XI. *On Steere's Sponge, a new Genus of the Hexactinellid Group of the Spongida.* *By* James Murie, *M.D., F.L.S., F.G.S., &c.*

(Plates XXXVI. & XXXVII.)

Read January 20, 1876.

The Order of Sponges now designated Hexactinellida has only of late years been prominently brought forward to the notice of naturalists. As early as 1833 by Quoy and Gaimard, and again more definitely in 1841 by Stutchbury, at least two or three forms of the group had been registered in zoological literature; and later on a few new members were occasionally added. From about 1860, or even a few years later, up to the present time a number of new and most curious genera and species have been minutely described. The issue of the monographs of Bowerbank, Oscar Schmidt, and Häckel, among others, have greatly helped to advance and give prominence to the history of the Spongida; but the study more especially of the Siliceous Sponges, however, received an unexpected impetus when the first results of the deep-sea explorations became known. Besides Dr. Gray, ever active in many fields, the labours of Carter, Wyville Thomson, Saville Kent, and Perceval Wright, among our own countrymen, have borne good fruit so far as the group in question is concerned. Not only has the deep-sea dredging yielded a partial resolution of some of the difficulties of structural organization of certain of the more singular kinds, but another item of considerable importance has become evident, as fresh faunal ground has accrued: I allude to distribution. The geographical dispersion, then, of the Siliceous or, as some prefer to call them, Vitreous Sponges, where unmistakable closely allied kinds are widely severed, suggests many possibilities, geological and otherwise, though no explanation is capable of easy proof from our as yet limited data. Every new genus or species entered into the catalogue thus has a cumulative significance, bearing ratio, moreover, to its peculiarities of build, where these either exhibit novelty, intermediate characteristics, or set at rest moot points. On grounds such as these the novel specimen I herewith call attention to I believe possesses unusual interest.

History of Specimen.—Professor Joseph B. Steere, M.A., LL.B., of the University of Michigan, U.S., a few years ago resolved on enriching the Museum collections of his *alma mater*. Young, enthusiastic, and fond of adventure, after an exploration and somewhat lengthened stay in the regions of the Amazon, sending home valuable material, he traversed the continent, crossing the Andes. Thence by the Pacific Ocean towards China, he remained awhile in Formosa. Afterwards making his way to the Philippines, he resided for longer or shorter periods in several localities of the group. In devious voyages, visiting the more notable islands of the Malay archipelago, he gathered a vast array of objects of Natural History. Time speeding, he betook himself homewards, and *en route* made a hasty stay in London, during the beginning of the month of October 1875.

Circumstances did not permit of his boxes and cases of material being unpacked here,

a few loose packages only being opened to gratify the curiosity of friends. Mere accident in conversation led me to a sight of a sponge the subject of the present communication.

Its appearance and history in a trice convinced me of its rarity, and I advised the owner to take advantage of the extensive collection at the British Museum, and after comparison &c. to describe the specimen. If ultimately deposited in the distant Michigan Museum, the chances were its value and uniqueness might temporarily be lost sight of among the plethora of his collections, and a long while elapse ere opportunity offered to bring it before the scientific public. Neither time nor indeed inclination to a special study of the group rendered Professor Steere desirous thereupon to enter on the task; but still, knowing the interest attached to the object, he requested my drawing out a notice of it for publication. This could have been little else than a mere superficial survey had he not given me possession of the tempting specimen for a brief period, to facilitate closer inspection and to procure a photograph of it. He still more generously gave me a portion, quite enough for a thorough examination of its microscopic structure, as the accompanying illustrations bear witness.

The following is Professor Steere's verbal account to me of how and where the sponge was obtained. When in the Philippines, 1875, his attention one day was called to what at first sight he deemed to be a branching coral, hanging in the sun near one of the native dwellings. On purchasing it, he learned from the fisherman, its first possessor, that it had accidentally been dragged up by his hooks* from a depth of what he supposed to be 400 to 600 feet, *i. e.* roughly, then, between 70 and 100 fathoms. The locality where originally obtained is the narrow deep channel between the strip-like and parallel islands of Negros and Zebu. This channel is said to be some 100 miles long, and varies from 2 to 3 miles in breadth. The water is comparatively still, or with only a slightly perceptible current, never, generally speaking, being boisterous. This condition in the main results from the construction of the channel, which to some extent is land-locked, as reference to a chart of the district shows.

As regards the nature of the sea-bottom, Professor Steere believes it to be sandy. As to the geological aspect of the surrounding country, according to him the island of Zebu is chiefly characterized by a limestone formation; but the larger island of Negros bears apparently marks of volcanic origin.

He further informed me that the *Euplectella* and other peculiar sponges hitherto

* Dr. Meyer (Ann. & Mag. Nat. Hist. (4) 1874, vol. xiii. p. 67) has drawn attention to the mode of fishing for sponges adopted by the natives of the Philippines. A number of small hooks are fixed to a light framework, and this, sunk by a stone, is dragged on the bottom in depths quite 50 fathoms or more, and the hooks catch the objects as the boat drives with the current. A confirmation of this has been published by one of the staff of the 'Challenger' (the 'Times,' 30th April, 1875, and quoted by Bowerbank, P. Z. S. 1875, p. 506). But see also Mr. T. J. Moore's letter to the late Dr. J. E. Gray on the mode of dragging for the "Regadera" (*Euplectella*) with a bamboo and nails at Talisay, in the island of Cebu, illustrated (Ann. & Mag. Nat. Hist. 1869, vol. iii. p. 196). It agrees substantially with what Professor Steere relates of how the fisherman obtained his specimen of sponge. In many of the Euplectellas sent to this country, ragged holes or other slight injuries to the spicular framework indicate where it has been caught by the fisherman's hooks. Since this paper was read, I have myself seen in Edinburgh one of the fishing implements in question, brought home by the officers of the 'Challenger' Expedition; and I may state, moreover, that a capital drawing representing a similar native instrument was exhibited at one of the meetings of the Linnean Society by Capt. Chimmo, F.L.S.

brought from the Philippine group are obtained by the natives in plenty on the opposite, eastern, side of the island of Zebu, but that no sponges are said hitherto to have been got from the sound or channel above mentioned.

One day, while in the forest, Professor Steere was suddenly apprised of the arrival of the 'Challenger' Expedition, by a note from Professor Wyville Thomson, who had heard of him and his whereabouts. He hastened on board, passing, as he assures me, a most agreeable day in the company of our countrymen. He doubts if the English naturalists obtained any other specimens of this sponge (*Dendrospongia*), though he told them of his one, and where and how acquired*.

I may only further add to the history of the specimen that its transport has been an adventurous one. Its great size and fragile nature prevented packing up in the boxes with the other objects collected. Safe carriage then depended on its being carried about by hand. To this end a native grass cord was fastened to the stronger portion of the root, the more delicate branches were partly wrapped in cotton-wool, and the object inserted in a paper bag, with a loop of the cord out. Thus slimly protected it afterwards was borne for hundreds of miles on foot and on horseback; afterwards on shipboard it was slung to the cabin roof, and there freely dangled during the subsequent long voyage homewards. The wonder is such a delicate brittle organism escaped injury and smash, or was preserved tolerably intact through such a journey.

Exterior and Sections.—This example of Steere's sponge may well be compared in outward figure to a shrub, or even with greater propriety, so far as superficial appearance is concerned, to some of the branching corals. The above remark of course only applies to the siliceous skeleton, the sarcode and dermal membrane being quite unknown to me. The lower basal end is laterally expanded and to a certain degree flattish, the thickness being less by one fourth than the breadth. The inferior left end (see fig. 1, Pl. XXXVI.) has a depending, slightly curved, broken stump or kind of resemblance to a root, which, however, may have been part of a horizontal branch; in this case the whole sponge might have had a greater tilt or inclination to the right than the drawing exhibits. To the inferior right corner a smaller broken branch projects upwards and slightly outwards. Above this the basal portion mounts as a gently sinuous stem, giving off three irregular, short, stoutish main branches about equidistant above each other. The middle one has a sinistral obliquity, but only a short and considerably worn part of it remains. The right main branch is given off lowest, and has received rather rough usage and considerable abrasion; about 2 inches from its commencement a knob only shows evidence of a branch now absent. As much again higher up is a trifurcation, and each of these secondary branches bifurcates, terminally producing the long upright but curvilinear whorled surface branches, one, if not two, of these exhibiting short forked ends. The left main branch also divides into three secondary branches expanding outwards; each of these again bifurcating and trifurcating, and some terminally being forked like those on the right. When in the living state doubtless this sponge has a somewhat more

* Since reading this communication, Sir Wyville Thomson's return has enabled me to show him the accompanying Plates; the species he does not recognize as being among their collections, although it is possible a less perfect specimen or fragmentary portions may be found among the stores of material as yet imperfectly worked out.

arborescent outline than that now represented (its dendritic characters suggesting the generic term), but I have preferred abiding by the photograph rather than adding branches where fractured portions indicate their former presence.

Dimensions of sponges are so exceedingly variable that this character is only of very subsidiary importance. Withal in the original description of a type full mastery of detail is needful, for one never knows on what trivial peculiarities important issues may afterwards be raised. Admeasurements in the present instance can be but rough approximations and not mathematical verities. On comparing the great *Askonema* of the Portugal coast with its relatively diminutive representative *Crateromorpha* of the Philippines, Carter*, in his excellent commentary on the group, says:—"In short, like most things in the west, if the Hexactinellidæ do not surpass in beauty, they do in size, for the most part, those of the east." Steere's sponge, however, has an area equalling the large vase-like *Askonema*, its branched character, though, differing widely.

Its greatest vertical height is 31 inches; from tip to tip of the most distant upper branches is a trifle over 28 inches. Some 8 or 9 inches may be allowed for the length of the broad lower, trifid stem portion; and the several longer branches vary, three measured being respectively 16, 20, and 23 inches in their entire length. Taken by compasses, the breadth quite at the flattish base, or what for convenience' sake may be termed the root, is fully $5\frac{1}{2}$ inches, but the same in the opposite diameter or thickness is barely more than $1\frac{3}{4}$ inch. Higher up and just below the broken middle main branch the stem lessens in breadth to 3 inches across. The girth taken round each of the three so-called short main branches, where about to divide into their numerous long upper branches, is from $4\frac{3}{4}$ to 5 inches. The long whorled branches have a circumference, at what further on will be explained as the frills, of from 3 to $3\frac{1}{2}$ inches, that is, a diameter of about an inch; the grooved portion intervening between the whorls, however, very little exceeds half that diameter.

In allusion to the superficial aspect as it looks to the eye and under a hand-lens, the way in which the specimen has been tossed and carried about should not be forgotten. Whilst many of the top twigs and branches here and there have wonderfully escaped injury, and the surface can be made out in detail with tolerable accuracy, other portions are greatly abraded, and particularly so the stem part. The latter seems to have been covered by a dermal membrane, now almost entirely rubbed off, at spots only a kind of fluffy residue proving its former presence. But the abrasion notwithstanding eliminates other features, especially the marked nature of the pores and oscula as connected with the internal tubular and canal system. The inferior cracked and fractured pieces also clearly point out that the said root- and stem-spicules are to a certain extent stronger and more solid than those higher up.

The colour of the entire siliceous skeleton save lower parts is frosty white, not quite so lustrous and pearly as is the "glass rope" of *Hyalonema*, nor so dull as *Dactylocalyx*; but yet the marginal spicules are translucent, and in spots, or under certain lights, some parts are more brilliant than others. The lower stem and so-called root is as a whole to the eye of a browner tint, its spicular meshwork with a pale yellowish hue. But this coloration

* Ann. & Mag. Nat. Hist. (4) 1873, vol. xii. p. 369.

is evidently due to the presence of a greater amount of dried-up sarcode mingled with interstitial foreign substances. This darker shade, moreover, brings out in relief specks and lines of pure solid white, viz. sparsely scattered minute shells of *Serpula*. These partially are superficial and partially are deeper seated in the sponge network. In one hole I observed a small Crustacean, seemingly an Amphipod.

The exposed surface of the stem has been rubbed down moderately even, but nevertheless is far from smooth, being drilled by innumerable holes—in fact resembles shaven cancellous texture, as is its real nature. The orifices are irregular in size and pattern, though the most prominent are either circular or ovoid. The larger have a diameter of nearly $\frac{1}{10}$ inch, and are more widely scattered than the greatly more numerous and much smaller intervening ones. Here and there also the former are so obliquely cut across or worn as to form short shallow grooves or canaliculi; whereas the finer more angular holes spring from a delicate lacework, of which more hereafter. The said perforations evidently correspond to the oscula and pores of other sponges. The general surface, moreover, exhibits several broad but very shallow impressions or concavities which traverse the stem obliquely. These slightly scooped areas are seemingly traces of the deep hollows so well marked between the whorls of the upper branches presently to be spoken of.

The distinguishing feature *par excellence* of the branches is a series of tufts or rosettes, so continuous and interwoven in the main as to present a whorl running successively round from base to apex. Each branch in this particular may be likened to a thick stranded coil of rope, or, still better, resembles the spiral twist of the horn of the Indian Antelope (*Antilope cervicapra*). In some instances where two forks or branchlets arise close together from a branch, before they tend to divaricate widely apart, their spiral fringes in passing each other so interlock as to form bridges of union (see fig. 2, Pl. XXXVI.). To the naked eye, but still more manifest with a pocket-lens, the spiral tufty elevation is seen to be composed of a bunch of long parallelly placed spicules, which issue from the axis of the branch at an oblique angle, and slightly spread out at their free ends. The radiation, however, tends upwards or chiefly towards the direction of the spire; and thus in each turn the upper border of the fringe or frill gently overarches the intervening depression, its lower border proportionally less so. The apex of each branch is closed, ending with a semitwist of the spicular frill. The said spicules are like so many glass bristles; but their true character is considerably masked by their being bound together throughout by short transverse and oblique secondary spicula, which produce a network further to be described under "Microscopic Structure." What is more plainly visible in this outward examination is a superficial frosty-like network of fine spicules, these, where best preserved, causing a woolly appearance; their precise nature will again be discussed. The spiral hollow between the frill differs from the latter rather in degree than in kind, the relative absence of long protuberant spicula being its characteristic. The depth varies, but averages a quarter of an inch. Its bareness brings out two features nevertheless, which are subdued in the frills. One is multitudinous oscula and pores, already sufficiently alluded to in the stem; the second, even more deeply interesting, is the presence of a most lovely, delicate gossamer lacework, composed of minute spicules forming a rectangular chequer. This is not everywhere intact, but sufficient traces of it exist as to

render it likely that it extended over a great part of the branch, probably excepting the summits of the whorled frills. Whether it extended over the stem it would be hazardous affirmatively to assert, though the chances are it may have had a partial covering, basing judgment upon what we know of other forms possessing a veil. Dr. Millar first drew my attention to this structural point, and then we thought it only stretched over the large orifices of the stem, a view we afterwards found erroneous. The significance of this surface layer, both in a morphological and physiological point of view, I am inclined to think is of considerable importance, but, as will be seen, it is not confined alone to this form of hexactinellid sponge.

Having run over the most noteworthy points of the external features of our specimen, I come to the interior. In studying this, pieces were cut across and in the long direction of the axis. The transverse sections of both stem and branches disclose not a hollow cylinder as in *Aphrocallistes* and *Aulodictyon*, a funnel-shaped or narrowed fusiform cloacal cavity as in *Rossella* and *Meyerina*, nor yet quite such close areolæ as in *Dactylocalyx*, but rather one may say a kind of compromise between the last two. While tubular, these openings are unequal, the larger corresponding to the exterior oscular apertures, the lesser to the pores aforementioned. The latter, angular and all sorts of shapes, are bounded by the small cross and tangental spicules; the former, rounder or ovoid, are the open passages between the larger-sized bundles of vertical and obliquely radiating spicules. In the centre of the body of the stem the open tubular character is best marked towards the periphery; radii here are more visible, between which the short secondary spicula intrude, while quite at the edge the frostwork of dermal sexradiate spicula encircles.

The longitudinal median sections still further explain the preceding, and morever, in some respects, agree with *Meyerina*, though in the general appearances and relative thickness of the spicula an approach is made possibly nearer to *Dactylocalyx*. Longitudinal fibrous-looking spicula appear to run up the entire length of the axis, but are in fact a continuous repetition of stout sexradiate spicules, the cross bars being the short arms. These median vertical pillars, moreover, most obviously branch off curvilinearly towards the margins; and it is evidently the production of these which gives rise to the exterior whorls. Thus there is a certain plumular arrangement, the obliquely directed spicules corresponding to the barbs, the smaller annectent spicules to the barbules, and the dermal appanage of terminal sexradiates to the so-called extradivisional fluff of owl-feathering.

Microscopic Structure.—Before adverting to this it behoves me to mention the invaluable assistance derived from my friends Dr. John Millar and Mr. H. J. Carter. To the former I am indebted for making my best illustrative microscopical specimens, and also with liberal hand placing others of different genera at my disposal for comparison, besides discussing points connected with the interpretation of structure. Mr. Carter's labours and knowledge of Sponges, and especially of the group in question, are well known and justly appreciated. When I add, then, that he has carefully examined portions of the sponge, compared these with the figures in my Plates, and, moreover, measured the spicula, drawing out a descriptive analysis of same for my use, it will be admitted I have been amply helped and stimulated in investigating Professor Steere's specimen. In my

own examinations of the structural peculiarities I have used object-lenses of both low and high defining powers, according as delineations of the coarser parts or of the minute spicula required.

The different constituents of the skeleton whereof *Dendrospongia* is built up I enumerate as under-mentioned; the measurements of spicules are after Mr. Carter.

1. *The Vitreous or Glassy Fibre* (figs. 4 to 13 inclusive).—This composes the basal structure of the sponge, forming its tolerably compact root, stem, and cylindrical branches. In the living state it supports the sarcode, which is charged with other minute spicula, to be described in the sequel. The glassy fibre is thickest in the central or oldest portions of the root, stem, and branches, and thinnest towards the circumferential parts of same. Admeasurements of that of the centre yield a thickness of $\frac{1}{180}$ inch, whilst the smaller fibre is about $\frac{1}{1800}$ of an inch in diameter. Every intermediate thickness between these is met with, and, as will be understood, the earliest condition of the growing spicula may even be less than the lowest dimension above mentioned. As has previously been adverted to in remarks on the sectional naked-eye view, the fibre presents main longitudinal and innumerable intercrossing branches—that is, extending upwards and outwards round the axis, leaving room for the canals of the excretory system, which take the same direction. These complicated anastomosing reticulations, however, are products of hexactinellid spicula, the various arms of which may either retain their straight character, or, bending to a lesser or greater extent (figs. 12 and 22), give rise to sinuosities as the case may be—their overlapping union and growth, with here and there ultimate coalescence of adjoining arms, producing all manner of configuration, and, indeed, the appearance of fibre throughout. The whorls, to some extent already explained, are due to the extension towards the circumference of the long, pointed, terminal filaments of, so to say, certain strands of the spicular fibre. Thus the protruding pitchfork character of the outermost hexactinellid fibres (over which the dermal network, fig. 9, is attached) results from the central and horizontal arms of the spiculum being elongated and turned outwards (fig. 12) towards the free surface of the sponge-branch, while the sixth or inner arm is in continuation with the rest of the spicular glassy fibre internally. The fibre itself is less or more roughened, that is, covered with short spines, very pronounced and prominent in the younger spicular fibre.

With regard to these spiny productions on the fibre, Mr. Carter has called my attention to a point concerning them, the importance of which I was not then aware of. Under a high magnifying-power the said elevations are found not to be simple, conical, and pointed, but, instead, "mucronate," that is, with the summit divided into two, four, or more expanded points (see woodcut, fig. 1). He further observes that the only other instance he knows of in which this form of spine is present is in *Farrea densa* ('Annals,' 1873, vol. xii. p. 463, pl. xvii. figs. 5 and 6). The accompanying woodcut is a reproduction of his sketch, kindly forwarded in a note to me.

Fig. 1.

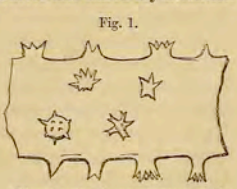


Diagram of spinous processes on the vitreous fibre of *Dendrospongia*, on the scale of $\frac{1}{12}$ to $\frac{1}{6000}$ inch. After Carter.

2. *Acerate spined Spicula* (figs. 17, 18, and 19).—These are of two sizes, large and small. Both sorts are long, acerate, fusiform, inequilateral, one half being thicker than the other. The thicker moiety is rather more abruptly pointed than is the attenuated one. The larger-sized spicula average $\frac{1}{10}$ inch long by $\frac{1}{900}$ inch at their thickest part. The smaller acerate spicula in most respects agree with the preceding, but are not more than one fourth or one fifth the size of the others. More frequently I have met with them as represented (fig. 19), in bundles, whereas the larger spicula are usually single and apart when obtained. The spines covering the large spicula (very manifest in fig. 18) point away from the thick end, and they all slope in the same direction, closely applied and almost parallel with the shaft. Each spine is simple, smooth, and conical, supported on a projecting basal portion of the shaft. These acerate spined spicula, and particularly the big kind, may be regarded as subskeletal, being situate throughout the structure of the sponge, though chiefly towards the surface. They appear to be a very common form among the Hexactinellid sponges.

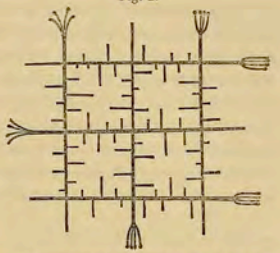
According to Mr. Carter, when elongated they apparently pass into the anchoring spined spicules of the bearded species of the Hexactinellida. Moreover such spicula he regards as "subskeletal," because he avers they are often drawn into the vitreous fibre, with which they become indistinguishably incorporated during life; he even holds that the larger scopuline spicules, presently to be described, are occasionally similarly amalgamated.

3. *Scopuline Spicula* (figs. 13 to 16).—Two forms of these obtain, likewise differing in dimensions. (*a*) The larger of the two spicula (fig. 13) consists of a straight shaft and terminal arms from two to four in number. The shaft is microspined, inflated and pointed at the free extremity, and the opposite end terminates in a palmate, bifid, or quadrangular inflation, springing therefrom two to four and occasionally five arms. These latter are opposite, extended fork-like almost in a line with the shaft itself, and are microspined and indistinctly capitate, or with convex head. The shaft of these large scopuline spicules is $\frac{1}{35}$ inch long, and the arms $\frac{1}{1200}$ inch long. (*b*) The smaller scopuline spicula (fig. 15) have also a straight shaft and from two to four terminal arms. They differ from (*a*), besides size, in the arms being opposite and expanded laterally or flower-like. Both shaft and arms are microspined, the arms very indistinctly capitate. In dimensions these second kind of scopuline spicules have a shaft $\frac{1}{135}$ inch long, the arms $\frac{1}{1200}$ inch long. Besides their terminal arms, both kinds of the spicula under consideration are often more or less provided with shorter armlets, which spring from the body of the shaft at right angles, and vary in number as well as in length (figs. 14 & 16). While they are often hardly traceable in the large scopuline form (*a*), they on the other hand are occasionally profuse in the smaller kind (*b*), numbering in the latter frequently as many as twelve, which usually are longest towards the middle of the shaft. These different figured scopuline spicula pass by almost imperceptible gradations into each other, though in most slides under the microscope the two sorts are readily distinguished even when lying in heaps, as is shown in fig. 11.

Mr. Carter remarks that the said scopuline spicula belong to the sarcode inside the dermal meshwork, where their original arrangement has been destroyed by the contracting

of this sarcode in drying and subsequent partial destruction of it by mucedinous fungi. They thus now appear in little detached masses without any definite arrangement, although, here and there, in the dry sarcode which holds them together, a circular hole may be seen indicative of their position and office in supporting the internal porous sarcodic expansions during the lifetime of the sponge. Indeed the sarcode generally has been destroyed throughout this sponge in this way, and now only hangs in small fragments here and there in the otherwise naked fibre (consult portions figs. 11 & 12). Such, he observes, is the fate of most sponges under these circumstances, especially if they are exposed to dampness owing to the salt-water not having been entirely soaked out of them at the commencement.

Fig. 2.



Diagrammatical representation of the probable mode of arrangement of the scopuline spicula of Steere's sponge, after a pen-and-ink sketch by Mr. Carter. Sarcode membrane, perforated by pores, may have stretched between the spicular bars and quadrangular spaces, that is, when the sponge was alive.

4. *Spicular Rosettes* (figs. 24 & 25).—Flesh-spicula of the rosette type obtain, and, as in the preceding, are likewise of two forms, a small and a large kind. (*a*) In this the small rosette or staple form (fig. 24) the figure is relatively globular, and is $\frac{1}{31\frac{1}{6}}$ inch in diameter. It consists of six straight, smooth arms parting at right angles from the centre, each arm terminating in a little discoid inflation from which spring four to eight rays spreading in what Carter terms a "*fleur-de-lis*" ("Hexactinellidæ and Lithistidæ," Ann. & Mag. Nat. Hist. 1873, vol. xii. p. 355; the spinulo-multifurcate hexradiate stellate spiculum of Bowerbank, Monog. Brit. Spong. vol. i. p. 259, pl. viii. fig. 192). Each ray terminates in an inflation which is expanded into a circular convex head bordered by four spines opposite and recurved. These rosettes (*a*) are chiefly congregated about the angle of the dermal meshwork and relatively numerous.

(*b*) The large rosettes (fig. 25), contrariwise, are very rare, and still more globular in appearance, whilst they range from $\frac{1}{78}$ to $\frac{1}{62}$ inch in diameter. Their centre or, so to say, nucleus appears to consist of six short, stout arms, each arm terminating in a quadrangular inflation, from which radiate several long straight rays. The rays themselves (very rarely met with bifurcate) end in a quadrangular or more often pentangular cap or head (fig. 26), with free convex surface, but provided with recurved spines at the angles of the opposite surface. This kind of rosette resembles the so called "multiradiate spicula of the sarcode" of *Askonema setubalense*, Kent (Monthly Microsc. Journ. 1870, p. 246, pl. lxiv. fig 9).

5. *Sexradiate or Dermal Hexactinellid Spicula* (figs. 20 and 23, and in position figs. 3 and 9).—These forming by the coalescence of the adjoining spicula the delicate veil latticework or rectangular dermal meshwork, have already had passing allusion called to them when speaking of the exterior characteristics. The six arms part at right angles from the centre, the horizontal ones being $\frac{1}{1\frac{1}{2}0}$ inch long; the vertical are shorter.

Towards the fixed end (or centre) the arms are thickest, and throughout are minutely tuberculate or subspined; the arm extremities are smoothish and pointed. It is by the overlapping of the horizontal arms (fig. 23, *a*), and this to a considerable extent, that the squares are produced, whilst the horizontal arms respectively project outwards and inwards. The outermost tip frequently bears the small rosette (fig. 23, *b*) already described.

Besides the foregoing spicula (save the large rosette), all present in abundance, I met with, by chance, at least in one of the slides of objects examined, another form of minute but not measured spiculum (fig. 27). Whether this had accidentally got amongst the *débris* shaken out of the *Dendrospongia*, or otherwise forms a constant part of the latter's skeleton, I cannot say positively. Possibly this spiculum in question forms but a segment of a "rosette with short arms and long, straight, pointed rays," similar to what Carter figures from *Euplectella aspergillum* (Ann. & Mag. Nat. Hist. ser. 4, vol. xii. pl. xiii. fig. 3); only one or two examples were observed by me. I have figured it rather to arrest future attention than to insist on its being an integral part of the sponge under consideration.

Remarks on the foregoing.—From what precedes it will readily be admitted that Steere's sponge is one among the many already singular forms of the Vitreous Sponges of considerable interest. In size, shape, and structural detail it differs sufficiently from others of the known Hexactinellida, as I presume, to warrant generic and specific distinction, while it no less combines certain peculiarities assimilative and explanatory, to some extent, of moot points in the construction and history of this altogether remarkable group. Its dendroid or shrub-like branching aspect has suggested the generic appellation I submit; and the collector's name, to whom I am so much indebted, I convert into its specific title. Its habitat but adds another to the many strange and delicate marine organisms hitherto obtained in the Philippine seas; and doubtless when hereafter studied in its live conditions some curious traits in its history may be unfolded.

Dendrospongia Steerii, gen. et sp. nov.

Hexactinellid sponge characterized by its dendritic or shrubby contour; occasionally attaining a height of 3 feet or possibly more. Branches forking or dichotomous, with continuous whorled series of spicular tufts from base to apices. Skeleton only known; basework composed of relatively stoutish glassy fibres of coalesced, sexradiate and spinomucronate spicula, disposed in tolerably compact trabeculæ. Main direction of fibre longitudinal to axis, in parallel straightish or slightly bent lines where continued into exterior whorls; intercrossing fibres more irregular, as are the very numerous excretory canals. Oscula and pores of moderate size distributed all over the free surfaces. Flesh-spicula abundant, and of scopuline, acerate, and rosette shapes. A dermal veil of slender, interwoven hexactinellid spicula probably clothes the major portion or possibly the entire sponge.

Hab. Philippines, Channel between Negros and Zebu, from 70 to 100 fathoms?

In discussing and assigning the affinities of this choice, indeed elegant, sponge, one naturally first looks to the kindred stock from the Eastern Archipelago. To the *Euplectella* group, including the genus *Habrodictyon* (*Corbitella* and *Heterotella*, Gray), their

open tubular unbranched and widely netted structure, besides basal cushion or root of great long anchoring spicula, sufficiently distinguish and separate them from our specimen in question, apart from the shape of the various spicula themselves. In *Meyerina* the more approximated condition of the glassy fibres composing the stem, the somewhat spiral and therefore to a certain extent whorled nature of outer, pronounced elevations of the same, and marked veil or latticework suggest closer ties with *Dendrospongia*; but *Meyerina* is unbranched, and besides has a birotulate form of flesh-spicule entirely absent in that compared. But, moreover, the Euplectellidæ, spite of their looser build of vitreous fibre, have frills bearing some relation to the said whorls, and an exceedingly delicate veil, though their true spicular skeleton, as well as that of *Meyerina*, has not such roughened nor spino-mucronate anastomotic fibre. In *Aphrocallistes* its branching character makes a closer approach, so far as mere outward configuration is concerned; but in the Malaccan as well as Atlantic species the widish tubular branches, relatively thin walls, absence of exterior whorled elevations, and other differences of framework stamp separation from *Dendrospongia*. The former genus notwithstanding has scopuline and flesh-spicula, and, at least in *A. beatrix*, such echinate closely reticulate main fibre as to show relationship with the latter, though not of the closest tie. The massive subglobose species of *Dactylocalyx* from Malacca, and even the branching forms of this genus from other regions, though possessing an anastomotic network of glassy fibre bearing a certain resemblance to some parts of *Dendrospongia*, nevertheless in other particulars strikingly depart from the latter. Such genera as the goblet-shaped *Crateromorpha* and *Labaria*, and the "sculptor's mallet"-like *Hyalonema*, in most aspects show recedence of type from our Zebu representative.

Again, other genera of the Atlantic and American seas, the purse-figured *Holtenia*, *Rossella*, and nut-like *Sympagella*, the bird's-nest *Pheronema*, and the felt or blanket sponge *Askonema*, to wit, present relationships rather with one another than in any specially marked degree to that under consideration. To *Aulodictyon* and *Farrea*, however, there undoubtedly seems to be a nearer affinity, if much weight is alone to be placed on the flesh-spicular identity. Examples of neither of those two genera, so far as I am aware, have ever been obtained in a perfect and complete form, save the diminutive *F. infundibuliformis*, Carter; but still sufficient is known to yield a useful comparison. Both are to some extent diminutive branching Hexactinellid sponges, but even in this respect widely different from the great, handsome, dendritic Steere's sponge. They are, besides, hollow and less or more tubular, with very thin walls and no trace of whorled tufted branches. In one species of *Farrea* the closely reticulate vitreous fibre is thickly spined (and mucronate according to Carter); there also obtains scopuline, acerate?, and rosette-shaped spicules, bearing considerable likeness to those of *Dendrospongia*.

With all this similarity to species of *Farrea* in spicular form, considerably departed from in other features, it seems to me that Steere's sponge in reality presents intermediate skeletal characters between *Meyerina*, *Aphrocallistes*, and *Farrea*, while yet so characteristic from all in several respects, that it is hard even to admit positive close affiliation to one or other. I expect the future may reveal some form from the eastern seas that may modify the difficulties of their relationships.

With regard to the homology of the so-called root, body, beard, and dermal spicules of at least the major section of the sexradiate sponges, I venture to offer a few mere passing remarks. I apprehend that the presence of a veil or thin dermal layer of latticework is far more constant among the Hexactinellida than is generally suspected, its delicacy in many instances, I fear, causing its destruction in whole or part ere examination of specimens is made. In *Meyerina* it is a very beautiful structure, readily apparent to the eye even at a distance. It exists like a spider's web on the surface of the Euplectellidæ. A fine sheet lies upon the *Askonema's* felt. *Labaria* and *Hyalonema* both possess such latticework. *Holtenia* and *Rossella* characteristically are veiled. Even *Dendrospongia* I am inclined to believe has such a covering spread all over its whorled branches during life. In other genera the evidence borne by fragments leads to the conclusion of its being a structural characteristic common to all. It seems to be for the support of the dermal sarcode in which the pores are situated.

The beard and whiskers, so termed by some authors, of such forms as *Pheronema*, *Rossella*, *Holtenia*, &c., evidently are the homologues of the spicula, shorter, it is true, composing the elegant sinuous frills of the *Euplectella* series. These latter frills, however much differing in aspect, moreover correspond essentially with the whorled tufts of *Dendrospongia*, and with the elevated obliquely ranged spicular vent-ridges in *Meyerina*. In these and doubtless other forms they appear to be more or less modified spicules in direct relation with the true skeletal vitreous fibre, and by or to which the finer dermal latticework is attached.

The long knitting-needle-like bundle of the glass rope in *Hyalonema*, the anchoring spicules so well known in *Holtenia* &c., and the hairy-like bunch of lengthened spicula at the root of *Euplectella*, have all strictly a homological relationship. Indeed nearly all the Hexactinellida that have been procured in any thing like a perfect condition offer some remnants, representing spicula specially adapted to retaining a hold of foreign bodies to which they are rooted, or the so-termed roots are sunk in the sand or mud.

Thus, again, however unlike may be the pattern of the vitreous fibre composing the body or basis of such forms as *Mylinsia* and *Iphiteon*, as contradistinguished from that of *Crateromorpha*, *Habrodictyon*, *Euplectella*, *Dendrospongia*, and *Hyalonema*, whether the sponge be shallow, cup-shaped, tubular, branched, or more solid, this, so to speak, basal or body-fibre of simple, fused, or compactly built sexradiate spicula has a common homological significance.

However much modified, then, I am inclined to think the whole of the Hexactinellid group, besides their bond of unity in six-armed spicula, are each provided with well-developed or traces of veil and root, superadded to such glassy fibre as more properly constitutes their basal or body skeleton.

Postscript.—It was not until some time after I had laid my paper before the Society that two contributions on the hexactinellid sponges by Dr. William Marshall, of Weimar, in the Zeitsch. für wissensch. Zool.*, came under my notice. The first published of these

* "Untersuchungen über Hexactinelliden," Z. f. w. Z. [1875, vol. xxv. (Supplementheft 2), pp. 142–243, pls. xi.–xvii.; and "Ideen über die Verwandtschaftsverhältnisse der Hexactinelliden," Z. f. w. Z. 1876, vol. xxvii. pp. 113–136.

bore a special interest to me, as containing a photograph of a new genus and species of sponge—*Sclerothamnus Clausii*, which I perceived had close affinity with Steere's sponge. Their identity at the first glance I certainly did not appreciate, possibly from his evidently being a much smaller imperfect specimen, and also doubtless owing to the blurred ill-defined photographic representation of it. A further careful study of his descriptions and close comparison of figures has, however, convinced me that in the said *Sclerothamnus* and *Dendrospongia*, without a doubt, we have the same generic type, and as regards specific distinction between them I am really at a loss to point out differences. *A fortiori*, I regard them as identical; and therefore Dr. Marshall's name to this remarkable form has the claim of priority, and my own will hereafter necessarily be sunk to that of a synonym. Hence *Sclerothamnus Clausii*, Marshall, = *Dendrospongia Steerii*, Murie. The examples on which Marshall founds his description and diagnosis are two odd pieces got in an old cabinet of the Leiden Museum, locality and history unknown. My data, therefore, clears habitat, and in many other respects supplies points wanting in his communication. Dr. Marshall, notwithstanding, has observed and figured the "mucronate" character of the glassy fibres, on which Mr. Carter has laid some stress, and he moreover calls attention to certain phenomena connected with the growth and coalescence of the glassy spicular fibre, besides what he regards as monstrous spicula.

In his ideas upon the relations of the Hexactinellida he constitutes a division Synauloidæ—"Das Lumen der Röhren der verschiedenen Nadeln hängt, wie diese selbst, continuirlich miteinander zusammen, so dass das ganze Zittergewebe des Schwammes von einen gleichfalls zusammenhängenden Röhrsystem durchzogen ist"—in which the only generic type is *Sclerothamnus*, whose characters are:—"Zu den zusammenhängenden Zittern gesellen sich als frei bleibende Nadelformen Besengabeln." The single species as yet known, *Scl. Clausii*, according to him, has the following diagnosis:—"Polyzoisch, buschförmig, mit dichotomisch verzweigten, nicht in einer Ebene gelegenen Aesten. Zwei Formen von Besengabeln. Zitterwork mit Höckerchen besetzt."

Into his second division Asynauloidæ and its subdivisions, and with his general conclusions and remarks on the relationships &c. of the Hexactinellida, neither space nor other circumstances permit me herein to enter.

Appendix. By H. J. Carter, F.R.S.

With Dr. Murie's description of *Dendrospongia Steerii* I should hesitate to interfere, even if I were not well acquainted with the general and microscopic structure of the more durable parts of the sponge itself, such is the descriptive power and truthfulness of the author.

Professor Steere's specimen is certainly the largest and noblest instance of the Hexactinellida on record, and from its branched form contributes to show that the Hexactinellida are subject to the same influences in this respect as those which determine the variation in form and size of all other sponges, which appears, to a certain extent, to be almost unlimited.

It is not a little remarkable, too, that a similar specimen, only not half so large (16 inches high), should have been described and figured by Dr. William Marshall, of Wiemar (Zeitschrift f. wiss. Zool. xxv. Suppl., 20th November, 1875), just two months before Dr. Murie brought Prof. Steere's specimen to the notice of the Linnean Society. Still more remarkable is it that just nineteen years before this, and before the same society (viz. 17th February, 1857), large fragments of this species should have been uncon-

sciously brought, and subsequently figured among the root-detritus of Prof. Owen's *Euplectella cucumer*, still where it was then, viz. in the possession of Dr. Arthur Farre (Trans. Linn. Soc. vol. xxii. pl. xxi. fig. 1), with a microscopic portion, highly magnified in fig. 8, which had been "discovered by Dr. Farre" himself, and thus had been thought worth figuring independently of the *Euplectella*—showing, as the sequel will prove, that the peculiarities of the structure had not passed unnoticed, although the sponge itself had not been discovered.

Lastly, it is worthy of remark that *Dendrospongia* appears to exist in the neighbourhood of the Euplectellas both at the Seychelles and among the Philippine Islands.

Besides the fragments of *Dendrospongia* Dr. Farre also discovered another structure, which Prof. Owen likened to a "harrow" (*l. c.* figs. 9, 9 *a*). After this Dr. Bowerbank obtained permission of Dr. Farre to examine the *entire* specimen of *Euplectella cucumer*, and (among other fragments) brought away with him specimens respectively of those discovered by Dr. Farre, to which I have above alluded. These Dr. Bowerbank examined, described, and figured respectively, under the general name of *Farrea occa* (Proc. Zool. Soc. 1869, pl. xxiv. figs. 1 and 7), conceiving the "harrow-like tissue" to have belonged to "the dermis," and the other structure to the body of this sponge.

We know, however, now, from *entire* specimens of the sponges represented by these two structures, that they belong to two distinct species, and that the "harrow-like tissue" is the *body*-structure of *Farrea occa*, and not identical with the dermal layer of the Hexactinellida, probably existing (according to Dr. J. Millar, who first directed especial attention to it) throughout all the species, although often, from its delicate structure, more or less rubbed off.

In 1873, just after having, by the kind assistance of Dr. Farre, examined his justly celebrated specimen of *Euplectella cucumer* myself, I also brought away specimens of the structures figured both by Professor Owen and Dr. Bowerbank (*l. c.*), and, having examined them microscopically, came to the conclusion that the "harrow-like tissue" should remain as *Farrea occa*, and the other structure be designated *Farrea densa*, as belonging undoubtedly to a different sponge (Ann. & Mag. Nat. Hist. 1873, vol. xii. p. 454, pl. xvii. fig. 5). Hence a fragment of the latter with its peculiar spines was figured (*l. c.* fig. 6), mentioning also (p. 463) that among the spicules boiled off from this fibre was a scopuline one like that of *Aphrocallistes beatrix* (which is nearly identical with that of *Dendrospongia*) "in great abundance."

As soon, therefore, as Dr. Murie, through Dr. J. Millar, kindly put me in possession of an actual fragment of *Dendrospongia*, I saw that the body-fibre was identical with that of *Farrea densa*, and that the scopuline spicules were also identical, but I had observed no rosette. However, on turning to a mounted specimen which had *not* been boiled in nitric acid, I found not only the rosette but the peculiar head of one of the scopuline spicules also present with the body-fibre. It may be here remarked, respecting the rosette, that Dr. Marshall states (Zeitschrift, *l. c.* p. 185) "bei Sclerothamnus und Aphrocallistes findet sich keine analoge Nadelform." Thus we have traced *Dendrospongia* back to the Linnean Transactions of 1857.

Whether *Farrea densa*, *Sclerothamnus Clausii*, or *Dendrospongia Steerii* is to take precedence in nomenclature I care not. Dr. Murie's description and illustrations take precedence with me as to accuracy and fullness of detail. This lasts for ever; but a name may be disputed to the end of time.

Dendrospongia Steerii evidently belongs to that group of sponges which possesses for one of its peculiarities the scopuline spicule, which must not be confounded with the rosette that, so far as my observation extends, always accompanies it. The scopuline spicule is often taken into the skeleton-fibre, and therefore may be regarded as a subskeleton spicule; while the rosette, being essentially a flesh-spicule (that is, confined to the sarcode) is seldom or never included in the vitreous fibre. Hence, if the skeleton-fibre alone remains, the rosette (as was probably the case in Dr. Marshall's specimen) may have fallen through it on the decomposition of the sarcode, since, as I have before stated, when this takes place the rosette passes out through the skeleton almost as easily as small pebbles through the meshes of a fishing-net. In such instances, therefore, the absence of the rosette may not indicate that there never was any.

The rosette, again, often presents itself under a variety of forms in each species of the Hexactinellida, as described and figured by Dr. Murie in *Dendrospongia Steerii*.

DESCRIPTION OF THE PLATES.

PLATE XXXVI.

Fig. 1. Steere's Sponge (*Dendrospongia Steerii*). Drawn on stone from a photograph, aided by a piece of the specimen itself, and reduced $\frac{2}{7}$ nat. size. In accordance with the text the lettering used signifies:—*ro*, root; *s*, stem; *r*, right, *m*, middle, and *l*, left main branches; *b*, secondary branch; *f*, fork.

Fig. 2. Portion of a terminally forking branch, of the natural dimension. *w*, whorl or spiral tuft; *br*, interlocking branch of same; *g*, intervening groove or spiral depression between the tufts.

Fig. 3. A small segment of a branch of *Dendrospongia* at one of the spiral grooves. Enlarged about twice nat. size. This shows the appearance of the veil or delicate latticework of square meshed spicules, spread over the surface and partially extending to the raised whorls; openings of the oscula or vents are seen beneath the veil.

Fig. 4. Fragment of the interior of a branch, illustrating mode of skeletal arrangement of the large glassy fibres. Enlarged about twice nat. size.

PLATE XXXVII.

Fig. 5. Sketch of the foreshortened summit of a branch, exhibiting termination of spines &c. Of nat. size.

Fig. 6. A transverse section (somewhat enlarged) of the stem at the base of one of the branches, and where the ruff or whorled spicula have been considerably rubbed away. The central framework has many irregularly contoured canals and of different sizes; towards and at the peripheral margin the glassy fibres appear to radiate, the most marked of which constitute what remains of the abraded whorls.

Fig. 7. Another cross-section made higher up, and where branching occurs; hence its more compressed oval form, also in part due to the exterior spicula being worn off. Nat. size.

Fig. 8. A median longitudinal section of part of a rubbed branch of *D. Steerii*, and where only indications of the spicular whorls are present. Enlarged about once and a half nat. size. This illustrates the exact disposition of the internal main body of the glassy fibres or basal structure of the sponge. The long, large, strong, and vertically directed bundles of spicula incline outwards or with slightly sinuous curve follow a certain spiral arrangement, the marginal elevations corresponding to the whorls and the depressions to the grooves. A network of short cross or oblique spicula bind together the axial and longitudinally directed stouter sorts. Canals and oscula permeate freely.

Fig. 9. A greatly magnified representation of a portion of the framework or glassy fibre as seen on its superficial aspect. It exhibits in position the so-called veil-layer or lattice-like squares of the dermal hexactinellid spicula (see fig. 23, *a*, *b*), also here and there deep-seated hazy patches of the flesh-spicula &c.

Fig. 10. Another portion of the glassy fibre, from the interior, still further enlarged, the dotting showing its spiny roughening. At *a* one of the larger rectangular interspaces between the reticulated vitreous spined fibre is partly shown; *b* is within a similar small circular area; *c* indicates a thin spined spicule, so bent and united at tips as to form a complete circle; springing from its middle is a still more delicate needle-shaped spicule (*d*), which lies across *c*; below is a mass of the common fibre variously agglutinated.

Fig. 11. Another piece of the vitreous fibre, wherein *a*, *b*, two main longitudinal branches, are seen, by degrees, to approach, and further on, at *c*, to unite, and ultimately, by coalescence, to constitute but a single thickened fibre. The areas between the glassy fibre are charged with loosely arranged scopuline and other flesh-spicula. Specimen also very considerably enlarged.

Fig. 12. A couple of what may be compared to sprays of the terminal filaments of the stout glassy fibre, greatly magnified. These, though compound branched, are characteristically pitchfork in appearance, the free tips towards the right (corresponding in part to what is shown in fig. 9) being those that, so to say, protrude through the veil latticework, and hold it in place even in the dried condition of the skeleton. In some of the terminal single fibres the sexradiate condition is marked, but the axial fibre, nevertheless, ends in a tapering point. Minute dermal and flesh-spicula abound in this specimen.

Fig. 13. One of the longer scopuline flesh-spicules whose shaft is microspined.

Fig. 14. Another spicule of the same kind, with secondary or spinal arms, set at right angles to the long axis of the shaft.

Fig. 15. Scopuline spicule, with microspined shaft and head, bearing expanded arms.

Fig. 16. Variety of the last, with secondary or spinal arms.

Fig. 17. One of the large (subskelatal) accrate spined spicula.

Fig. 18. Portion of same, still further enlarged, to demonstrate arrangement of the spines on its shaft.

Fig. 19. A group of the smaller-sized accrate flesh-spicula.

Fig. 20. A hexactinellid spiculum, with short axial arms, all the arms being slightly roughened or microspined.

Fig. 21. Sketch of the point of junction of a sexradiate spicule, the four arms of which persist, but only a rudiment of one of the axial arms is apparent in a central knob.

Fig. 22. A couple of the circumferential younger sexradiate glassy fibre, the arms being unequal in length, the longer ones tending to curvature.

Fig. 23. A few of the dermal hexactinellid spicula, *i. e.* those composing the lattice-like veil. At *a* the mode of union of the squares is displayed, and at *b* a single sexradiate spicule is shown, with a rosette in position tipping the free extremity of the axial arm.

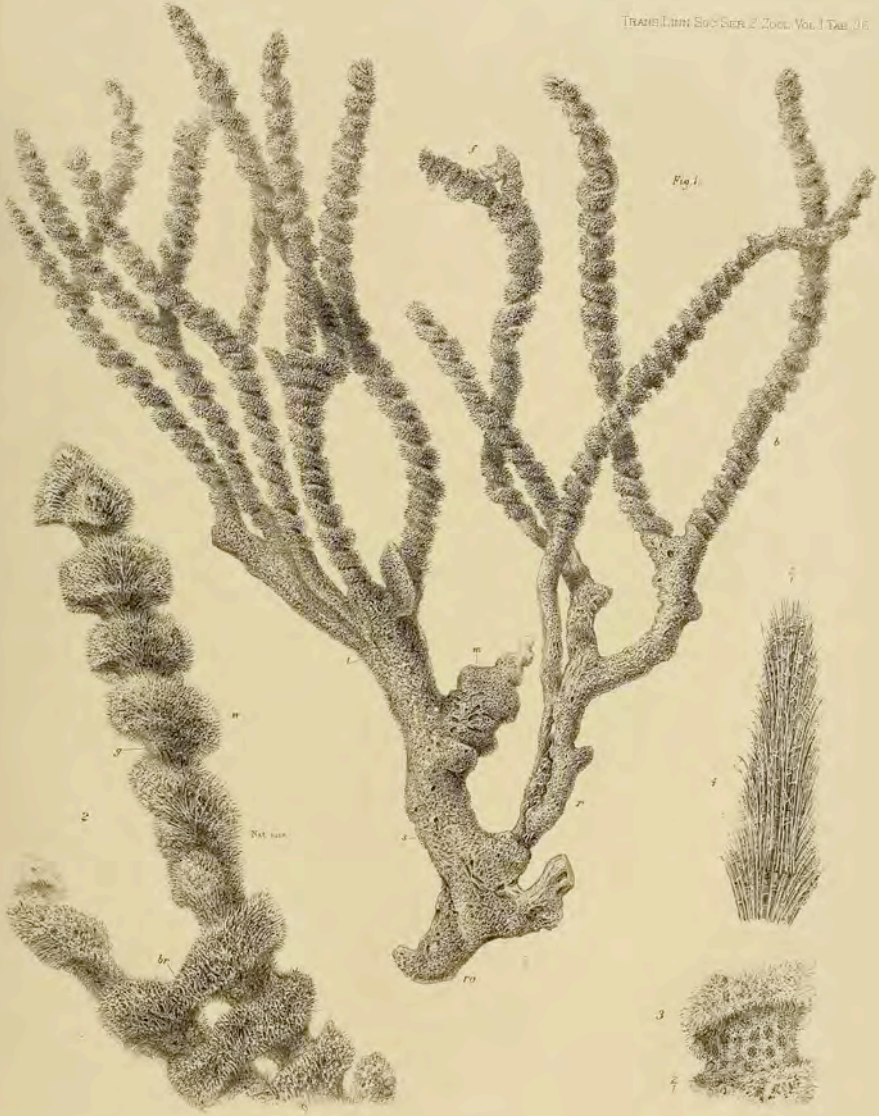
Fig. 24. A highly magnified representation in perspective of one of the small rosettes of the fleshy, dermal, rectangular meshwork. (See fig. 23 *b* for its position with respect to the free axial arm of the sexradiate spicule.)

Fig. 25. The larger kind of multiradiate rosette, sparsely met with among the débris of the sponge.

Fig. 26. A foreshortened view, or from above, of the cap or head of one of the rays of the rosette, fig. 25.

Fig. 27. A spicule of a minute kind, of which only one or two were observed among the loose substance shaken off the *Dendrospongia*.

All the figures of the spicula, from 13 to 27 inclusive, are enormously enlarged; and the relative proportions as to size of the different sorts have not been strictly adhered to, though in the main approximated. For their accurate measurements &c. consult description in body of text.



DENDROSPONGIA STERRII.

SKELETAL DETAILS OF DENDROSPONGIA