass, showing the circular arrangement of the motive fibres of the outer valve of the osculum *in situ*, and the attachment of their apices to the outer margin of the central osculer membrane, their basal portions curving downward at the outer margin of the corrugated apex of the organ to their respective basal attachments. Mounted in water and viewed by transmitted light, magnified 50 times linear.

### Plate V.

Fig. 1. One of the lamellæ of the skeleton from the basal mass of sponge of *Hyalonema mirabile* in the British Museum, exhibiting the general structure of the skeleton and the mode of disposition of the fimbriated multihamate birotulate spicula, the spiculated cruciform, and the various forms of interstitial spicula. *a*. One of the largest of the attenuato-rectangulated hexradiate interstitial spicula *in situ*, with a group of three fimbriated multihamate birotulate spicula, and spiculated cruciform spicula dispersed on the transparent interstitial membranes. *b*. Skeleton-fasciculi, with a row of spiculated cruciform spicula based on one of them. Magnified 50 times linear.

Fig. 2. A fimbriated multihamate birotulate interstitial spiculum of the primary system. Magnified 175 times linear.

Fig. 3. An elongo-recurvate dentato-birotulate interstitial spiculum of the secondary system. Magnified 308 times linear.

Fig. 4. A group of the same form of spicula as No. 3, *in situ* around a skeleton-fasciculus, from the specimen of *Hyalonema* in the Bristol Museum. Magnified 108 times linear.
Fig. 5. An inflato-fusiformi-acerate external defensive spiculum hemispinous distally. Magnified 108 times linear.
Fig. 6. A spiculated cruciform internal defensive spiculum. Magnified 175 times linear.
Fig. 7. Inflato-acerate tension spiculum. Magnified 108 times linear.
Fig. 8. Large atttenuato-rectangulated hexradiate interstitial spiculum. Magnified 90 times linear.
Fig. 9. Small attenuato-rectangulated hexradiate interstitial spiculum. Magnified 90 times linear.
Figs. 10, 11, 12, 13, 14. Various states of development of the cylindro-cruciform interstitial spicula, common to the basal mass of sponge and the coriaceous investment of the spiral column of the cloacal system. Magnified 175 times linear.
Fig. 15. Attenuato-rectangulated triradiate tension spiculum, occasionally found dispersed among the other tension spicula. Magnified 90 times linear.
Fig. 16. Asperated or jointed condition of portion of the long acerate spicula of the spiral axis of the cloacal system. Magnified 108 times linear.
Fig. 17. A detached joint from a specimen similar to that represented by fig. 16, from which a portion has been fractured longitudinally, exhibiting the uniform solidity of the incrusting silex. Magnified 108 times linear.
Fig. 18. Quadrihamate retentive spiculum.

## 5. Note on the Identity of certain Species of *Lycænidæ*.

By Arthur G. Butler, F.Z.S.

An observation in the second part of Mr. Hewitson's valuable work on 'Diurnal Lepidoptera,' p. 53, has induced me to compare the description of *Hesperia freja*, in Fabricius's 'Entomologia Systematica,' iii. p. 263. n. 19, with the numerous specimens of *Lycænidæ* in the collection of the British Museum; and I am now fully satisfied that this species, which Mr. Hewitson has placed provisionally at the end of the genus *Hypolycæna*, is perfectly identical with the well-known *Myrina jaffra* of Godart, figured in Horsfield's 'Catalogue,' pl. 3. figs. 5, 5 *a*.

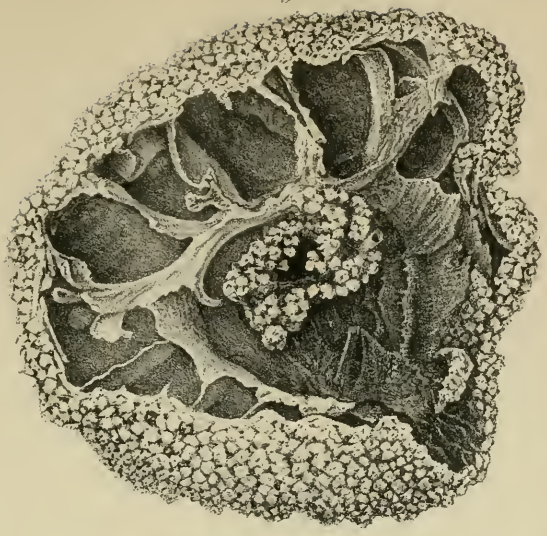
The only apparent defects in the description given by Fabricius consist in the misapplication of the term *apex* to the anal area of the hind wings (a substitution of frequent occurrence in early descriptions), and in the somewhat loose account of the position of the transverse lines on the front wings,—the internal discal line, which in some specimens is almost submarginal, being described as central. The corrected description would be as follows:—

"*Magna in hac familia. Antennæ atræ. Palpi albi, apice nigri. Corpus fuscum. Alæ anticæ supra fuscæ, immaculatæ, subtus albæ limbo, lineola transversa discali strigaque postica fulvis. Posticæ fuscæ, area anali albæ fascia lata nigra. Caudæ duæ, anterior longissima alba, posterior brevior nigra margine albo.*

"*Subtus albæ striga postica valde undata atra. Margo strigis fulvis nigrisque. Apex alæ prominet fascia lata, læte cærulea, quæ utrinque terminatur puncto magno atro.*"

1

3



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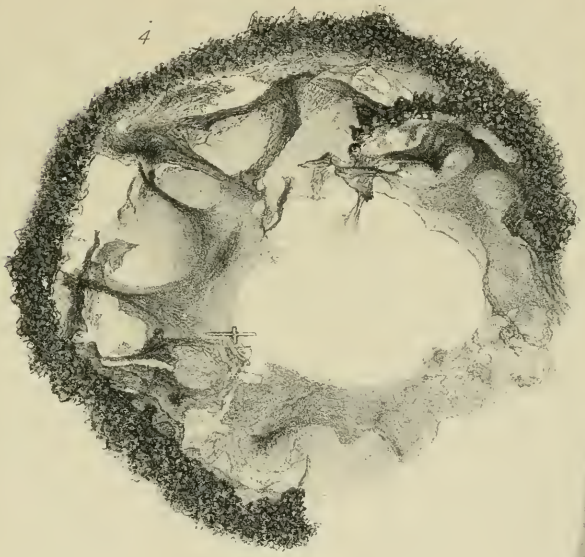
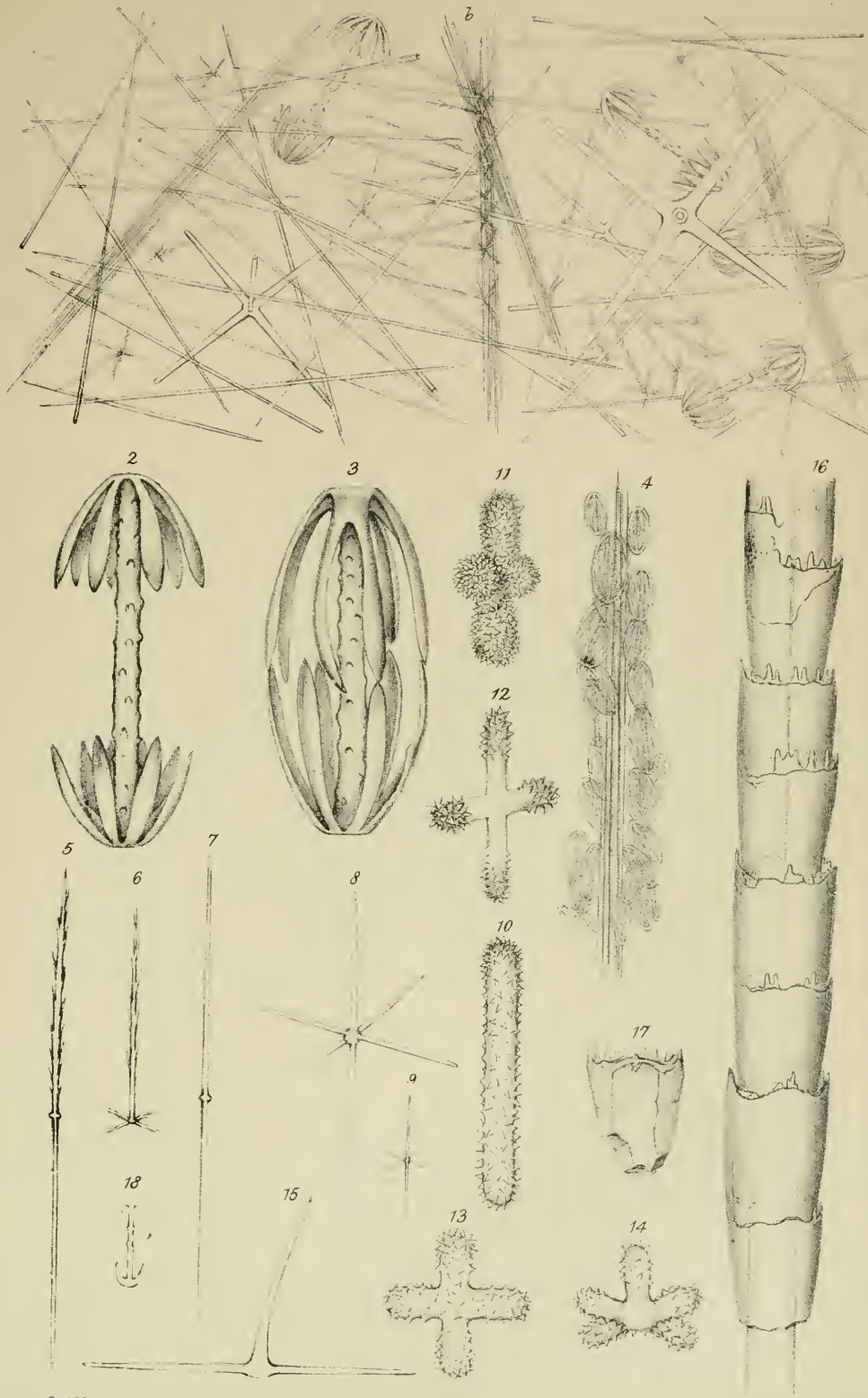


5

L. Aldous lith. ad nat.

W. West imp.




L.Aldous lith ad nat.

Hyalonema mirabile

W.West imp.