XVI. *On the Anatomy and Physiology of the Spongiadæ.*

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PART I.—ON THE SPICULA.

Hitherto the Spongiadæ have been classified either by their external form or in accordance with their chemical constituents. In the second edition of Lamarck's 'Anim. s. Vert.,' 138 species are included in the genus *Spongia*, without the slightest reference to their internal structure; and they are divided into seven groups by external form only, the same characters serving also, in a great degree, to discriminate the species.

Fleming, Grant, Johnston, and other modern naturalists, have made their principal divisions depend on their chemical constituents, and have therefore constructed three great divisions as genera:—*Spongia*, composed of keratose fibres unmixed, as it was supposed, with earthy matter; *Halichondria*, formed principally of siliceous spicula; and *Grantia*, having the skeleton composed of calcareous spicula. Included in the second of these divisions are the genera *Tethea*, *Geodia*, *Pachymatisma*, *Spongilla*, *Dysidea*, and *Halisarca*, and these nine genera are all that are contained in Dr. Johnston's 'History of British Sponges.'

Both of these arrangements are very insufficient, and that of Lamarck completely ineffectual, inasmuch as there is no class of animals in which the form varies to so great an extent, according to the difference of locality or other circumstances; and also even when there is a striking normal form, it is rarely thoroughly developed until the animal has reached its full maturity. According to the practice of Lamarck, even under the most favourable circumstances there are frequently recurring difficulties in the determination of the species by this method, as the same forms are found to be common to a great number of sponges, the internal organization of which are widely different to each other. From these causes it is, that no naturalists with whom I have conferred on this subject, have been able to determine with certainty the species of a sponge by the description given by Lamarck in his 'Anim. s. Vert.,' or by those of any other author who has adopted the same method of description, with the exception of perhaps a few very striking species.

The division of the Spongiadæ by their chemical constituents, may serve very well to separate them into primary groups, but they are far too limited to be applied as generic characters. I have therefore for this purpose rejected both systems, and have retained the latter one for the purpose of forming primary divisions only, and I purpose founding the generic characters principally on the organic structure and mode of arrangement of the skeleton. *Spongilla* differs in no respect from *Halichondria*, as now accepted by naturalists; and the latter, even in the narrow circle of the list of British species, contains at least ten distinct modes of arrangement of the skeleton, each of which is constant and well-defined in its character.

It is not my intention to propose the rejection of any of the well-established genera of my predecessors*, but to confine each genus strictly within the bounds indicated by the peculiar mode of the structure of the skeleton which exists in that species of sponge which is the oldest-established and best-known type of the genus, and to refer all others that may distinctly differ from that type to new genera founded on structural principles.

When I commenced in a similar manner a critical examination of the specific characters of preceding authors, and endeavoured to collect and classify them, I found them to be still more indeterminate than those of class or genera; in truth, it appeared that there was scarcely an approach to a distinct terminology to the science, and that the same author frequently designated the same organ, under different circumstances, by a totally different name; I therefore felt it absolutely necessary, before proceeding to the description of new species, to enter into a thorough systematic examination of the organization of the whole of the species within my reach, and to characterize the organs in such a manner as to render the terms I applied to them definite in their meaning and limited in their application; and in pursuing this object I quickly found an abundance of constant and well-characterized forms and combinations of organization capable of being applied with precision to the purposes of generic and specific descriptions.

I propose, therefore, in the first instance, to characterize the elementary tissues in the following order:—

1. Spicula.
2. Keratode or horny substance.
3. Membranous tissues.
4. Fibrous tissues.
5. Cellular tissues.
6. Sarcode.

And, in the second place, to treat of the organization and physiology in the following order:—

1. The skeleton.
2. The sarcodous system.
3. The interstitial canals.
4. Intermarginal cavities.
5. Dermal membrane.
6. The pores.
7. The oscula.
8. Inhalation and exhalation.

* *Tethea*, *Geodia*, *Dysidea* and a few others are the only well-defined genera that have yet been established.

9. Nutrition.
10. Cilia and ciliary action.
11. Reproduction, gemmules, &c.

And to conclude with observations on

The generic characters;
The specific characters; and
On the method of examination.

In my references to the views of preceding writers regarding the anatomy and physiology of the Spongiadæ, I shall endeavour to correct the errors, rather than to point out the authors of them, feeling satisfied that posterity will care as little about the petty angry discussions concerning the facts and opinions of the present period as we do about those of our ancestors; at the same time I shall endeavour to do justice to the industry and research of preceding naturalists, whose errors of omission are entitled to every possible excuse, when we remember the difficulties they laboured under in the course of their investigations, for want of competent microscopic powers with which to work out the organization of the minute and delicate objects of their research, while we are in full possession of all the advantages of the modern improvements of the microscope, giving a pleasure and facility to our investigations that must have been comparatively almost unknown to our predecessors.

The Spicula.

The spicula are essentially different in character from the fibres of the sponge, although the latter may be equally siliceous with the former. However closely the spicula may be brought into contact with each other or with siliceous fibre, they do not appear to unite or anastomose, while the fibre, whether siliceous or keratose, always anastomoses when it comes in contact with other parts of its own body or of those of its own species.

They differ exceedingly in dimensions; the longest I have seen are the prehensile ones, at the base of *Euplectella cucumer*, Owen, which exceed 3 inches in length.

They are among the earliest organs that are produced in the young sponge. Dr. Grant, in his valuable papers on the development of the Spongiadæ, states that immediately after the ciliated gemmule of the sponge he has described as *Halichondria panicea** has attached itself to a rock or stone, it spreads out into a thin gelatinous-looking spot, and very shortly afterwards there appears a few spicula irregularly disposed in about the centre of the mass†.

In the young gemmules of *Tethea cranium*, while in a very immature condition, they are projected for half their length beyond the surface of the small nucleus of animal matter that exists at the early stage of its development, while in the mature gemmule not a vestige of them is apparent beyond its surface.

In the early stage of their development the spicula appear to consist of a double

* *Halichondria incrustans*, Johnston's 'British Sponges.'

† Edinburgh Phil. Journ. vol. xiii. p. 381-3.

membrane, between which the first layer of silex is secreted, and in this condition they present an internal cavity approaching very nearly to the size of their external diameter. In this state they readily bend abruptly in any direction without breaking, as may be seen in Plate XXIII. fig. 1, which represents a porrecto-ternate spiculum from the termination of one of the radial lines of the skeleton at the surface of *Tethea cranium*. This spiculum has been considerably distorted by pressure on the points of the rays at its apex. The deposit of the silex is not continuous and homogeneous, but is produced in successive concentric layers, which it would appear are, at least for a period, equally secreted by the inner surface of the outer membrane and the outer surface of the inner one; for we always find that as the development of the spiculum progresses, the internal cavity gradually becomes less, until finally it exists only as a central canal of very minute diameter in comparison with that of the spiculum itself. These stages of development may often be seen in the spicula of young specimens of *Spongilla fluviatilis*, especially in the spring, when they are growing rapidly. If small fragments of the sponge be slightly charred in the flame of a lamp, and then submitted to microscopical examination, the outer and inner membranes of the spicula will readily be rendered visible (Plate XXIII. figs. 2 and 3); in immature spicula the internal membrane, is represented by a dense black film of charcoal, as in Plate XXIII. fig. 3, while in the mature ones the small central cavity is seen to be lined by so thin a membrane as to afford by its charring a slight brown tinge only to its walls (Plate XXIII. fig. 2). The concentric deposition of the layers of silex or carbonate of lime in the spicula are also readily to be seen (Plate XXIII. fig. 4) in transverse fractures of almost any large spiculum, either siliceous or calcareous, and they present the same aspect as similar sections of either the prismatic cells of shell tissue, or the spicula of a Gorgonia. The amount of silex, and the manner of its deposition in the spicula, is not the same under all circumstances. Where the spiculum is simply required to give strength and firmness to the skeleton, as in the greater number of the Halichondraceous sponges, the whole interior of the spiculum becomes rapidly filled with silex; but where strength is required to be combined with great elasticity and toughness, the mode of deposit is especially adapted to the requirements of the occasion; the amount of the silex deposited is small, and confined wholly to the surface, while the interior appears to be filled with keratode. These laws of deposit will perhaps be best illustrated by my detailing a series of experiments I made by the incineration of the spicula of various sponges in the flame of a small spirit-lamp. I was led to this series of experiments by frequently observing during the course of my investigations the great amount of flexure that many of the large and long spicula would sustain without fracture, and the perfect elasticity with which they regained their original form and position. Thus, in mounting the spicula of *Tethea cranium* in Canada balsam, the long and slender porrecto-ternate defensive spicula projected from its surface would frequently have the shaft bent into a series of sigmoid curves or even loops; and the thickest portion of the same spicula, while in their natural condition, may be bent down to the surface of the sponge, from which they spring at right angles, so as to form an arc of the third of a circle with perfect impunity. This great flexibility appeared to me to be so incompatible with a purely siliceous structure, that I determined to select the spicula of *Tethea cranium*, more especially to work out this problem, and from the large size of those of the skeleton fasciculi they are more than usually favourable for the purpose. If we view these spicula in their natural condition, mounted in either water or Canada balsam, by transmitted light and a linear power of 150, they present all the usual appearances of solid siliceous spicula; there is a small central tubular cavity, and the substance of the spicula intervening between it and the external surface presents to the eye the linear appearance that characterizes a deposit in concentric circles; and the fractured ends have precisely the same aspect that filaments of the same size of hard dry glue or glass would present to the eye. If these spicula be now burned in the flame of a small spirit-lamp until the combustion is completed and the mass is brought to a white heat, and it be then examined as before, the results are widely different in their aspect; the spicula have become considerably increased in diameter, and instead of being solid, they are now extremely thin tubes of silex lined with a dense and nearly opake film of charcoal, rough and granulated in its appearance. I thought in the first instance that I might have unwittingly selected a fasciculus of young spicula only for burning, and I therefore repeated the experiment, burning only half of the fasciculus and preserving the remainder in an unaltered condition; and on carefully mounting the specimen in Canada balsam, I found the same results precisely; the unburned half of the fasciculus presented all the characters of solidity that I have before described, while the burned half was in perfect unison with the previous results of incineration; and at the junction of the two, the transition from the one state to the other might be readily traced even in single spicula. The external coat of silex in these spicula is so thin and the coat of charcoal with which it is lined so rough and opake, that the thickness of the silex cannot be readily ascertained; but in one of the short, stout, fusiformi-acerate spicula of the dermal coat of the sponge, which is about the same diameter as that of the skeleton spicula, I succeeded in measuring the thickness of the siliceous coat accurately after incineration. The length of the spiculum was $\frac{1}{30}$th of an inch, the greatest diameter $\frac{1}{530}$th of an inch, and the thickness of external siliceous case $\frac{1}{7500}$th of aninch. Plate XXIII. figs. 5 and 6, represent portions of two of the large spicula of the skeleton after incineration.

I have very little doubt that the combustible matter in the interior of these large spicula is really keratode, one of the most elastic and durable animal substances with which we are acquainted. The mode of its deposition within these organs is precisely the same with that presented in all the varieties of keratose fibre with which I am acquainted; and from its concentric arrangement, the nature of the material itself, and its combination with a thin external case of silex, it presents perhaps one of the most admirable natural combinations of strength, elasticity, and durability.

The structure which I have described as prevailing in *Tethea cranium* is not peculiar to that genus. I obtained very similar results from the incineration of the spicula of

Geodia M^cAndrewii, BOWERBANK, MS., a new and remarkably interesting species. In this sponge there appeared to be a greater amount of silex secreted in the large skeleton spicula than in *Tethea*, while some of them after incineration were resolved into thin shells of silex, others withstood the operation and retained their form; and some were so completely siliceous, that on plunging them into the drop of water for examination while red-hot from the flame of the lamp, the result was the same as if they had been solid glass rods, and these were cracked and shattered in every direction (Plate XXIII. fig. 8).

I submitted to the same mode of incineration a few of the long siliceous spicula or fibres of *Euplectella aspergillum*, OWEN, burning about half of each fibre, and the result, although somewhat different, was equally satisfactory. The unburned portion appeared perfectly solid, but exhibited the usual trace of concentric structure. The end thoroughly burned became reduced to a thin filament of densely black matter like charcoal, but the junction of the burned and unburned portions was extremely interesting. At this point the action of the heat upon the concentric layers had separated them from each other in the form of a series of thin curved flakes or coats, illustrating the thin concentric structure in a very satisfactory manner; demonstrating that the outer coat of siliceous matter was not the only one, and that probably there were several coats, each containing a sufficient amount of silex in its composition to resist disintegration by incineration (Plate XXIII. fig. 7).

On operating in like manner on the spicula of *Halichondria oculata*, JOHNSTON, little or no alteration was perceptible in the spicula, the inner cavity remaining the same as in the unburned ones, and distinguished only by a slight brown tint, indicating the existence of but a very small amount of animal matter within. This result might be expected; the spicula being, imbedded in the keratose fibre to give it additional firmness and strength, are not required to be elastic; they are therefore short, comparatively stout, and solid in their structure.

A specimen of *Halichondria panicea*, JOHNSTON, burned in the flame of a spirit-lamp to a white heat, exhibited no alteration in the mature spicula, in many of which I could not detect a central tubular cavity; and I presume in these cases the spicula were entirely filled with silex, as in younger spicula it was more or less apparent. When the cavity was very small, the colour had a very faint tinge of brown, and, as in other cases, when the cavity increased in diameter, the amount of colouring matter produced by the incineration of the animal matter within became greater, and deeper in its tint, until in the young and immature spicula the internal cavity occupied the greater part of its diameter, and it became perfectly black and opake; and in one spiculum the gaseous matter generated within expanded one part of the spiculum to such an extent, as to cause it to resemble exactly a hydrometer in form.

The result of the incineration of *Halichondria incrustans*, JOHNSTON, was very similar to that of *Hal. panicea*. The adult spicula remained unaltered, and the central canal was rendered more apparent than it was before.

On burning portions of *Spongilla fluviatilis* and *lacustris*, JOHNSTON, and of *Spongilla* *cerebellata*, Bowerbank, MS., I found the results were similar to those obtained from *Halichondria panicea* and *incrustans*, as regards the spicula of the skeleton; but in the small spinous spicula investing the gemmules of the last-named species there was no apparent alteration, nor could any indication of a central cavity be seen.

The calcareous spicula of *Grantia compressa* withstood incineration better than I expected. The surface was studded with numerous little vesicles generated by the heat, and which interfered with their transparency; but they retained nearly their original colour and proportions; and it may therefore be concluded that they contained so great a proportion of calcareous matter as to prevent their disintegration by heat.

Many of the forms of the spicula are by no means peculiar to the Spongiadæ; but, on the contrary, as I shall hereafter show, their types are frequently to be found in the more highly organized classes of animals, and especially among the Zoophyta, the Tunicata, and the Nudibranchiate Mollusca. They are always of an organic type, never crystalline or angular.

Each of the elongated forms of spicula may be said to be composed of three parts, the base, the apex, and the shaft intervening between the two; and generally speaking, these parts may be readily determined, even when the spicula are isolated.

Each species of sponge has, not one form of spiculum only, equally dispersed throughout its whole substance; but, on the contrary, we find that separate parts have each its appropriate form; and thus we find that three, four, or even more forms often occur in the same individual; and in *Tethea cranium* there are no less than seven distinct shapes. But these differences in structure must not lead us to believe that every strange form of spiculum that meets the eye is a normal one: remarkable variations are often produced for especial purposes in the construction of the skeleton or for other objects; and in some species, *Spongilla lacustris*, for example, the number of odd malformations that are occasionally found is very remarkable. The size also of the normal forms of spicula will often vary to a considerable extent in the same sponge; but if adult, they are always in accordance with the type form, and if not adult, intermediate states of growth are generally present to assist us to form correct conclusions regarding them. The forms thus appropriated to the different parts of the sponge are not always peculiar to certain species, but, on the contrary, they are frequently found to be repeated in other species differing widely in their construction.

The spicula thus appropriate to particular parts of the sponge are uniform in their general characters throughout the whole of the Spongiadæ, and a great portion of them are so well characterized by their form, as to enable the student, when once well acquainted with their peculiarities, to assign each readily to its proper place in the sponge. I purpose therefore, in describing them, to treat of these organs in the following order:—

1. Spicula of the skeleton.
2. Connecting spicula.
3. Defensive spicula.
4. Spicula of the membranes.

5. Spicula of the sarcode.
6. Spicula of the gemmules.

1. *Spicula of the Skeleton.*

The spicula of the skeleton in the siliceous sponges are usually simple, elongate in form, slightly curved, and occasionally more or less furnished with spines. They are either irregularly matted together, collected in fasciculi, or dispersed within or upon the keratose fibres of which the skeleton is to a great extent composed. Occasionally, but not frequently, they assume the triradiate form. In the calcareous sponges, beside the simple elongate form, the triradiate spicula are found in abundance.

All the elongate forms of spicula of the skeleton are subject to extreme variety in length. In some species they maintain a great degree of uniformity, while in others they vary to a very considerable extent, according to the necessities arising from the mode of the construction of the skeleton.

The commonest form of skeleton spiculum is perhaps the

ACERATE.—Of the same diameter for the greater part of the length of the shaft, but decreasing equally near each termination, and ending acutely at both.

The proportions of length and diameter vary to a considerable extent in this form. In *Halichondria panicea*, JOHNSTON, it is of about the medium proportions (Plate XXIII. fig. 9, *a*). In *Spongilla fluviatilis* it is much shorter and stouter (Plate XXIII. fig. 9, *b*).

FUSIFORMI-ACERATE.—Having the greatest diameter at the middle of the shaft, and decreasing gradually to each acute termination. *Halichondria coccinea*, BOWERBANK, MS. (Plate XXIII. fig. 10).

INFLATO-FUSIFORMI-ACERATE.—Fusiformi-acerate, with a globular inflation at the middle of the shaft. This form of spiculum is abundant in the skeleton of *Isodictya anomala*, BOWERBANK, MS. A new British sponge. It is sometimes extremely fusiform in shape (Plate XXIII. fig. 11).

ACUATE.—Of the same diameter from the hemispherically-terminated base to near the acutely-terminated apex. *Halichondria Alderi*, BOWERBANK, MS. (Plate XXIII. fig. 12, *a*). *Hymeniacidon caruncula*, BOWERBANK, MS. (Plate XXIII. fig. 12, *b*).

FUSIFORMI-ACUATE.—Having the largest diameter near the middle of the shaft, and decreasing thence gradually towards the hemispherical base and the acute apex. *Halichondria crustula*, BOWERBANK, MS. (Plate XXIII. fig. 13).

ATTENUATO-ACUATE.—Decreasing gradually in diameter from the hemispherical base to the acutely terminated apex. *Halichondria infundibuliformis*, JOHNSTON (Plate XXIII. fig. 14).

FLECTO-ATTENUATO-ACUATE.—Attenuato-acuate bent suddenly near the base of the spiculum. *Halichondria infundibuliformis*, JOHNSTON (Plate XXIII. fig. 15). In other species of sponges, and in other forms of spicula, the bending near the base is not so abrupt, but it is still characteristic and constant in the species, as for example in the flecto-acuate spicula of *Halichondria variantia*, BOWERBANK, MS. (Plate XXIII. fig. 16).

Cylindrical.—Having the shaft of the same diameter throughout its length, and terminating at each end hemispherically, as in *Pachymatisma Johnstonia*, Bowerbank (Plate XXIII. fig. 17).

Fusiformi-cylindrical.—Having both terminations hemispherical, and the shaft gradually increasing in diameter to its middle. *Pachymatisma Johnstonia*, Bowerbank (Plate XXIII. fig. 18).

Attenuato-cylindrical.—Terminating hemispherically at both ends, but the shaft slightly decreasing from the base to the apex. *Pachymatisma Johnstonia*, Bowerbank (Plate XXIII. fig. 19).

Fusiformi-attenuato-cylindrical.—Both terminations being hemispherical, the fusiform shaft has a much smaller diameter towards its apex than it has at its base. From *Tethea robusta*, Bowerbank, MS. A new species from Australia in the British Museum (Plate XXIII. fig. 20).

Biclavated cylindrical.—The shaft equally cylindrical, with gradually inflated terminations. The inflations are almost as great as that of a spinulate spiculum, but without sphericity (Plate XXIII. fig. 21). From a new and undescribed species from Australia, Bowerbank Collection.

Inequi-Biclavated cylindrical.—The shaft attenuated from the base to the apex, with clavated terminations of unequal diameters (Plate XXIII. fig. 22). From *Pachymatisma Johnstonia*, Bowerbank.

Angulated inequi-Biclavated cylindrical.—This singular angulated form does not appear to be purely accidental, as I have found other instances of similar angulation at the middle of the shaft in other sponges, and the angle in each instance has been as nearly as possible at the same spot in the shaft. *Pachymatisma Johnstonia*, Bowerbank (Plate XXIII. fig. 23).

Spinulate.—Shaped like a pin, having the same diameter from the spherical base to very near the acutely terminated apex. *Halichondria carnosa*, Johnston (Plate XXIII. fig. 24).

Fusiformi-spinulate.—The base being spherical, the shaft more or less fusiform and terminated acutely. *Halichondria suberea*, Johnston (Plate XXIII. fig. 25).

Attenuato-depresso-spinulate.—Having the basal inflation considerably depressed, and the shaft gradually attenuated from the base to the apex. From a new species of sponge from Ash Island, in the cabinet of Mr. Thomas Ingall (Plate XXIII. fig. 26).

Enormi-spinulate.—Having the spherical inflation slightly within the basal portion of the shaft of the spiculum. *Halichondria celata*, Johnston (Plate XXIII. fig. 27).

Flexuous.—Having the shaft of the spiculum curved repeatedly (Plate XXIII. fig. 28). *Halichondria ventilabrum*, Johnston.

Ensiform.—Expanding towards the apex, but terminating acutely; so that the outline has more or less the form of the blade of a sword. Sponge unknown (Plate XXIII. fig. 29).

The spicula of the skeleton in some species of siliceous sponges are more or less furnished with acutely conical spines, which are irregularly dispersed over the whole or a portion of the spiculum, and they are therefore said to be,—

ENTIRELY SPINED.—When the spines are equally dispersed over the spiculum from the base to the apex (Plate XXIII. fig. 30). *Halichondria incrustans*, JOHNSTON.

BASALLY SPINED.—When the spines do not occupy more than about one-third of the basal portion of the spiculum (Plate XXIII. fig. 31). *Halichondria Ingalli*, BOWERBANK, MS., a new British sponge.

MEDIALLY SPINED.—When the spines occupy only about one-third of the middle of the spiculum (Plate XXIII. fig. 32). *Halichondria Ingalli*, BOWERBANK, MS.

APICALLY SPINED.—When the spines occur only at and near the apex of the spiculum: from an undescribed sponge, locality unknown (Plate XXIII. fig. 33).

TERMINALLY SPINED.—When the spines occur near both the base and apex of the shaft of the spiculum, but not at the middle: from an undescribed species of sponge, locality unknown (Plate XXIII. fig. 34).

TRIRADIATE SPICULA.—These forms among the siliceous sponges are occasionally found imbedded among the other spicula of the skeleton at the angles of the reticulation; and the radii in nearly all the specimens I have seen terminate acutely. But it is in the calcareous sponges, *Grantia* of FLEMING, they are essentially the spicula of the skeleton. They are,—

EQUIANGULAR TRIRADIATE.—Having the three attenuating rays in the same plane, and the intervening angles equal, or very nearly so (Plate XXIII. fig. 35). *Grantia compressa*, FLEMING.

RECTANGULAR TRIRADIATE.—Having the three attenuating rays in the same plane, two of them forming a straight line, and one being projected from the middle of the line, forming right angles to it. Abundant in the base of the ciliary fringe of the mouth of the cloaca of *Grantia tessellata*, BOWERBANK, MS. A new British species (Plate XXIII. fig. 36).

Both the above forms are subject, even in the same species, to considerable variations, arising from the necessities of their situation in the skeleton. The radii also vary greatly in thickness and length in different species: the stoutest form I have seen occurs in a new species of calcareous sponge from Africa, a spiculum of which is represented (Plate XXIII. fig. 37).

EQUIANGULAR SPICULATED-TRIRADIATE.—Having the three rays in the same plane with the intervening angles equal, and a fourth ray projected from the basal junction of the radii at right angles to their plane. This is the only case in which I have found this form of spiculum in a siliceous sponge, *Halina Bucklandi*, BOWERBANK, MS. A new British species. But this form is very common in the calcareous sponges, where it appears as a defensive organ; and in treating of it as such I have given my reasons for not designating it as a quadriradiate spiculum (Plate XXIII. fig. 38).

BIANGULATED QUADRIRADIATE.—Having two radii projected from a common basal point, in one plane forming an angle of about 90°, and the other two projected in a similar manner in an opposite direction in a second plane at right angles to the first one.

This singular form is associated with the spiculated triradiate one in the skeleton of *Halina Bucklandi*, BOWERBANK, MS. (Plate XXIII. fig. 39).

TRIFURCATED PATENTO-BITERNATE.—Consisting of a short stout shaft, each end being furnished with three short equiangular radii passing off at right angles to the shaft, and each having its termination trifurcated (Plate XXIII. fig. 40, a side view, and fig. 41 a view of one end of a spiculum). This singular form occurs in the tortuous excavations of probably a small annelid in a soft limestone, the sponge lining the cavities in a manner similar to *Halichondria celata*, JOHNSTON. The skeleton consists entirely of this singularly complicated form of spiculum: I am indebted to my friend Mr. THOMAS INGALL for a portion of the sponge.

Connecting Spicula.

The connecting spicula are not necessarily a part of the skeleton, they are a subsidiary portion of it occurring under special circumstances, in a few genera only, such as *Geodia*, *Pachymatisma*, and other sponges which have a thick crustated surface, which they serve to support and retain in due connexion with the mass of the animal beneath. The triradiate apices also serve to construct areas in which are situated the proximal orifices of the intermarginal cavities, which are imbedded in the crustated surface of the sponge. The normal form of these spicula is very different from that of the spicula which constitute the general mass of the skeleton, and they are far more complex and varied in their structure. They usually have a long, stout, cylindrical, or attenuated shaft, terminating either acutely or hemispherically at the base, while the apex is divided into three stout equiangular radii, which assume in different species a considerable amount of variety as regards form and direction. The triradiate apices are usually cemented firmly to the inner surface of the crustated coat of the sponge, while the stout and elongated shaft is intermingled with and firmly cemented by keratode to the general mass of the skeleton. From the trifid nature of the apex, I have designated the seforms as ternate spicula, prefixing such terms as may best serve to distinguish them individually in accordance with their permanent variations from each other. The prefixed designations of the spicula must necessarily in some measure be arbitrary, as the differences in the degree of the expansion of the radii cannot be strictly defined; and although the forms are well characterized in each species, yet even within these bounds a slight degree of variation, arising from the local necessities of the case, will occur. The ternate spiculum, therefore, as a general designation, may be said to be an elongate spiculum, with a triple apical termination. These spicula are not confined to the office of connecting only, but are also found among the defensive ones, as will be hereafter shown.

PORRECTO-TERNATE.—Having the terminal radii projected forward at an angle to the shaft of less than 45 degrees.

The best type of this form is in *Tethea cranium*, JOHNSTON, where it is a defensive spiculum as well as a connecting one (Plate XXIV. fig. 10).

EXPANDO-TERNATE.—Having the terminal radii projected forward at angles varying from 45 to 60 or 70 degrees to the long axis of the shaft. Plate XXIII. fig. 42, represents an attenuated spiculum from *Pachymatisma Johnstonia*, and Plate XXIII. fig. 43, a cylindro-ternate spiculum from the same sponge.

PATENTO-TERNATE.—Having the terminating radii disposed at, or nearly at right angles to the shaft of the spiculum, the curves of the radii being usually more or less inclined backwards towards the base of the shaft. Plate XXIII. fig. 44, represents a spiculum from *Geodia M^cAndrewii*, BOWERBANK, MS. A new species from Vigten Island, coast of Norway.

Patento- and expando-ternate spicula are both subject to variations dependent on the form of the shaft, which in some cases is attenuated from the apex to the base, where it terminates acutely; or the shaft is cylindrical, subfusiform or spinulate: in such cases, we should designate them as spinulo-expando-ternate, or otherwise, as might be requisite for accurate distinction of the form.

RECURVO-TERNATE.—The terminating radii, recurved from about 100 to 140 degrees from the apical line of the axis of the shaft. The curves of the radii are always more or less inclined towards the base of the shaft of the spiculum (Plate XXIII. fig. 45). From *Geodia Barretti*, BOWERBANK, MS. Vigten Island, Norway.

FURCATED ATTENUATO-PATENTO-TERNATE.—The radii of the ternate apex is not always simple; in some species, as in *Pachymatisma Listeri*, BOWERBANK, MS., a new species from Madeira, and in *Geodia Barretti*, BOWERBANK, MS., from Vigten Island, Norway, each of the rays have bifurcated terminations in the same plane as the primary radii, as represented in Plate XXIII. figs. 46 and 47, the former being erect, and the latter having the plane of the radii presented to the eye. From *P. Listeri*, BOWERBANK, MS.

SPICULATED DICHOTOMO-PATENTO-TERNATE (Plate XXIII. fig. 48), is a still more complicated form, the radii of the bifurcations each terminating again dichotomously; but the secondary bifurcations are not all of them in the same plane as the primary ones, a portion of them being at right angles to it, and the shaft is also carried through the common central base of the whole, giving it a spiculated form, as represented in the figure. This prolongation of the shaft through the common base of the radii of the ternate spicula is not confined to the one described above, but it does not appear to be a normal form.

I have never seen a quaternate spiculum associated with the connecting spicula, in which all the radii were equi-divergent; in all such cases three appear to represent the ternate type of spiculum, and the fourth, or supplemental one, is a continuation of the axial line of the shaft, which passes through the united bases of the ternate portion of the spiculum. I have therefore designated these forms as spiculated ternate rather than quaternate.

These spicula are rather anomalous in their character. They frequently, but not universally, accompany the true connecting spicula; the ternate apices do not usually reach the under surface of the crustated coat; in *Geodia Barretti* and some other species, in which they occur but occasionally, they partially fulfil the office of connecting spicula. There is a constant and striking difference in the proportions of the true and the pseudo-connecting spicula, if we may so term them; the proportions of the former are generally stout and strong, while those of the latter are always long and very much more slender.

Spiculated porrecto-ternate.—Having three equidistant porrect terminal rays, and a fourth or central one in a line with the axis of the shaft (Plate XXIII. fig. 49). From *Geodia Barretti*, Bowerbank, MS., from Vigten Island, Norway.

Spiculated recurvo-ternate.—Having three equidistant recurved radii, and the central terminal one porrect in the line of the axis of the shaft of the spiculum (Plate XXIII. fig. 50). From *Geodia Barretti*, Bowerbank, MS., from Vigten Island, coast of Norway.

The central porrect terminal ray is often more or less deflected from the axial line of the shaft, as in Plate XXIII. fig. 51; and occasionally, in the simple recurvo-ternate form, one of the three rays will be bent upward, even to a greater extent than is represented in fig. 53; but these, it must be recollected, are but accidental variations in form.

The shafts of the recurvo-ternate forms of spicula are much less in diameter than those of the patento or expando-ternate ones from the same sponge, and they are frequently very long and exceedingly attenuated.

Prehensile Spicula.

Spicula projected from a sponge as a means of attachment to other bodies.—I know of but one form of this description of spiculum, an exceedingly elongated, fusiformi-acerate one, with a stout recurvo-quaternate apex. It occurs at the base of *Euplectella aspergillum* and *E. cucumer*, Owen. The long attenuated basal portions of the shaft being without spines, are incorporated with the longitudinal fasciculi of the skeleton, while the apical portions of them are projected from the base of the sponge, and embrace and hook on to any extraneous mass near which it may be situated; and this free portion is thickly beset with strong acutely conical spines, reflected at about the same angle and in the same direction as the radii of the quaternate apex, and to which they are auxiliary as prehensile organs; and as we proceed from the apex towards the central portion of the spiculum, the spines successively decrease in length, until at about one-third of the length of the spiculum from its apex they become obsolete. I am indebted to my friend Dr. Arthur Farre for the specimen figured of this singular and interesting form of spiculum; and the only sponge in which they have been found in a perfect state, is the delicate and beautiful one designated by Professor Owen *Euplectella cucumer*. They occur in great profusion, embracing the mass of matter at its base in every direction. I propose, therefore, to designate this form as an apically spined recurvo-quaternate spiculum (Plate XXIII. fig. 53: *a*, the apical portion of the spiculum; *b*, a portion from that part of the shaft at which the spines become obsolete).

As a solitary instance of the occurrence of a spiculum, so singular in its form and so unusual in its application, and being, like the connecting spicula, to a considerable extent incorporated with the skeleton of the sponge, I have thought it advisable to describe it as an auxiliary form, rather than to consider it as the type of a class.

Defensive Spicula.

There are two classes of defensive spicula:—

1st. Those of the exterior,
2nd. Those of the interior of the sponge.

They are neither of them necessarily present in every species, nor are they confined to particular genera, but occur occasionally, and in certain species of various genera, apparently as the necessities of the animal may render their presence requisite. If the exterior of the animal be amply supplied with them, the interior rarely possesses them. Their office is evidently to defend the sponge from the attacks of predacious animals that would otherwise very probably destroy it; and thus it is that the external defensive spicula are frequently of more than the usual length and strength of these organs. They are projected for about half or two-thirds of their length, at various angles from the surface of the sponge, apparently with the object of meeting the attacks of the larger class of depredators; but as between these large spicula the smaller tribes of annulate animals would readily insinuate themselves, there is frequently a secondary series of defences, consisting of innumerable short, finely-pointed spicula, the *apices* of which are projected a short distance only beyond the surface of the dermal membrane, thus rendering the progress of the smaller and more insinuating enemies extremely difficult, if not impossible. In young sponges, as in *Spongilla fluviatilis* and others, the office of external defensive spicula is frequently performed by the continued extension of the radial lines of the skeleton, the terminal spicula of which often project to more than the extreme length of a spiculum beyond the surface of the dermal membrane.

When the defensive spicula are internal they assume a different character from the external ones. The most common form under these circumstances is that of a short, stout attenuato-acuate spiculum, profusely and entirely spined; they are firmly based in the substance of the skeleton; and the greater portion of their length is projected at various angles from the sides of the interstitial canals and cavities of the sponge. They would thus render the passage of minute annelids and other small enemies extremely difficult; and in one instance, the mode in which the protection of the interior of the sponge is provided for is very remarkable and curious. Large spinulo-recurvo-quaternate spicula with attenuating radii are grouped together on the angles of the network of the skeleton, and are projected in a radiating manner into the cavities of the interior of the sponge, forming a most effectual prevention to the passage of any small animal. The occurrence of this complicated and beautiful form of spiculum is a singular deviation from the normal mode of defence, and almost induces the belief that it was intended that such intruders as effected an entrance were meant to be retained, and their decomposed particles appropriated to the nutrition of the sponge. In other cases, where no definite form of defensive spiculum forms a part of the sponge, the office of those organs is frequently performed by the projection of spicula similar to those of the skeleton into the canals and cavities of the interior.

FUSIFORMI-ACERATE.—*Geodia Barretti*, BOWERBANK, MS. On this remarkably fine species of *Geodia* this form of defensive spiculum occurs in parts in such abundance, that they completely cover and obscure the surface of the sponge, from which they project nearly the whole of their length, the proximal ends of many of them scarcely passing through the dermal crust of the sponge. This sponge has also a secondary series of defensive spicula, of the same form as the larger ones; the latter often exceeding $\frac{1}{8}$th of an inch in length, while the secondary spicula do not exceed $\frac{1}{64}$th of an inch in length. For the form of this spiculum see Plate XXIII. fig. 10.

ATTENUATO-ACUATE: ENTIRELY SPINED.—*Dictyocylindrus ventilabrum*, BOWERBANK, MS. This short form of spiculum is of very frequent occurrence in the interior of sponges of several different genera. They are usually profusely spinous, and especially at the base, which is firmly imbedded in the keratode of the skeleton. The spines are irregularly dispersed over all parts of the shaft, to the very apex of the spiculum; they are projected into the interstitial cavities and canals of the sponge at all angles to the axis of the skeleton on which they are based, and no degree of regularity exists in their mode of dispersion. In some sponges they occur in considerable numbers; but in others, where the animal is well protected by the abundance of the large radial spicula, they are few in number, and are not to be detected without a very careful search (Plate XXIV. fig. 1).

ACUATE: ENTIRELY AND VERTICILLATELY SPINED (Plate XXIV. fig. 2).—This form of spiculum is one of the most remarkable and beautiful of its tribe. I have found it in two distinct species of sponge from the West Indies. In one it is irregularly dispersed, and in the other it is collected into radiating groups. The form of the spiculum is short, stout, and regularly acuate, having the acutely-conical spines arranged in nearly equidistant rings of a single series each, from the base to the apex of the spiculum.

CYLINDRICAL: ENTIRELY AND VERTICILLATELY SPINED (Plate XXIV. fig. 3).—I am not acquainted with the sponge whence this beautiful spiculum came. I found it in the refuse matter from the base of a specimen of *Oculina rosea*, from the South Seas. The shaft of the spiculum, from end to end, has equidistant rings of single series of acute conical spines, and the base and apex of the spiculum are each equally crowded with spines. I have arranged it as a defensive spiculum, from its near approximation to the characters of the spiculum last described; but it is subject to the doubt whether it may not ultimately prove to have belonged to the skeleton, as we have in *Halichondria incrustans*, JOHNSTON, entirely spined acuate spicula forming the skeleton, the characters of which are so closely allied to the attenuato-acuate defensive spicula so common in the interior of some sponges, that had we found but a single spiculum of the skeleton of that sponge, we should very naturally have concluded it to have been an internal defensive spiculum.

SPINULO-RECURVO-QUATERNATE.—I have found this remarkable form of spiculum in one sponge only, and I am indebted to my friend Mr. THOMAS INGALL, in whose cabinet it is, for my knowledge of it. They occur in great profusion in the cavities of the sponge, clusters of them consisting frequently of as many as twelve or fifteen radiate from the angles of the reticulations of the skeleton into the interstitial cavities of the sponge. The shaft is stout and cylindrical, with the spherical base of a spinulate spiculum; and in a fully-developed condition the apex is formed of four equiangular attenuated incurved radii (Plate XXIV. fig. 7). The gradual development of this form of spiculum is interesting and very instructive. In an early stage of its development it has the appearance of a slender inequi-biclavate cylindrical spiculum (as represented in Plate XXIV. fig. 4); in the next stage there is a slight indication of the spinulate base, and a corresponding amount of expansion of the apex, but no indication of the radii (Plate XXIV. fig. 5). From this state to the next well-marked stage of growth (represented in Plate XXIV. fig. 6) the progressive development of the radii may be readily traced, and thence to the adult condition represented in Plate XXIV. fig. 7.

In its fully-developed state we find a great increase in its size in every respect; the base becomes fully developed and globular, and the radii elongated to a very considerable extent.

FUSIFORMI-PORRECTO-TERNATE.—These spicula form the greatest portion of the fasciculi of defensive spicula with which the external surface of *Tethea cranium* is armed. They are very long and slender, frequently exceeding a quarter of an inch in length, with a diameter of $\frac{1}{1415}$th of an inch at the thickest portion of the shaft. The ternate radii are projected from the apex of the shaft at about an angle of 20° from its axis, and are about $\frac{1}{150}$th of an inch in length (Plate XXIV. fig. 10). The shafts of these spicula possess a considerable amount of flexibility; and as the central cavities of the radii, excepting at the apices, are often very large, it is probable that they possess flexibility to a certain extent also; and this appears to be the case from the singular contortions that they frequently exhibit. One of these accidents is well represented (Plate XXIII. fig. 1), which exhibits the distal end of one of these spicula. In this case it is evident that a violent downward pressure has bent the ray, while in a young condition, in no less than six different places without destroying it, or indeed materially injuring its efficiency as a means of defence. The slenderness of the shaft of this as well as of the recurvo-ternate spicula which accompany it, as compared with those of the skeleton, which are occasionally protruded along with them, is probably designed by nature to allow of their yielding more or less to pressure from without. If we burn in the flame of a spirit-lamp a thin slice at right angles to the surface of the sponge, so as to consume the whole of the animal matter enveloping the spicula and char that within, the beautiful adaptation of these spicula to their especial office is rendered apparent. When immersed in Canada balsam and viewed by transmitted light with a power of about 150 linear, we often find the lower portion of the spiculum, which was seated in the sponge with a small tubular central cavity which gradually becomes larger, until it occupies by far the greater part of the diameter of the shaft, in that part of it which is projected beyond the dermal membrane, and it terminates in a large bulbous cavity at the base of the ternate radii of the apex. In the mature spicula three small tubular cavities traverse the radii from the base to the apex, having a diameter not exceeding one-tenth of that of the ray at any part, while that of the apex of the shaft occupies about nine-tenths of its diameter at that point; while the defensive points are thus strengthened as much as possible to adapt them to their especial office, the shaft is so constructed as to possess the greatest amount of combined strength and flexibility. Plate XXIV. fig. 11 represents the head of a ternate spiculum thus charred. In less-developed spicula we often find the central cavity of the ternate ray comparatively large and gradually decreasing to the apex, and in older spicula than that first described, the central cavity of the shaft is sometimes comparatively small near its apex; but if so, we generally find that it expands rapidly as we proceed lower, so that in this case it is only a transference of the elasticity to a lower portion of the shaft. Plate XXIV. fig. 8 exhibits the earliest stage of development of the porrecto-ternate head of the spiculum; fig. 9 a more advanced stage of growth; and fig. 10 a mature and fully developed spiculum.

FUSIFORMI-RECURVO-TERNATE SPICULUM.—This form of defensive spiculum occasionally accompanies the porrecto-ternate ones of the defensive fasciculi of *Tethea cranium*. The length and proportions of the shaft of the former is very much the same as those of the latter. The recurvate apex of this spiculum undergoes a progressive development, which does not appear to commence until after a great extent of the length of the slender flexible shaft has been produced, when an enlargement of the apex of the shaft takes place, and the rudiments of the stout recurvate radii appear as represented by fig. 12, Plate XXIV., and between this and the fully-developed form, fig. 13, all the intermediate gradations of development may be observed among the spicula of young specimens of the sponge. The two figures are drawn by the same power, 260 linear, and the difference in size between the young and the fully-developed spiculum is very remarkable.

In the calcareous sponges, *Grantia* of FLEMING, we find the defensive spicula which are projected into the great cloacal cavities emanating from the basal junction of the radii of the ordinary triradiate spicula of the skeleton, and they are frequently of a different form to that of the radii of the skeleton spicula, and in most of the sponges of this class they form very effective specific characters. The production of a spicular ray from the centre of the ordinary triradiate skeleton spiculum often seems to cause an extra development of one or more of the radii of the latter, and occasionally the basal radii are bent or distorted in a manner rarely observed in the simple skeleton spicula.

SPICULATED EQUIANGULATED TRIRADIATE.—When the spicular ray is of the same form and at right angles to the common plane of the basal radii (fig. 14, Plate XXIV.), from *Grantia nivea*, JOHNSTON.

SPICULATED RECTANGULATED TRIRADIATE.—This form of defensive spiculum is occasionally found intermixed with the equiangulated triradiate forms in several species of *Grantia*.

ENSIFORM SPICULATED EQUIANGULATED TRIRADIATE.—The spicular ray is at right angles to the common plane of the basal radii, but not of the same form. In *Grantia ensata*, BOWERBANK, MS., a new species from the Island of Sark, it is very much longer and stouter than the basal radii, and its diameter is considerably increased in the distal third of its length, giving its outline very much the form of an ancient sword (fig. 15, Plate XXIV.). In *Grantia tessellata*, BOWERBANK, MS., a new species from the Island of Sark, the spicular ray is short, very stout, and curved throughout its whole length in the form of a sabre, as represented by fig. 16, Plate XXIV.

EQUIANGULATED SPICULATED TRIPODATE.—When the basal radii are projected backward so that their apices only are in the same plane, and the spicular ray at right angles to that plane. The short spicular ray in this case is not based on a triradiate skeleton one, but the whole spiculum is essentially a defensive one only. They occur in the lining membrane of the cloaca of *Grantia nivea*, and are very minute (fig. 17, Plate XXIV.).

EQUIANGULATED TRIRADIATE: UNIRADIALLY SPINED.—I obtained a considerable number of this form of spiculum from the dissolution in nitric acid of a small fragment of a parasitical sponge, in the collection of the late Mr. CHARLES STOKES. I have not seen it *in situ*, but I have very little doubt from its structure that the spiculated ray is a defensive one, while the two spineless rays formed part of the skeleton (fig. 18, Plate XXIV.).

ATTENUATO-CLAVATE: INCIPIENTLY SPINED.—The enlargement of the base of this spiculum is not spherical as in a spinulate form, but it expands more or less gradually and is usually exaxial. They are projected in abundance into all parts of the interstitial cavities of a new species of British sponge, *Hymeniacidon clavigera*, BOWERBANK, MS. (Plate XXIV. fig. 19).

EQUIANGULAR TRIRADIATE: VERTICILLATELY SPINED.—This beautiful spiculum was found among minute fragments of various sponges scraped from the bases of specimens of *Oculina rosea*. I have never found verticillately spined sponge spicula under any other character than that of defensive spicula, and I have therefore arranged this one as such until further information shall be obtained regarding it (fig. 20, Plate XXIV.). Other forms are frequently found disposed as defensive spicula, but as they do not differ in shape from the skeleton spicula already described and figured, it is unnecessary to figure them again.

Spicula of the Membranes.

There are two distinct classes of spicula appropriated to the membranous tissues of sponges. The office of the first of these is simply to strengthen and support those delicate tissues when necessary, and to communicate to them a certain amount of tension when it is required. The forms are few in number, and their structure comparatively simple.

The office of the second class is that of assisting in the retention of the sarcode on the interstitial and other membranous structures. They are usually minute in size, and often very complicated in form.

I propose to designate these organs as,—

1st. Tension Spicula.
2nd. Retentive Spicula.

Tension Spicula.

In some species of sponges the dermal membrane is without spicula especially appropriated to it, and it then appears, as in *Spongilla fluviatilis*, to be a simple translucent membrane filling up all parts of the network of the external surface of the skeleton, and closely adhering to it; but the membranous areas thus formed are devoid of peculiar forms of spicula. In other cases, as in *Spongilla lacustris*, we find spicula dispersed more or less abundantly over the whole of the surface of the membrane, which are entirely unconnected with the skeleton, and give to the dermal membrane a degree of firmness and tension that it would not otherwise possess. I therefore propose to designate spicula thus occurring in the membranes, whether dermal or interstitial, as tension spicula.

These spicula are sometimes of the same form as those of the skeleton, as in *Halichondria panicea*, JOHNSTON, where we find them thickly, but irregularly dispersed on the inner surface of the dermal membrane; or they have a separate and distinct form, as in *Halichondria incrustans*, JOHNSTON, where they are slender and cylindrical with mucronate terminations, while those of the skeleton are of a stout acerate form. In both cases they are exceedingly numerous, and are evidently designed by nature to strengthen and support the dermal membrane. In the interstitial membranes the same object is frequently attained by the incipient skeleton spicula, and we often find either very young and minute skeleton spicula in the membranous areas of the network of the skeleton, or there will be one or more spicula very little less in size than those of the skeleton, imbedded in the surface of the membrane, but quite unconnected with the surrounding skeleton; or occasionally connected by one termination only, but ultimately by the development of other spicula, becoming incorporated with, and forming part of the skeleton. And it is not in the Halichondraceous sponges only that the tension spicula occur, for we find them abundantly dispersed in the dermal membrane of one of the Turkey sponges of commerce, the honey-comb sponge of dealers, in which siliceous spicula play a very subordinate part in the construction of the skeleton.

FUSIFORMI-ACERATE: ENTIRELY SPINED (Plate XXIV. fig. 21).—This form of spiculum occurs abundantly in the dermal and interstitial membranes of *Spongilla lacustris*, JOHNSTON.

FUSIFORMI-ACERATE: TRUNCATEDLY SPINOUS (Plate XXIV. fig. 22).—Abundant in *Spongilla alba*, CARTER, in both the dermal and interstitial membranes.

MUCRONATO-CYLINDRICAL (Plate XXIV. fig. 23).—The dermal membrane of *Halichondria incrustans*, JOHNSTON, is abundantly furnished with large flat fasciculi of this form of spiculum. They are as long as those of the skeleton, but not above half their diameter; they are entirely destitute of spines, while the spicula of the skeleton are covered with those organs.

TERMINALLY SPINED SUBFUSIFORMI-CYLINDRICAL.—This form of spiculum is abundant in the dermal membrane of *Halichondria nigricans*, BOWERBANK, MS., where it occurs in irregular fasciculi. It is as long as the spicula of the skeleton, but has not quite so great a diameter, and is distinctly different in its form.

TUBERCULATED FUSIFORMI-CYLINDRICAL (Plate XXIV. fig. 24).—These minute spicula are profusely dispersed on the inner surface of the dermal and interstitial membranes of *Pachymatisma Johnstonia.* They are short and stout, and are covered very irregularly with ill-defined tubercles. They vary very considerably in form and proportions. Their average dimensions are, length $\frac{1}{857}$th of an inch, diameter $\frac{1}{5000}$th of an inch.

INFLATO-CYLINDRICAL (Plate XXIV. fig. 25).—This form of spiculum is very minute. It is slightly curved, and has a single, well-defined bulbous inflation near the middle of the shaft, but in this respect, as well as in size, there is, comparatively, a considerable amount of variation. The normal condition of the inflation is equidistant from the ends of the spiculum, but in some cases it is not more than a third of the length of the spiculum from one end of it. The only sponge in which I have found this form is *Halichondria ficus*, JOHNSTON, where it occurs in the dermal membrane in great profusion.

TRICURVATO-ACERATE (Plate XXIV. figs. 26, 27, and 28).—This form of spiculum has always three curves in the course of its length, one at the centre of the shaft, and one near each termination, the terminal ones curving in the same direction, and always opposite to that of the central curve.

These spicula vary greatly in form and proportions in different sponges, and frequently even in the same species. The normal form is that of three curves of about equal value (Plate XXIV. fig. 26), but sometimes, as in fig. 27, the central curve is very much the larger of the three, while in fig. 28 we find the extreme condition of the form, the spiculum being comparatively straight, with a very small curve in the centre of the shaft, and the terminations exhibiting only the rudiments of curves in an opposite direction to the middle one. They are usually very much more slender than the spicula of the skeleton, and are comparatively of rare occurrence in every species in which I have found them. I have never seen them *in situ* with the terminal curves elevated above the surface of the membrane, but always reposing on one side, with all parts of the shaft closely attached to its surface. The three forms figured are from the same specimen of sponge.

UNICURVO-CRUCIFORM (Plate XXIV. fig. 29).—This form occurs abundantly on the membrane lining the great cloacal cavities of *Grantia nivea*, JOHNSTON. The axial radii are disposed very nearly in the direction of the long axis of those organs, and the curves formed by the lunate radii always have their points towards the mouth of the cloaca.

FALCATO-ACERATE (Plate XXIV. fig. 30).—This form is abundant in a small species of *Grantia* from Australia, which is found on several species of Fuci in the collections brought home by Dr. HARVEY. The sponges do not frequently exceed the eighth of an inch in length.

BICURVO-ACERATE (Plate XXIV. fig. 31).—This form is from a small parasitical *Grantia* from Algoa Bay, in my collection. The sponge is about the size of a large pea, and is not uncommon on Zoophytes from that locality.

Foliato-peltate Spicula.

These spicula have the shaft exceedingly short and conical; the basal termination being acute, and the shaft dilating rapidly to its distal end, to the extent of an angle of about 15 or 20 degrees. The apex of the spiculum expands into a large, more or less circular, disc or shield, having in the fully developed state an extremely sinuous or foliated margin; the plane of the shield or disc being at about right angles to the line of the shaft, and having the under side thickly studded with tubercles, which are separate in the young spicula, and more or less confluent in the fully developed ones (Plate XXIV. figs. 32, 33, 34, 35, 36, 37, and 38).

In an early stage of its development, the peltate apex of the spiculum is irregularly circular, and entirely devoid of the complex and beautiful sinuous foliations that render the adult spicula such elegant objects (Plate XXIV. fig. 32). As the development proceeds, it assumes a trilobular shape, and the margins are slightly indented or serrated (fig. 33).

In a further advanced condition, the sinuation of the margin becomes deeper and more complex, as represented in figs. 34 and 35, until at last it becomes, in the fully developed peltate apex, so deeply and irregularly sinuated as nearly to obliterate all traces of its original trilobular character (fig. 36).

Much as their beautiful foliated apices differ from that of an expando-ternate spiculum, they are in reality but an extreme development of that form. If we examine them mounted in Canada balsam, with a linear power of about 300, we frequently find at the junction of the shaft with the inner surface of the disc, the remains of three central tubular cavities radiating from the distal termination of the tubular cavity of the shaft, and extending to about the line of its extreme diameter, or rather beyond, as shown in fig. 32, which represents a nearly circular disc or shield; and in the three-lobed forms in which they are apparent, it will be observed that the axial line of each lobe is conformable with one of the three rudimentary tubular cavities radiating from the distal termination of the shaft. There is good reason therefore to believe that these lobes are due to lateral expansions of the radii of originally a ternate form of spiculum. In other cases we find sometimes one, and at other times two of the radiating central cavities bifurcating at their terminations, as in Plate XXIV. fig. 38, which represents the under surface of a fragment of one of these spicula; and in this case the tubular cavities extend considerably beyond the circumference of the distal end of the shaft. This bifurcation of the radiating tubular cavities is in perfect accordance with the corresponding structures in the furcato-patento-ternate spicula of *Pachymatisma Listeri*, BOWERBANK, MS., as represented in Plate XXIII. figs. 46 and 47. The number of lobes into which the margin of the great apical disc or shield is divided in the adult condition, is exceedingly various, and, as a matter of course, would be influenced, to a certain extent, by the amount of bifurcation of the radial tubular cavities of the apex; and thus it is probably that we find so great a variation in the form and number of the marginal lobes of these beautiful and interesting spicula.

There is some difficulty in deciding whether this singular form of spiculum should be classed with the connecting ones or with those of the dermis. It is found in a very beautiful but minute siliceous sponge, forming a thin film on the base of a specimen of

Oculina rosea from the South Seas, and it is very little more than the eighth of an inch in diameter, the foliato-peltate apices of the spicula forming a tesselated outer surface to the sponge. Whether the foliated expansions were merely covered by, and attached to the dermal membrane during the life of the animal, or whether they occupied similar situations, and served the same purposes as the expando-ternate spicula of *Geodia* and other similarly constructed sponges, cannot be determined at present, as we have the sponge only in the condition of a skeleton, with but a small portion of the internal animal matter remaining. From the great strength and even disposition of the apical plates over the surface of the sponge, I am inclined to believe that they really form an external defence to the sponge, and have been closely covered by, and connected with, the dermal membrane, and I have therefore provisionally classed them with the spicula of the dermis. The expansion of the terminal radii into continuous plates precludes them from the performance of one of the offices of the ternate spicula in *Geodia* and *Pachymatisma*, that of forming areas for the inner terminations of the intermarginal cells; while their expansion renders them admirable substitutes for the large flat fasciculi that strengthen and support the dermal membranes in *Halichondria panicea*, *incrustans*, and other similar sponges.

Retentive Spicula.

In the interior of the sponge we find a series of retentive organs in the various forms of bihamate and anchorate spicula, which exist in large numbers attached to the surfaces of the interstitial membranes. The simplest forms of spicula of this kind are those of the bihamate, in which we have an acerate form of spiculum, bent near each termination into the shape of a hook, the curves being either in the same plane or at right angles to each other, and the terminations being attenuated and acute.

The next gradation of form is similar to the last, excepting that the terminations, instead of being acute, are more or less solid and clavate. We then find the terminations expanding into circular plates; and again, a fuller and more elaborate expansion is found in the anchorate forms of spicula. The whole of these are attached to the sarcodous membranes of the sponge, in such a manner as to become material aids in the retention of the sarcode with which the membranes are furnished.

As the occurrence of one or more of these descriptions of spicula in a sponge often constitutes an important specific character, it is necessary to describe their peculiarities in detail.

SIMPLE BIHAMATE, are acerate spicula having each end of the spiculum curved in the form of a hook in the same plane and towards each other (Plate XXIV. fig. 39).

REVERSED BIHAMATE SPICULA.—Having each end of the spiculum curved in the form of a hook in the same plane, but in opposite directions to each other (Plate XXIV. fig. 40).

CONTORT BIHAMATE SPICULA.—Having each end of the spiculum curved in the form of a hook, but in planes at right angles to each other (Plate XXIV. fig. 41).

Abbreviated bihamate.—The bihamate spicula, especially the simple form, are subject to considerable varieties of size and shape. Sometimes, as in abbreviated bihamate, we have the hooks terminating abruptly immediately beyond the proximal curves, as represented in Plate XXIV. fig. 42. I have found but very few specimens of this form, and in no case *in situ*; and I am therefore in doubt whether it be an adult spiculum, or merely a variety arising from an arrest of development.

Deflected bihamate.—When the hami are both deflected in the same direction at nearly right angles to the plane of the shaft (Plate XXIV. fig. 43).

The variety in the amount of curvature at the middle of the shaft of the spiculum is also very great, as represented in Plate XXIV. figs. 39, 42 and 43, but these variations are not purely accidental; on the contrary, they are more or less constant in each species of sponge, and frequently afford good specific characters.

In the simple bihamate form, where the two hami are curved in the same plane and towards each other, the spiculum, in its natural condition, is usually attached to the surface of the membrane by the middle of the back of the curved shaft, and the two hooks are projected into the sarcode at right angles to the plane of the membrane on which it is based. When the hami are developed reversed or at right angles to each other, one of them is then usually imbedded sideways on the membrane, and the other with the shaft is projected from the plane beneath into the sarcode at various degrees of angle. Or in the deflected form the shaft may be firmly cemented to the membrane by one side, while the hami are both projected upward into the mass of sarcode. In some species of sponge one or the other of these forms more especially prevails, but in others, as in *Halichondria incrustans*, Johnston, the simple, reversed, and contort forms are indiscriminately mixed in the tissues, and they occur in every imaginable form of attachment in great profusion, and accompanied by the anchorate forms as well.

The type of this form of spiculum, the simple bihamate, is not peculiar to the Spongiadæ; it occurs in a much more highly organized class, in a radiate animal, *Echinus sphæra*, Forbes, 'British Starfishes,' where we find an abundance of these organs disposed on the external surface of the tubular suckers of the animal, but they are composed of carbonate of lime instead of silex. I am indebted to my friend Mr. John Howard Stewart for my knowledge of this interesting fact.

Sometimes the simple forms of bihamate spicula have the middle of the shaft umbonate, and this occurrence is subject to three varieties:—

Exter-umbonate.—When the umbo is on the middle of the outer curve of the shaft (Plate XXIV. fig. 44).

Inter-umbonate.—When the umbo is on the middle of the inner curve of the shaft (Plate XXIV. fig. 45).

Bi-umbonate.—When the middle of both the inner and outer curve of the shaft have an umbo (Plate XXIV. fig. 46).

Clavated bihamate.—This singular form of bihamate spiculum was found by Mr. Topping in a small piece of sponge from the coast of Sicily, the terminations of the hami being distended in the form of large round or ovoid masses, as represented in Plate XXIV. figs. 47, 48 and 49. I found the remains of the membranous structures crowded with these very minute spicula, which varied exceedingly in form and in amount of development, and among them were a great variety of other forms of bihamate spicula.

UNICLAVATE BIHAMATE (Plate XXIV. fig. 47), I believe to be an arrest of development rather than a separate form; for although I found many specimens of it intermixed with the biclavate forms, I also found others assuming transitional forms, that appeared ultimately to connect it with the biclavate spicula.

BICLAVATE BIHAMATE (Plate XXIV. figs. 48 and 49).—There is a considerable variation in the shape of this spiculum. The form represented by figure 48 is perhaps the most numerous, but that of figure 49 is the largest and most fully developed.

In a new species of British sponge, *Halichondria Hyndmani*, BOWERBANK, MS., we find another form of expanded termination to the hami, the pocillated bihamate, which gradually leads us to the true anchorate forms.

In the simple form of pocillated bihamate spicula, the terminations of the curved shaft resolve themselves into two nearly equal, circular, concavo-convex plates, the convex surfaces being in each case outward, and the sides of each plate curving considerably towards the other, their planes being at a right angle to the axis of the shaft. In other cases, one cup will be developed with its plane in the same direction as the axis of the shaft, while the other cup is produced with its plane at right angles to the axis and also of the plane of the first cup. In these variations of development, therefore, this form of spiculum may be compared to the simple and contort forms of bihamate spicula; and in truth they differ from them only in this, that in the one the terminations of the hami are attenuated and acute, and in the other they are expanded into concavo-convex discs.

These two modes of development appear to be subject to a considerable amount of variation in the growth of the terminal discs; as in some cases we find the distal part of the terminal plate to consist of a uniform curve, while in other cases the shaft is carried through the centre of that curve, forming, as it were, a supplemental hook. These variations are in perfect accordance with the general laws of development in this class of spicula, as we find, both in the bihamate and anchorate forms, a considerable amount of difference in the structure and position of these organs in the same species of sponge.

UNIPOCILLATED BIHAMATE (Plate XXIV. fig. 50).—One termination fully developed in the form of a cup, while the other is only produced to the extent of the two lateral curves, and a terminal umbo to the shaft.

SIMPLE BIPOCILLATED BIHAMATE (Plate XXIV. fig. 51).—Having both terminations developed in the form of cups in coincident planes.

CONTORT BIPOCILLATED BIHAMATE (Plate XXIV. fig. 52).—Two cups being developed, but in planes at right angles to each other.

Umbonated bipocillated bihamate (Plate XXIV. fig. 53).—Having a slight prolongation of the shaft through the distal edge of one or both of the cups; in this case through the distal edge of the lower one only.

Plate XXIV. fig. 54. A view in profile of a unipocillated spiculum: the upper part of the figure represents a side view of the cup, while the termination of the lower portion is more than usually elongated; showing how the umbonation is produced on the distal edge of the spiculum, represented by fig. 53.

The transition from the pocillated bihamate to the more fully developed and beautiful anchorate spicula is easy and natural. The terminations are more elaborately adapted to their retentive purposes; and the mechanism of the curved bow, with the broad palmate terminations of the anchor, which cost man the accumulated experience and wisdom of ages to bring to perfection, is wonderfully foreshadowed in these beautiful little organs.

Anchorate Spicula.

The anchorate spicula, unlike the bihamate forms, appear never to occur reversed or contorted, but always to present their terminations in the same position as those of the bow of an ordinary ship's anchor. In some sponges they are tolerably uniform in shape and proportions, while in others they vary exceedingly, not only while in course of development, but even in their adult condition; they glide so insensibly from one form into another, that it is difficult to draw a distinction between them; and yet, notwithstanding this latitude in shape and development, they are very characteristic of species, as there are always a sufficient number of fully developed ones that exhibit the normal form.

In almost every case of their occurrence, beside the large and fully developed organs, we find a secondary series accompanying them, which are very much smaller in size, and vary exceedingly both in symmetry and amount of development; and there is every appearance that they are simply abortive developments of the larger and more perfect organs, with which they always appear to agree in their normal characters.

There are two primary divisions of these forms of spicula,—equi-anchorate, when both terminations are produced to an equal extent, as in Plate XXIV. fig. 57, or Plate XXV. figs. 1 and 2, and inequi-anchorate, when the distal termination is largely and fully developed, while the proximal one is, comparatively, produced to a very limited extent, as in Plate XXIV. figs. 55 and 56; each of these is subject, to a certain extent, to similar degrees of further diversity of form, which may be designated bidentate, tridentate and palmate. These forms are in truth but different degrees of development of the normal palmate form; but as we find these variations constant in different species of sponges, it is desirable that they should be separately designated, as they afford excellent specific characters. Thus in *Halichondria granulata*, Bowerbank, MS., a new British sponge, we find large equi-anchorate spicula, in which the lateral expansions of each end of the curved shaft or bow which forms the palmate terminations of the spiculum extend along the shaft towards the middle of the bow, very little beyond the point of curvature forming the basal commencements of the hooks; but although not decurrent on the shaft, the lines of the inner margins are projected forward at an angle of about 45 degrees to the axis of the shaft; and as the outer lines are projected in a corresponding degree, we have the palm produced in the form of two concave conical teeth or palms at each end of the spiculum; and between these there is not the slightest appearance of the ends of the hami, which appear to be equally divided between the terminal palms or teeth. This form I therefore propose to term bidentate equi-anchorate. The same termination occurs among the inequi-anchorate forms; and this mode of the development of the teeth is well shown in the distal or larger portion of the bidentate inequi-anchorate spiculum, represented in Plate XXIV. fig. 55. In other cases the termination of each hook does not thus merge in the teeth, but is carried forward between them either in the form of a simple attenuated termination, as represented in Plate XXIV. fig. 57, or it expands laterally and forms a third intermediate tooth of a hastate form, as represented in Plate XXV. fig. 7. In either of these cases I therefore propose to designate the spiculum as tridentate. In other cases, the lateral expansions forming the palm are continued along the shaft of the spiculum to nearly, or quite, the full extent of the palm, forming a single, undivided, more or less concave termination, as in Plate XXIV. fig. 56. I propose therefore to designate this form as palmato-anchorate; and intermediate forms between the decidedly dentate or palmate ones would be designated as tridentato-palmate (Plate XXV. fig. 7), the palmate form being in excess of the dentate structure; or palmato- tri- or bi-dentate, when the teeth are in the ascendant.

Generally speaking, the ends of the shaft of each anchorate spiculum either become obsolete at the base of the teeth, as in bidentate forms, or they are continued in a regular curve, forming the third tooth, as in the tridentate form; but in some cases, as in *Halichondria plumosa*, JOHNSTON, the shaft appears to terminate abruptly at each end, and the palms or teeth are projected towards each other at a sharp angle to the ends of the shaft or bow of the spiculum: in this case we should term the spiculum angulated anchorate, as represented in Plate XXV. figs. 1, 2 and 3.

The anchorate spicula are not, like the acerate, acuate and other simple forms, of the same shape, or nearly so, from the commencement to the termination of their growth, but, on the contrary, they are developed progressively.

In a new species of *Halichondria*, for which I am indebted to my friend Mr. THOMAS INGALL, the course of their development is displayed in a very interesting and instructive manner. The first condition in which we detect them, is in the form of an exceedingly slender and elongated simple bihamate spiculum, which is readily distinguished from the true bihamate form by the straightness of the shaft, the comparative shortness of the hami, and the obtuseness of their terminations, as represented in Plate XXV. fig. 4. We next find the same form increased in strength, and with slight lateral fimbriæ near each end of the shaft at the commencement of the hami, as in Plate XXV. fig. 5. In a more advanced stage we find a regularly curved extension of the fimbriæ, slightly so at one extremity of the shaft, and considerably so at the other; and as the development progresses, the curves of the fimbriæ are extended in an outward direction, and become angular; the extremities of the hami expand laterally and assume a foliated appearance, as seen in the distal or larger end especially (Plate XXV. fig. 6); but the fimbriæ at the smallest or proximal end of the spiculum, and the foliated extremity of the adjoining hamus, are still separated from each other; and this progressive development may be observed in all its stages, until the connexion of the parts is completed, and the fully developed form represented in Plate XXV. fig. 7, is produced. The same progressive development of this form of spiculum may be traced in those of *Halichondria lingua*, Bowerbank, MS., a new species of British sponge from the Hebrides.

In the performance of their natural office in the sponge, we find the same laws of attachment and projection obtain that I have described in treating of the bihamate spicula. In the equi-anchorate forms, where the terminal palms or teeth are equally developed, the shaft is attached by the middle of the external curve; but in the inequi-anchorate forms, where one palm is developed to a very much greater extent than the other, we find the smaller one is attached to the membrane, and the larger is projected at about an angle of 45 degrees. Generally speaking, the anchorate spicula, like the bihamate ones, are irregularly dispersed over the surface of the membranes, but occasionally, as in *Halichondria lingua*, they are developed in circles or rosette-formed groups.

As may be imagined, from their office and situation in a thin stratum of a gelatinoid sarcode, they are at all times small, and in many cases so minute as to require a microscopic power of at least 600 linear to render their structure distinctly visible. They occur in all parts of the sarcodous surface of the interior of the sponge, and are frequently found in greater profusion than usual on the inner or sarcodous surface of the dermal membrane; but I do not recollect an instance of their occurrence on the outer surface of that organ, while on the sarcodous or interstitial membranes they are frequently to be observed in about equal proportions on both sides of the same membrane.

It will not be necessary to describe or figure the whole of these variable forms of spicula. I have therefore selected those only that may be considered more especially as type forms.

Tridentate equi-anchorate (Plate XXIV. fig. 57).—Having each termination equally and fully developed, in the form of two lateral and slightly palmate, and one central attenuated tooth. From an undescribed sponge in the collection of Mr. George Shadbolt: $\times 660$.

Bidentate inequi-anchorate (Plate XXIV. fig. 55).—Each termination divided into two distinct teeth, the distal ones being largely and fully developed, while the proximal ones are but slightly produced. From an undescribed sponge from the coast of Sicily: $\times 660$.

Palmated inequi-anchorate (Plate XXIV. fig. 56).—Having the distal termination largely developed in the form of a cordate palm, while the proximal end is produced to a much less extent, is compressed laterally, and has the terminal point expanded into a short broad tooth.

DENTATO-PALMATE INEQUI-ANCHORATE (Plate XXIV. fig. 58).—Having the distal spatulate palm produced to the extent of about half the length of the spiculum, while the proximal one is developed in the same form to only about one-fourth the length of the spiculum, and having the apices of the hami produced beyond the extremities of the palms, each in the form of a short obtuse tooth. From *Spongia lobata*, MONTAGU, in the collection of Professor GRANT: $\times 1060$.

DENTATO-PALMATE ANGULATED ANCHORATE (Plate XXV. figs. 1, 2, 3).—I have found this form of spiculum only in *Spongia plumosa*, MONTAGU. Each of the hami appear as if forcibly compressed towards the termination of the shaft, which seems to have been equally influenced by the compression, so that the hami have become angulated, as represented in the profile view of one of the spicula (Plate XXV. fig. 3). The whole of the spicula are dentato-palmate, and the adult ones have the terminations of the hami strongly produced, as represented in Plate XXV. fig. 1; while in the immature spicula, although the palms are fully produced, the tooth appears in a rudimentary condition, as in Plate XXV. fig. 2.

Spicula of the Sarcode.

As the tension spicula of the membranes are destined to strengthen and support those tissues, so the numerous and beautiful tribe of stellate spicula appear to be devoted to connect and give substance to the gelatinoid sarcode, which so abundantly covers the whole of the interior membranous structures of the sponges in which they occur. It is difficult at first sight to determine the difference in the office of this class of spicula and those of the internal retentive ones; and it is probable that in some cases, when it so happens that the radii of the stellate forms rest on, and become cemented to the membranous structures, they may perform, to a certain extent, the same function, that of assisting to connect the membranes and sarcodous structures more firmly together. But generally speaking this is not the case, and especially with the smaller forms of these organs; for in comparatively thick layers of sarcode we find them in all parts, and manifestly unconnected with the membranes beneath; and in sponges which have undergone such an amount of decomposition as to leave the membranous structures entirely or very nearly free from sarcode, while we see the retentive forms remaining firmly attached to the membranes, we rarely find the stellate ones, excepting when entangled among the surrounding spicula of the skeleton. We may therefore reasonably conclude, that their normal function is that of increasing the strength and substance of the sarcodous structure of the sponge.

In the performance of this office of strengthening and supporting the sarcode, we find a singular class of spicula, consisting of from three to six rays, emanating from a common centre, and always disposed at right angles to each other. Between the extreme forms of development of these and the simple stellate spicula, there is a very great amount of structural difference; but on a more intimate acquaintance with the intermediate forms, we find them passing into each other so gradually as finally to connect the whole into one group.

Simple Stellate Spicula.

Stellate spicula are composed of few or many radii emanating from a centre in all directions. Their simplest form is when the bases of the radii all proceed from a common central point (Plate XXV. fig. 9), in which case they should be designated simply stellate spicula; but when the radii spring separately and distinctly from a common central spherical or oval base, they should be designated sphero-stellate spicula (Plate XXV. figs. 13, 16, 17). In both these classes of spicula there is a very considerable difference in their size and form, in the various species of sponges in which they occur.

ATTENUATO-STELLATE (Plate XXV. fig. 9).—Having the radii gradually attenuated from the base to the apex.

Pachymatisma Johnstonia, BOWERBANK, affords a large and very excellent type of this form of spiculum. The radii vary from three to seven or eight, but five or six rays are the most common numbers. *Geodia gibberosa*, the type species of LAMARCK'S genus, also affords an excellent example of this form of spiculum.

CYLINDRO-STELLATE (Plate XXV. fig. 10).—Having the radii of equal diameter throughout and terminating hemispherically: from *Pachymatisma Johnstonia*, BOWERBANK.

This form also occurs abundantly in *Tethea robusta*, BOWERBANK, MS. The sponge is in the British Museum, and was brought from Australia by Mr. S. STUTCHBURY. The form and proportions of these spicula vary considerably; sometimes the distal terminations of the radii are slightly inclined to be clavate, and at others there is a gradual transition from simply stellate to subsphero-stellate. The radii are also in some of the larger specimens slightly inclined to attenuation.

CRASSATO-CYLINDRO-STELLATE (Plate XXV. fig. 11).—This spiculum is remarkable from its having the radii twice as broad as they are thick, and their distal terminations abruptly truncated. It occurs intermixed with the more regular forms of cylindro-stellate in *Tethea robusta*.

CLAVATED SUBSPHERO-STELLATE (Plate XXV. fig. 12).—The cylindrical radii having the distal terminations more or less dilated, and the central basal sphere not exceeding in diameter the length of one of the radii. This form of spiculum is very abundant in *Tethea Ingalli*, BOWERBANK, MS., intermingled with attenuato-cylindro-stellate spicula.

CLAVATED SPHERO-STELLATE (Plate XXV. fig. 13).—The cylindrical radii having the distal terminations dilated, and the central basal sphere greater in its diameter than the length of one of the rays. This spiculum is abundant in the sarcode of the dermal and interstitial membranes of *Geodia Barretti*, BOWERBANK, MS. It is very minute, the extreme diameter varying from $\frac{1}{3000}$th to $\frac{1}{7000}$th of an inch.

SUBSPHERO-STELLATE (Plate XXV. fig. 14).—Having the radii more or less acutely conical, and as long or longer than the diameter of the central basal sphere: from

Tethea Ingalli, Bowerbank, MS. In this sponge and in other species this form occasionally presents a very gradual transition from the purely stellate form to the full subsphero-stellate one, in which the radii and the spherical centre are of about equal length, while in the fully developed sphero-stellate forms this graduation is never seen.

Sphero-stellate (Plate XXV. fig. 15).—Having the radii acutely conical and based on a large central sphere of greater diameter than the length of the radii. *Tethea robusta*, Bowerbank, MS., a new species from Australia, in the British Museum, presents an excellent type of this form of spiculum. As the central nucleus appears, under favourable circumstances, we distinctly trace a central canal in each ray, passing from the centre of the sphere to near the distal termination of each of the radii, as represented in Plate XXV. fig. 17. These canals are not usually apparent in the perfect spicula, probably in consequence of the fluid being hermetically sealed within the canals of the radii, but I could not determine the presence of the fluid by polarized light.

Sphero-stellate with cylindro-subfoliate radii (Plate XXV. fig. 16).—Having the cylindrical radii slightly expanded and somewhat foliated at the distal extremities. This remarkable form was obtained by washing some specimens of *Oculina rosea*, from the South Sea, and there is little doubt of its being from an unknown species of *Tethea*.

Elongo-attenuato-stellate (Plate XXV. fig. 18).—Having the radii springing from an elongated instead of a central base. This form of spiculum occurs abundantly in *Tethea muricata*, Bowerbank, MS.: from Vigten Island, Norway.

Arborescent elongo-subsphero-stellate (Plate XXV. fig. 19).—Having the radii springing from a dilated and elongated common base of about the dimensions of two subsphero-stellate spicula, partially fused together.

This remarkable form occurs abundantly in *Geodia carinata*, Bowerbank, MS., from the South Sea. The nucleus, whence the radii proceed, is always more or less elongated, but is not usually so much dilated as in the specimen figured. The arborescent character of the distal terminations of the radii is also very variable.

Pileated cylindro-stellate (Plate XXV. figs. 20, 21, 22 and 23).—Having several recurved spines uniting and forming a pileus at the apex of the ray, shaped like that of a young mushroom. These singularly variable spicula are abundant in *Spongilla plumosa*, Carter. They are remarkable as affording a series of transitional forms from a single straight spiculum to the regular multiradiate stellate one. Fig. 20 represents, about the first stage of variation from the simple elongate spinous spiculum, a few rather strongly produced cylindrical spines appearing near the middle of the shaft. In fig. 21 two of these spines are considerably more elongated than those in fig. 20, and the shaft is not so long as that of fig. 20. In fig. 22 the axial shaft is still more curtailed in its proportions, and the central radii are further elongated and increased in number; and in fig. 23 we find the axial spiculum scarcely distinguishable from the lateral rays. When the radii projected are few in number, they are usually at right angles to the axial spiculum; but when they are produced in greater numbers, they are projected at various angles, and the axial spiculum can scarcely be detected. In spicula having numerous radii, they frequently unite at their bases, and produce their extreme variation of form, a subsphero-stellate spiculum. No two of these singular spicula are alike, and they present every imaginable variation in the mode of their development. In their origin from an axial spiculum, and in their tendency to the projection of secondary radii at right angles to that axis, these spicula form a connecting link between the simple multiradiate forms and the more complicated ones belonging to the next division of the subject.

Compound Stellate Spicula.

The curious and beautiful forms of this series of spicula all belong to the class of sponges that have a skeleton composed of siliceous fibre, and they are principally from tropical climates. The central basal structure from which the radii are projected, in every case with which I am acquainted, is a rectangulated hexradiate spiculum, from the apices of which a variety of beautiful terminations are projected, which vary in form exceedingly in different species of sponges. In the class of sponges to which I have alluded there are also numerous rectangulated spicula, varying in the number of radii from three to six, the apices of the radii being either acutely terminated or more or less clavated, and these forms vary very much in size. They are unconnected with the skeleton, and evidently belong to the Sarcodous system of the sponge. They are very much larger than the hexradiate centres of the compound stellate spicula, but as they are evidently the normal forms of that tribe, I shall describe the general characters of these large, simple, hexradiate forms before those of the more complicated stellate ones.

ATTENUATED RECTANGULATED HEXRADIATE (Plate XXV. fig. 32).—The first state in which we find them is in that of an inequi-acerate spiculum (Plate XXV. fig. 24), in which condition they are in fact the two axial radii of the hexradiate form which they ultimately attain when in their fullest state of development. In the next stage we find a bud-like projection issuing from the side of the thickest portion of the inequi-acerate spiculum (fig. 25), which is ultimately developed in the form of a rectangulated triradiate spiculum, as in fig. 28. Or two buds are simultaneously projected, as in figs. 26 and 27, and the result is a regular rectangulated quadriradiate form, as in fig 30. Or if the second ray be at a right angle to the one first projected, the result is an irregular quadriradiate figure, as represented by fig. 29. In like manner the irregular pentradiate form arises from the absence of one of the four secondary rays, as in fig. 31; or it sometimes occurs that the apical portion of the inequi-acerate axial spiculum is deficient, and then the result is, as represented by fig. 33, a regular pentradiate form. If the whole of the radii are equally produced, the result is then the regular attenuated rectangulated hexradiate spiculum, fig. 32.

Sometimes, but rarely, we find a single ray more or less spinous at its distal end; in this case it is probable that it was attached by that point to the membranous structure, or to some part of the keratode of the skeleton.

The whole of these interesting spicula were obtained from Mr. CUMING'S specimen of

Euplectella aspergillum. They are abundant in that sponge, frequently filling up the interstices of the network of the siliceous skeleton, or otherwise entangled in the tissues. In Dr. A. FARRE'S specimen of *Euplectella* they are equally abundant, and are not to be distinguished from those in Mr. CUMING'S specimen. They are, like the great external prehensile spicula, and the fibre of the skeleton, composed of numerous concentric layers of silex, which readily separate from each other by decomposition.

I cannot say with absolute certainty that this tribe of spicula belong really to the sarcode, as I have never seen specimens of either of the species I have named, in which they occur in profusion, in such a state of preservation as to allow of their position being positively determined; but as in another specimen of sponge with a siliceous skeleton like that of *Dactylocalyx pumicea*, STUTCHBURY, the sarcode is preserved in excellent condition, and occurs in such abundance, filling all the interstices of the skeleton of the sponge, and affording ample space for the imbedment of such spicula in its substance, I am, therefore, induced to think it probable that a similar abundance of sarcode may exist in *Dactylocalyx* and other similarly constituted sponges, and that hereafter even the largest of this tribe of spicula will be found completely imbedded in the sarcode.

SLENDER ATTENUATED RECTANGULATED HEXRADIATE (Plate XXV. fig. 34).—Beside the large and stout attenuato-hexradiate spicula in *Euplectella aspergillum*, there are comparatively small and very slender ones, many of which are nearly of the same proportions as the larger ones; but generally speaking the axial radii are more elongated, and in some cases the basal end is extended to four or six times the length of the apical portion.

These spicula do not present the same irregularity in their development that we observe in the stout ones, and it is a rare occurrence to find one without the full number of rays. They are exceedingly numerous in the sponge, and they occur in closely packed fasciculi, the axes of the spicula nearly touching each other. Amidst these fasciculi we find the large stout forms imbedded, the whole of them apparently having been completely enveloped by the sarcode of the sponge.

CYLINDRO-RECTANGULATED HEXRADIATE: APICALLY SPINED (Plate XXV. fig. 35).—This form is very abundant in an undescribed species of *Euplectella* in the Museum of the Jardin des Plantes, Paris. The figure represents the upper portion of the spiculum only, the lower portion of the axial shaft being exceedingly elongated. When examined with a power of 400 linear, the apices of the radii are seen to be abundantly, but minutely spined. The axial shaft of this spiculum without any of the lateral radii developed, is also abundant; it is exceedingly long, and at the proper distance below the apex we often observe a gradual enlargement of the diameter, as represented in fig. 37, and the rudimentary canals for the lateral radii are frequently apparent.

This form of spiculum is also very abundant in *Dactylocalyx pumicea*, STUTCHBURY, *Iphiteon* of the French Museum. In general character they are very similar to those of the *Euplectella* described above, with the addition of the apices of the radii being more or less clavated.

All the simple rectangulated hexradiate forms of spicula hitherto described are large, compared with the rectangulated hexradiate spicula which form the central bases of the compound stellate forms, and excepting the disparity in size, the transition from the last form described, to the complicated and beautiful compound stellate ones, is easy and natural; the apices of the hexradiate form becoming the bases of the numerous radii of the stellate ones. This transition from the simple to the compound forms is admirably illustrated in a bifurcated spiculum that occurs in the new species of *Euplectella* in the Museum of the Jardin des Plantes, which I propose to designate as follows:—

BIFURCATED RECTANGULATED HEXRADIATE STELLATE (Plate XXV. fig. 38).—It is minute and slender, and the bifurcating rays are irregular, often tortuous, and are frequently not produced on one or two of the primary radii. These indecisive characters, common to all the specimens of this form of spiculum that I have seen, combined with the elongate characters of the radii, seem strongly to mark this spiculum as the connecting link between the simple hexradiate and the compound stellate forms of spicula.

TRIFURCATO-HEXRADIATE STELLATE (Plate XXV. fig. 39).—The central radii consist of six rectangulated primary rays of equal length, each of which terminates in three equidistant secondary attenuating rays, which are projected from the apices of the primary ones at an angle of about 45 degrees to the common basal, or primary ray.

These spicula occur in abundance in *Euplectella aspergillum*, OWEN, and in *Dactylocalyx pumicea*, STUTCHBURY. I observed them first in some fragments of the magnificent specimen of *D. pumicea*, half of which is in the possession of Dr. J. E. GRAY; and the other half is, I believe, in the Museum of the Bristol Institution; and subsequently in a second specimen in the possession of my friend Mr. THOMAS INGALL, in whose sponge there are remains of the sarcodous structure, which is literally crowded with them and the spinulo-hexradiate stellate ones. They are also abundant in a specimen of, I believe, a different species in the Museum of the Jardin des Plantes at Paris, where the sponge is designated *Iphiteon*. There is a slight difference in the form and mode of radiation of the secondary rays in the specimens of these spicula that occur in Mr. CUMING's beautiful specimen of *Euplectella aspergillum* and those from *Dactylocalyx*, and they are not in the former species accompanied by the spinulo-hexradiate ones, as in *Dactylocalyx pumicea*. In my friend Dr. A. FARRE's beautiful specimen of *Euplectella* they are to be found, but not so abundantly as in Mr. CUMING's sponge, but they are of precisely the same form as the spicula from that specimen.

SPINULO-TRIFURCATED HEXRADIATE STELLATE (Plate XXVI. fig. 1).—The central radii consist of six rectangular primary rays of equal length, each of which terminates in three equidistant cylindro-spinulate radii, projected from the apices of the primary ones at an angle of about 45 degrees to the axis of the common basal primary ray.

Occasionally we find four secondary radii in place of three, but this is not of common occurrence; and in the fully developed spicula the spinulate terminations are usually not globular, but of a more or less depressed form. This spiculum I have found only in

Dactylocalyx pumicea, intermingled with the trifurcato-attenuato-hexradiate spicula, and it appears to be even more abundant than the last-named form.

SPINULO-QUADRIFURCATE HEXRADIATE STELLATE (Plate XXVI. fig. 2.).—A rectangulated hexradiate spiculum, having each primary ray terminating in four nearly equidistant cylindro-spinulate secondary radii.

These spicula occur abundantly in a beautiful and unique specimen of a cup-shaped siliceo-fibrous sponge in the cabinet of my friend Mr. THOMAS INGALL. The remains of the sarcode are crowded with them in a perfect state of preservation. The specimen represented by figure 2 has had three of its primary radii broken off near their common base, thus enabling us to see distinctly the structure of this curious and beautiful form of spiculum.

FLORICOMO-HEXRADIATE (Plate XXVI. figs. 3 and 4).—The central radii consist of six rectangulated primary rays of equal length, with slightly expanded terminations, from each of which there issue seven or more petaloid secondary spicula, the whole forming one of the most beautiful simulations of a flower imaginable.

Each petaloid spiculum is slender at its proximal termination, and continues to be so until near its distal end, where it expands laterally, and presents a nearly semicircular concavo-convex termination, with a beautiful dentate margin, the number of the dents being usually seven. Each of the petaloid spicula curves gently outward from its base, the flowing line returning towards the central axis of the flower at about half of its height from the base, and then it again curves outward, until the apical expansion is at right angles to the floral axis; so that the whole resolves itself into a form like that of the flower of a Jasmin. The beautiful terminal petaloid expansions, with their regularly disposed marginal dents, renders the illusion complete; the united basal curves looking as if they had been produced by the swelling ovarium of a flower.

I have obtained a considerable number of these elegant spicula from my friend Mr. CUMING's beautiful specimen of *Euplectella aspergillum*, which, with his accustomed liberality, he placed at my disposal for examination. They are found also in Dr. A. FARRE's specimen of *Euplectella*, agreeing in every respect with those from Mr. CUMING's sponge.

CORONATO-HEXRADIATE STELLATE (Plate XXVI. fig. 5).—The central radii consist of six rectangulated primary rays of equal length, each terminating in a discoid expansion, the margin of which is furnished with numerous curved petaloid radii.

I obtained this beautiful but very minute spiculum through the kindness of Professors MILNE-EDWARDS and VALENCIENNES, from a specimen of *Euplectella* in the Museum of the Jardin des Plantes, Paris, in which there are two of these beautiful sponges, one being in a much better state of preservation than the other, and in the mutilated specimen this beautiful form was found.

The spiculum is evidently not in a perfect state of preservation, as there are only four rays out of the six present; but at the centre of the spiculum there is the indication of the former existence of one of the two missing radii. The coronal terminations are very like the receptacle of the great common Helianthus or Sun-flower, and the marginal radii resemble the petals of the same flower, but are somewhat longer in their proportions. The spiculum is very minute, the extreme diameter measuring $\frac{1}{1132}$ of an inch, and the diameter of the largest coronal termination $\frac{1}{3571}$ of an inch.

Pocillated hexradiate stellate (Plate XXVI. fig. 6).—The central radii consist of six rectangulated primary rays of equal length, each terminating in a concavo-convex disc or cup, the convex surface being outward.

I found this extremely minute form entangled in the tissues of a specimen of *Halichondria incrustans*, dredged up by my friend Mr. McAndrew at the Orkney Islands, and it is probably from one of the small species of *Euplectella* that are found in the North Sea.

The specimen has shifted in the slide in which it is mounted into so oblique a position, that the accuracy of the size only can be depended upon. But when first observed, immediately after it was mounted, I obtained a very satisfactory view of its structure, and made a rough sketch of it at the time, and from this and from its projection by the camera lucida at the present period, the drawing of it has been made. There are four only of the radii remaining, and its hexradiate form is therefore only surmised on the strength of its affinity to more perfect specimens of that type of form. It is the most minute spiculum of this description that I have seen; the extreme diameter of the distal ends of the opposite radii measured only $\frac{1}{2143}$ of an inch.

Beside the stellate and hexradiate forms of spicula, there are a few others found in the sarcode which do not appear to be constructively connected with either of those groups.

Attenuato-rectangulated triradiate: apically spined (Plate XXVI. fig. 7).—This form is not, as it might be hastily surmised, the triradiate stage of development of a hexradiate spiculum. It is larger in every respect than the slender variety of the hexradiate form, and less stout, but much longer than the stout variety of the hexradiate form previously described; and although intermingled with them and the other forms of spicula in *Euplectella aspergillum*, it is always readily to be distinguished by an experienced observer.

The spines are small but thickly dispersed over the apices of the radii for a short way down the shaft, and occasionally the apices of the radii are more or less clavate.

Cylindro-rectangulated triradiate.—This form of spiculum is abundant in *Dactylocalyx pumicea*, Stutchbury. The basal axial ray is often very much elongated. The radii are also incipiently spined, and their apices are more or less spinulate or clavate. The form of this spiculum is precisely that of fig. 7, Plate XXVI., excepting that the radii are cylindrical instead of attenuated.

Spiculated biternate (Plate XXVI. figs. 8 and 9).—I found several of these spicula in the dust shaken from the siliceo-fibrous massive sponge at the base of my friend Dr. A. Farre's specimen of *Euplectella cucumer*, Owen, and I have no doubt of their belonging to the sarcode of the sponge at its base. They appear to vary greatly in the amount of their development. In figure 8 the biternate spicula are simple, and it is spiculated at one end only. Some of them were similar to figure 8, but were spiculated at both ends; while in others, one or more of the rays have their terminations bifurcated as in figure 9, which represents a spiculum with the greatest number of bifurcated radii that I have yet seen. They vary also considerably in size; the simpler of the two forms, figure 8, being much larger than that represented by figure 9.

MULTIANGULATED CYLINDRICAL (Plate XXVI. fig. 10).—This singular little form of spiculum occurs abundantly in the sarcode of *Geodia carinata*, BOWERBANK, MS. It is angulated alternately in opposite directions, at regular distances, from two to six or seven times. It is extremely minute; a full-sized five-angled one measuring in length $\frac{1}{1304}$th of an inch, and diameter of shaft $\frac{1}{16666}$th of an inch. It is difficult to decide whether this should not be considered as belonging to the membranes; but its extreme minuteness is not in favour of that supposition, and in carefully focusing the specimens of the spicula *in situ*, no two appear to be imbedded in the same plane above the interstitial membranes, where they are to be observed best. I have therefore considered it as belonging to the sarcodous rather than to the membranous structures*.

Spicula of the Gemmules.

The spicula appropriated to the gemmules of sponges occur in various modes of disposition.

1st. They are imbedded irregularly in an external envelope of the gemmule, or on the surface of the gemmule itself, at right angles to lines radiating from its centre.

2ndly. They are arranged symmetrically in the crust of the gemmule parallel to lines radiating from its centre.

3rdly. They are disposed in fasciculi in the substance of the gemmule, from the centre to the circumference.

In the first mode of disposition they are sometimes of the same form as those of the skeleton, but considerably less both in length and diameter, to adapt them to the office they have to perform. In other cases they differ materially in both size and form from those of the surrounding skeleton; but in every case with which I am acquainted, their long axes are parallel to the outer surface of the case of the gemmule, or to the surface of the gemmule itself.

In the second mode of disposition they are immersed in the comparatively thick crust of the gemmule, their long axes being always at right angles to lines radiating from its centre to its circumference. Their forms become widely different from those of the skeleton spicula, and especially adapted to their peculiar office; and their terminations frequently expand into broad plates, as in *Spongilla fluviatilis*, JOHNSTON. Their forms vary considerably in shape and structure in different species. In the gemmules of some sponges, one of these modes of the disposition of their spicula only can be observed.

* Since the above description was written, I have found in a sponge from the Mauritius specimens of this form of spiculum, both simple and strongly spinous, with seven angulations, and very much larger and longer than the one figured.

Thus in *Spongilla lacustris*, JOHNSTON, we find the elongate form of spicula, and in *Spongilla fluviatilis*, JOHNSTON, the birotulate form; while in *Spongilla gregaria*, BOWERBANK, MS., we find both; the first occurring on the outer surface of the coat of the gemmule, and the second immersed in the crust at its inner surface.

In the third mode of arrangement, where the spicula abound in every part of the gemmule, as in *Tethea cranium*, JOHNSTON, they are various in form, but resemble to a considerable extent those of the skeleton, with an intermixture of forms peculiar to the gemmule. I shall therefore describe these organs in the order in which I have enumerated their modes of occurrence.

1st. SPICULA ELONGATE, DISPOSED AT RIGHT ANGLES TO LINES RADIATING FROM THE CENTRE OF THE GEMMULE TO ITS SURFACE.

ACERATE (Plate XXVI. figs. 11 and 12).—This form occurs abundantly in the envelope of the gemmule of *Spongilla Carteri*, BOWERBANK, MS., or *Sp. friabilis*, CARTER, from the water-tanks of Bombay; and in *Sp. Brownii*, BOWERBANK, MS., from the River Amazon. In both these species the spicula of the gemmules agree in form with those of their respective skeletons, but are not more than half their size. Fig. 11, a spiculum of the envelope of the gemmule of *Spongilla Carteri*. Fig. 12, a spiculum of the envelope of the gemmule of *Spongilla Brownii*.

SUBARCUATE ACERATE: ENTIRELY SPINED (Plate XXVI. fig. 13).—The envelope of the gemmule of *Spongilla lacustris*, JOHNSTON, abounds in this form. The length and mode of spination of these spicula are nearly the same in all of them, but the amount of curvature varies from nearly straight to nearly a semicircle, as represented by fig. 13; and in one case the terminations of the spiculum have crossed each other, forming a loop. In some sponges the spicula of the gemmules agree in form with those of the dermal membrane, but this is not the case in the present instance, those of the membrane being slender fusiformi-acerate.

FUSIFORMI-ACERATE: ENTIRELY SPINED, SPINES CYLINDRICAL (Plate XXVI. fig. 14).—These spicula are long, slender, and very slightly curved; they are dispersed abundantly in the envelope of the gemmule of *Spongilla Batei*, BOWERBANK, MS., from the River Amazon.

The spination of the spiculum is very remarkable; those near the middle of the shaft are frequently of a length equal to half or two-thirds the greatest diameter of the spiculum on which they are based. They are of the same diameter from the base to the apex, and terminate as abruptly as if they had been truncated.

ACERATE: ENTIRELY SPINED, SPINES CONICAL (Plate XXVI. fig. 15).—This form of spiculum occurs in the envelope of the gemmule of *Spongilla cinerea*, CARTER. It is very abundant and somewhat minute, and requires a linear power of about 600 to define it accurately. The spines are very numerous, and all of them appear to pass from the spiculum at right angles to its axis. The largest of them is about one-third the length of the greatest diameter of the spiculum.

CYLINDRICAL: INCIPIENTLY SPINED (Plate XXVI. fig. 16). This short stout form of spiculum occurs abundantly in the envelope of *Spongilla gregaria*, BOWERBANK, MS., from the River Amazon. It is usually without spines, but occasionally a few incipient ones are dispersed over the shaft.

CYLINDRICAL: ENTIRELY AND RECURVEDLY SPINOUS (Plate XXVI. fig. 17).—This large and beautiful form of spiculum is abundant in the envelope of the gemmule of *Spongilla alba*, CARTER. It has a considerable amount of curvature, and the spination is remarkably bold and striking. Very few of the spines issue from the shaft at right angles to its axis, and these are always near its middle; the remainder of the spines are all curved from the apices of the spiculum towards the middle of the shaft. The spines are congregated in considerable numbers at each termination of the spiculum, and are larger and more curved there than on any other part of the shaft.

CYLINDRICAL: ENTIRELY SPINED; SPINES OF THE MIDDLE CYLINDRICAL, THOSE OF THE TERMINATIONS CONICAL AND RECURVED.—These spicula might readily be mistaken by a hasty observer for those of *Spongilla alba*, but a closer observation exhibits essential differences in their mode of spination. The spines are distributed over the whole of the spiculum, and are rather more numerous at the terminations than towards the middle of the shaft. At the ends of the spiculum the spines are conical, acutely terminated, and are recurved towards the middle of the shaft; but near the middle of the spiculum the spines are cylindrical, stout, obtusely terminated, and occasionally expanded or branched. They are very numerous in the envelope of the gemmule of *Spongilla cinerea*, CARTER, from the water-tanks of Bombay. They are so nearly of the same form as those represented in Plate XXIV. fig. 17, as to render it unnecessary to figure them.

2nd. SPICULA DISPOSED IN LINES RADIATING FROM THE CENTRE TO THE CIRCUMFERENCE OF THE GEMMULE.

Birotulate and Boletiform Spicula.

The whole of this beautiful group of spicula occur in the thick coriaceous proper coat of the gemmules of the Spongilladæ. Sometimes we have but one form thus located, as in *Spongilla fluviatilis*, JOHNSTON, where we find them very close together in the case of the gemmule, the outer rotula supporting the external membrane, and the inner one performing the same office for the internal one. At other times we find two distinct forms in the coat of the gemmule, as in *Spongilla recurvata*, BOWERBANK, MS., from the River Amazon; the inner one being slender boletiform, and the outer one multihamate birotulate. In every case these spicula are so completely immersed in the thick coriaceous coat of the gemmule, that they are perfectly invisible under ordinary circumstances; and it is only after the gemmule has been boiled in nitric acid for a very short period, that it is rendered sufficiently transparent to allow of the spicula being seen *in situ*.

The progressive development of these forms of spicula is very beautifully exhibited in the spicula from the gemmules of *Spongilla plumosa*, CARTER. We first observe them, with a linear power of 660, in the shape of slender, smooth, cylindrical spicula, with a slight enlargement at each termination, and without the slightest indication of spines on the shaft; and in this condition the central cavity is large, occupying about one-third of its diameter (Plate XXVI. fig. 18). In the second stage, the only alteration in its form is an enlargement of the terminations, the edges assuming an angular shape, and a few slender spines are observable (Plate XXVI. fig. 19). In the third stage of development the terminations assume the form of distinct circular plates or incipient rotulæ, the margins of which are slightly crenate; the shaft exhibits numerous long slender spines, and the central cavity now does not occupy more than one-fifth of the diameter of the spiculum (Plate XXVI. fig. 20). From this form specimens in every stage of development may be readily traced, until the strongly spinous margin, the prominent convexity of the rotulæ, and the robust shaft with its long conical spines, indicate the completely adult condition of the spiculum, and in this state the central cavity can very rarely be seen (Plate XXVI. fig. 21).

The growth of these spicula in their early stages is probably very rapid, as the number of those in the first and second stages is remarkably small as compared with those in the third and subsequent stages.

In the inequi-birotulate spicula of *Spongilla paulula*, BOWERBANK, MS., we find a number of radial canals passing from each end of the central cavity of the shaft to the extreme circumference of the rotulæ; and it is therefore probable that this expanded part of the spiculum is similar in character to that of the folio-peltate spiculum which I have described page 299, in treating of the spicula of the membranes; and that they are, in fact, originally composed of a series of terminal radial spicula expanding and coalescing laterally, and thus forming one plane circular surface in place of numerous separate radii (Plate XXVI. fig. 32).

BIROTULATE: MARGINS OF THE ROTULÆ ENTIRE (Plate XXVI. figs 23, 24, 25 and 26).—This form of spiculum occurs in the coat of the gemmule of *Spongilla gregaria*, BOWERBANK, MS., from the River Amazon. The rotulæ consist of two thin flat plates of equal size, without any appearance of crenation at their margins. They are connected by a very short thick smooth cylindrical shaft, a slight protrusion of which through the centre of each rotula forms a very short convex umbo on the centre of each outer surface. They are very minute; an average-sized one measured, length, $\frac{1}{3000}$th of an inch; diameter of rotula, $\frac{1}{1538}$th of an inch; length of shaft within the rotulæ, $\frac{1}{6838}$th of an inch.

BIROTULATE: ROTULÆ IRREGULARLY AND DEEPLY DENTATE (Plate XXVI. figs. 27 and 28).—This form of spiculum is abundant in the coat of the gemmule of *Spongilla fluviatilis*, JOHNSTON. The rotulæ are flat and are deeply and irregularly divided, the divisions frequently extending from the circumference to very near the centre. The smallest diameter of the shaft is usually at its middle, from which part it gradually increases in size as it approaches the rotulæ. Occasionally, but rarely, we find a single large spine projected from the shaft at right angles to its axis.

BIROTULATE: ROTULÆ IRREGULARLY AND DEEPLY DENTATE, SHAFT MEDIALLY SPINED (Plate XXVI. fig. 29).—This form occurs in the gemmules of *Spongilla Meyeni*, CARTER, from the water-tanks of Bombay. It is the largest spiculum of that form that I have yet seen. It differs from the congenerous form in *Spongilla fluviatilis*, inasmuch as the spination of the shaft in *Sp. Meyeni* is the rule, while in *Sp. fluviatilis* it is a rare exception.

RECURVO-DENTATE BIROTULATE (Plate XXVI. figs. 21 and 22).—This elegant form of spiculum is from the coat of the gemmule of *Spongilla plumosa*, CARTER, from the water-tanks of Bombay. It is the most perfectly developed form of its class with which we are acquainted. It varies to some extent in size and form. The length of the shaft is from three to three-and-a-half times the diameter of the rotulæ, and it is covered profusely with stout acutely-conical spines, which frequently exceed the diameter of the shaft in length.

The rotulæ are internally concave, and considerably and regularly convex on the outer surface, and they have their margins irregularly dentate, the dents in fully-developed specimens being much recurved. The shaft is usually regularly cylindrical throughout its length, but in very fully-developed spicula it sometimes increases considerably in its diameter at a slight distance from its junctions with the rotulæ.

In this spiculum, as it occurs in *Spongilla plumosa*, CARTER, the gradual development of the birotulate form is beautifully displayed, as I have described at length in my introductory observations, page 316: figs. 18, 19 and 20 exhibit progressive stages of development.

MULTIHAMATE BIROTULATE (Plate XXVI. fig. 30).—This singular form of spiculum is from the outer portion of the gemmules of a new species of freshwater sponge from the River Amazon, *Spongilla recurvata*, BOWERBANK, MS.

The external surfaces of the rotulæ are smooth, very convex, and in many cases almost hemispherical; so that the points of the curved spines are in the direction of lines parallel to the shaft of the spiculum, and the rotulæ are cleft almost to the point of union with the shaft. The number of the curved spines vary; in one rotula there were as many as ten, but the usual number is five or six. An average-sized specimen measured $\frac{1}{1056}$th of an inch long; diameter of the rotulæ, $\frac{1}{1500}$th of an inch; and diameter of the shaft, $\frac{1}{4286}$th of an inch.

INEQUI-BIROTULATE (Plate XXVI. figs. 31 and 32).—This spiculum exhibits a gradual transition from the fully developed birotulate to the completely boletiform tribe of spicula. It occurs in a new species of freshwater sponge, *Spongilla paulula*, BOWERBANK, MS., from the River Amazon. It is a stout fully developed form, and the whole of them exhibited, as nearly as possible, the same proportions, which are as follows:—

Length $\frac{1}{750}$th of an inch, diameter of largest rotula $\frac{1}{1818}$th of an inch, and diameter of the shaft at the middle $\frac{1}{6000}$th of an inch. The shaft increases slightly and gradually in its diameter from the middle to each of the rotulæ. The central cavity of the shaft is very distinct, and has a diameter equal to about one-fifth that of the medial one of the shaft. From both terminations of the shaft a number of minute radial canals pass from the centre to the circumference of the rotulæ, and in one of the large ones I counted twenty radial canals. The rotulæ are flat, or very slightly convex outward near the centre, and the margins are perfectly entire.

Boletiform (Plate XXVI. fig. 33).—The form of this spiculum is very like that of the common edible mushroom when fully grown. The large discal end is convex externally, and has the margin entire. The shaft is nearly of the same diameter throughout its length, and occasionally it has one or two large spines projected from it, near the middle and at right angles to its axis.

The small end is more or less lentiform, but it is frequently very irregular both in size and shape.

This interesting form of spiculum is from the gemmule of *Spongilla reticulata*, Bowerbank, MS. From the River Amazon.

Boletiform: slender (Plate XXVI. figs. 34 and 35).—This graceful and elegant form of spiculum occurs at the inner surface of the crust of the gemmule of *Spongilla recurvata*, Bowerbank, MS., from the River Amazon. The shaft is exceedingly slender, measuring at the middle $\frac{1}{25000}$th of an inch in diameter. The large discal end of the spiculum is slightly convex externally, has the margin perfectly entire, and is $\frac{1}{1027}$th of an inch in diameter. The small lentiform end measured $\frac{1}{6000}$th of an inch in diameter, and the total length of the spiculum is $\frac{1}{707}$th of an inch.

Umbonato-scutulate (Plate XXVI. figs. 36 and 37).—This spiculum is found immediately beneath the outer membrane of the gemmule of a new species of freshwater sponge, from the River Amazon, *Spongilla Brownii*, Bowerbank, MS. The form is truly that of a little shield, the lower surface being concave, while the upper one has a corresponding degree of convexity, and the umbo projects from its centre in the shape of a small cone. The diameter of an average-sized one is $\frac{1}{1200}$th of an inch, and the height very nearly equalled the diameter.

Inequi-trirotulate (Plate XXVI. fig. 38).—Having two terminal rotulæ of equal size, and one intermediate of greater diameter than the terminal ones. I have no knowledge of the sponge from which this spiculum is derived, nor in truth whether it be from a sponge. I found two of them among a great variety of sponge spicula procured by washing some specimens of *Oculina rosea*, from the South Sea. The general structure of the spiculum is the same as that of a Birotulate one from a *Spongilla*, and the rotulæ exhibit, rather indistinctly, the same description of radial canals that are so distinctly portrayed in Plate XXVI. fig. 32. It may possibly have been disengaged by decomposition from the gemmule of some unknown species of *Spongilla* brought down the rivers which discharge their contents in the estuaries, or between the islands of those seas.

3rd. SPICULA DISPOSED IN FASCICULI IN THE SUBSTANCE OF THE GEMMULE FROM THE CENTRE TO THE CIRCUMFERENCE.

INEQUI-FUSIFORMI-ACERATE (Plate XXVI. fig. 39).—This form is found in the fasciculi of spicula that radiate in all directions from the centre to the surface of the gemmules of *Tethea cranium*, JOHNSTON. The largest diameter of the spiculum is at about one-fourth or one-fifth of its length from its base, and thence it gradually diminishes in size to the very attenuated apex. They are about $\frac{1}{50}$th of an inch in length.

UNIHAMATE ATTENUATO-CLAVATE (Plate XXVI. fig. 40).—This singular form occurs abundantly in the gemmules of *Tethea cranium*, JOHNSTON. The long attenuated shaft increases gradually in size from its proximal end to its distal one, where it rapidly but progressively increases in diameter, and terminates hemispherically. From this clavate mass a single hook is projected, which curves slightly towards the shaft of the spiculum, so that its apex reaches a point at about 45° from the axis of the spiculum. The length of the hook is about equal to the diameter of the clavate mass from which it emanates. I have seen a great number of spicula of this form from different specimens of *Tethea cranium*, and never found more than one terminal hook; but it appears highly probable, from a comparison of these spicula with allied forms from the gemmules of *Tethea similimus*, BOWERBANK, MS., from the South Sea, in the Museum of the Royal College of Surgeons, that it is but a permanent variety of the recurvo-ternate form that occurs sparingly among the defensive spicula of *T. cranium*.

ATTENUATO-RECURVO-TERNATE (Plate XXVI. figs. 41 and 42).—In the gemmules of *Tethea similimus*, BOWERBANK, MS., from the South Sea. There are numerous spicula like those represented by figure 40, from *T. cranium*, but not quite so much recurved, and many of these have the rudimentary canal opposite to the well-developed hook, indicating a predisposition to eliminate a second one. In other spicula we find the second hook fully produced, as represented by figure 41; and occasionally, though rarely, we find a completely ternate termination, as represented by figure 42.

ATTENUATO-PORRECTO-TERNATE (Plate XXVI. fig. 43).—This form is found in abundance in the fasciculi of spicula in the gemmule of *Tethea cranium*, JOHNSTON. It is very like the porrecto-ternate spicula that are projected from the surface of that sponge, but it differs from them in always having the radii expanded to a greater amount, in many cases attaining an angle of nearly 40 degrees to the shaft of the spiculum. The ternate termination is always the distal one.

The positions in the sponge of the whole of the spicula hitherto figured have been determined with as great a degree of accuracy as circumstances permitted. Beside these there are other interesting forms of spicula, of the spongeous origin of which there can be no reasonable doubt, which have presented themselves during the course of my researches, and which I have thought it advisable to describe separately.

Spicula, the position of which are unknown.

BIRECURVO-QUATERNATE: MEDIALLY SPINED (Plate XXVI. fig. 44).—This spiculum is figured and described by my friend Prof. QUEKETT in the 'Catalogue of the Histological Series in the Museum of the Royal College of Surgeons,' plate 11. fig. 9 *b*, p. 187. A, p. 46, as a recurvo-ternate form, but a careful examination of three specimens, for which I am indebted to him, has satisfied me that the terminations are quaternate. The two ends of the spiculum differ considerably in structure. At one termination there is little or no enlargement of the shaft, and the hooks are projected somewhat upward as well as outward, and are so curved that each forms nearly a semicircle; while those at the opposite end each curves downward from its base to its apex, describing not more than the fourth part of a circle; and this end of the spiculum has the shaft stronger and more clavate than the other. The spines on the shaft are more or less curved in accordance with the hooks of the larger end. From these characters I am inclined to believe that the spiculum is an internal defensive one, and that the smaller end, the least recurved, is the basal one. The two perfect spicula in my possession were as nearly as possible of the same size, $\frac{1}{166}$th of an inch in length. It was obtained from some spongeous matter taken from the base of a large cup-shaped sponge in the Museum at Edinburgh.

TUBERCULATED FUSIFORMI-CYLINDRICAL (Plate XXVI. fig. 45).—This beautiful spiculum is siliceous. It has been repeatedly found in the matter obtained by washing the roots of *Oculina rosea* and other corals from the South Sea, by my friends Messrs. MATTHEW MARSHALL, LEGG and INGALL, but the sponge, whence it is most probably derived, has never yet been determined. It is remarkable as being the only well-defined and perfect siliceous spiculum that has yet been observed to possess the short stout tubercles that are so characteristic of its structure. Fragments of two other spicula, possessing similar characters, have been observed by me, and are represented by figures 46 and 47. In the specimen represented by figure 46, the tubercles are less in number, but are considerably more produced, and their terminations are more abruptly truncated. In the spiculum represented by figure 47, they are still more widely distributed, are shorter and more inclined to be conical, so that there is little doubt that they have belonged to three distinct species of sponge. But in all three of them there is one peculiarity, that of the manner of the disposition of the tubercles on the shafts of the spicula, where we observe them to be disposed in more or less regular longitudinal lines, and that the tubercles forming each line alternate with those of the line next to them, so that they assume the appearance of a spiral arrangement. The close alliance in the structure of these spicula would seem to indicate the existence of a peculiar tribe of sponges, with which we are at present entirely unacquainted.

ACERATE: VERTICILLATELY SPINED (Plate XXVI. fig. 48).—I obtained this singular form from a parasitical sponge from Western Australia. This curious sponge, in the formation of its skeleton, appears to have appropriated the spicula of every other kind of sponge that came within its reach, and among a great variety of forms I found several of the same description as that represented by figure 48. From its general character, I am inclined to believe that it belongs to the sarcode.

SPINULATO-ENSIFORM (Plate XXVI. fig. 49).—I have never found this spiculum *in situ*. A few specimens were obtained from the same sponge from which the spiculum represented by fig. 48 was taken.

ACUATE: BASALLY RECTANGULATED (Plate XXVI. fig. 50).—I obtained this spiculum from the spongeous matter scraped from the base of *Oculina rosea*, by a dealer in the process of cleaning the coral. It is not a malformation, as there are several of them in the same slide, and they are all angulated to the same extent. It is probably an internal defensive spiculum.

SUBSPINULATO-ARCUATE (Plate XXVI. fig. 51).—I obtained this singular form of spiculum from my friend Mr. THOMAS INGALL, a zealous and liberal investigator of the Spongiadæ. It is said to be from Ash Island, New South Wales. When well-developed, both the terminations of the cylindrical shaft are more or less spinulate, and one or both of the ends of the shaft are incipiently spinous.

The nearest form to this spiculum is the arcuate one that is found on the surface of the gemmule of *Spongilla lacustris*, JOHNSTON, and it is probable that this one is also from a sponge of that genus, as I have never seen any spicula of that form in any marine sponge from Australia.

EXPLANATION OF THE PLATES.

PLATE XXIII.

Structure of Spicula.

Fig. 1. Distal termination of a porrecto-ternate spiculum from *Tethea cranium*, with angular distortions from external pressure, ×260 linear: page 282.

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Fig. 3. A portion of an immature spiculum from *Spongilla lacustris*, charred to exhibit the dense membrane lining the large central cavity in the young spiculum, ×260 linear: page 282.

Fig. 4. A section at right angles to the axis of the upper part of the shaft of a ternate spiculum from *Geodia Barretti*, BOWERBANK, MS., exhibiting the concentric layers, ×260 linear: page 282.

Figs. 5 and 6. Portions of charred spicula from the skeleton fasciculi of *Tethea cranium*, exhibiting their hollow condition after incineration, ×90 linear: page 283.

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Fig. 8. A portion of an adult spiculum from the skeleton of *Geodia McAndrewii*,

BOWERBANK, MS., cracked by the application of cold water while in a heated state, ×90 linear: page 284.

Spicula of the Skeleton.

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Fig. 9 *b*. ACERATE, from *Spongilla fluviatilis*, JOHNSTON, ×160 linear: page 286.

Fig. 10. FUSIFORMI-ACERATE, from *Halichondria coccinea*, BOWERBANK, MS., ×160 linear: page 286.

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Fig. 12 *b*. ACUATE, from *Halichondria caruncula*, BOWERBANK, MS., ×160 linear: page 286.

Fig. 13. FUSIFORMI-ACUATE, from *Halichondria crustula*, BOWERBANK, MS., ×160 linear: page 286.

Fig. 14. ATTENUATO-ACUATE, from *Halichondria infundibuliformis*, JOHNSTON, ×160 linear: page 286.

Fig. 15. FLECTO-ATTENUATO-ACUATE, from *Halichondria infundibuliformis*, JOHNSTON, ×160 linear: page 286.

Fig. 16. FLECTO-ATTENUATO-ACUATE, from *Halichondria variantia*, BOWERBANK, MS., ×160 linear: page 286.

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Fig. 18. FUSIFORMI-CYLINDRICAL, from *Pachymatisma Johnstonia*, BOWERBANK, ×90 linear: page 287.

Fig. 19. ATTENUATO-CYLINDRICAL, from *Pachymatisma Johnstonia*, BOWERBANK, ×90 linear: page 287.

Fig. 20. FUSIFORMI-ATTENUATO-CYLINDRICAL, from *Tethea robusta*, BOWERBANK, MS., ×90 linear: page 287.

Fig. 21. BICLAVATED CYLINDRICAL, from a new Australian sponge, ×260 linear: page 287.

Fig. 22. INEQUI-BICLAVATED CYLINDRICAL, from *Pachymatisma Johnstonia*, BOWERBANK, ×90 linear: page 287.

Fig. 23. ANGULATED INEQUI-BICLAVATED CYLINDRICAL, from *Pachymatisma Johnstonia*, BOWERBANK, ×90 linear: page 287.

Fig. 24. SPINULATE, from *Halichondria carnosa*, JOHNSTON, ×260 linear: page 287.

Fig. 25. FUSIFORMI-SPINULATE, from *Halichondria suberea*, JOHNSTON, ×260 linear: page 287.

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Fig. 28. FLEXUOUS, from *Halichondria ventilabrum*, JOHNSTON, ×160 linear: page 287.

Fig. 29. ENSIFORM, from an unknown sponge, ×130 linear: page 287.

Fig. 30. Spiculum, ENTIRELY SPINED, from *Halichondria incrustans*, JOHNSTON, ×260 linear: page 288.

Fig. 31. Spiculum, BASALLY SPINED, from *Halichondria Ingalli*, BOWERBANK, MS., ×260 linear: page 288.

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Fig. 37. EQUIANGULAR TRIRADIATE, a very stout variety of form, from an undescribed African sponge, ×90 linear: page 288.

Fig. 38. EQUIANGULAR SPICULATED TRIRADIATE, from *Halina Bucklandi*, BOWERBANK, MS., ×90 linear: page 288.

Fig. 39. BIANGULATED QUADRIRADIATE, from *Halina Bucklandi*, BOWERBANK, MS., ×90 linear: page 289.

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Fig. 44. PATENTO-TERNATE, from *Geodia M^cAndrewii*, BOWERBANK, MS., ×90 linear: page 290.

Fig. 45. RECURVO-TERNATE, from *Geodia Barretti*, BOWERBANK, MS., ×90 linear: page 290.

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PLATE XXIV.

Defensive Spicula.

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Fig. 3. CYLINDRICAL, ENTIRELY AND VERTICILLATELY SPINED. Sponge unknown, ×400 linear: page 293.

Fig. 4. SPINULO-RECURVO-QUATERNATE, first stage of development, ×130 linear: page 294.

Fig. 5. The same spiculum as fig. 4 in the second stage of development, ×130 linear: page 294.

Fig. 6. The same spiculum as fig. 4 in the third stage of development, ×130 linear: page 294.

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Fig. 8. FUSIFORMI-PORRECTO-TERNATE, a very early stage of development, from *Tethea cranium*, JOHNSTON, ×660 linear: page 295.

Fig. 9. A further stage of development of a fusiformi-porrecto-ternate spiculum from *Tethea cranium*, ×260 linear: page 295.

Fig. 10. An adult fusiformi-porrecto-ternate spiculum from *Tethea cranium*, ×160 linear: pages 289 and 295.

Fig. 11. A fusiformi-porrecto-ternate spiculum from *Tethea cranium*, charred to exhibit the cavities of the shaft and radii, ×260 linear: page 295.

Fig. 12. FUSIFORMI-RECURVO-TERNATE spiculum, in an early stage of development, from *Tethea cranium*, JOHNSTON, ×260 linear: page 295.

* The number of the figure in page 291 is erroneously printed 53 instead of 52.

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Fig. 15. Ensiform spiculated equiangulated triradiate, from *Grantia ensata*, Bowerbank, MS., ×130 linear: page 296.

Fig. 16. Ensiform spiculated equiangulated triradiate, from *Grantia tessellata*, Bowerbank, MS., ×130 linear: page 296.

Fig. 17. Equiangulated spiculated tripodate, from *Grantia nivea*, Johnston, ×660 linear: page 296.

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Fig. 23. Mucronato--cylindrical, from *Halichondria incrustans*, Johnston, ×400 linear: page 297.

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Fig. 33. Foliato-peltate, second stage of development, ×160 linear: page 299.

Fig. 34. Foliato-peltate, third stage of development, ×160 linear: page 299.

Fig. 35. Foliato-peltate, fourth stage of development, ×160 linear: page 299.

Fig. 36. Foliato-peltate, an adult spiculum fully developed, ×130 linear: page 299.

Fig. 37. FOLIATO-PELTATE,, a side view of a spiculum, exhibiting the form and comparative length of the shaft, ×160 linear: page 299.

Fig. 38. FOLIATO-PELTATE, a fragment exhibiting furcated terminations to two out of the three radiating canals, ×260 linear: page 299.

Retentive Spicula.

Fig. 39. SIMPLE BIHAMATE, from *Halichondria variantia*, BOWERBANK, MS. British, ×1060 linear: page 300.

Fig. 40. REVERSED BIHAMATE, from *Halichondria incrustans*, JOHNSTON, ×1066 linear: page 300.

Fig. 41. CONTORT BIHAMATE, from *Halichondria incrustans*, JOHNSTON, ×1066 linear: page 300.

Fig. 42. ABBREVIATED BIHAMATE, from an unknown sponge, ×1060 linear: page 301.

Fig. 43. DEFLECTED BIHAMATE, from the spongeous mass at the base of *Euplectella cucumer*, OWEN, ×660 linear: page 301.

Fig. 44. EXTER-UMBONATE, from an undescribed sponge from Sicily, ×1060 linear: page 301.

Fig. 45. INTER-UMBONATE, from the same sponge as fig. 44, ×1060 linear: page 301.

Fig. 46. BI-UMBONATE, from the same sponge as fig. 44, ×1060 linear: page 301.

Figs. 47, 48 and 49. CLAVATED BIHAMATE, from the same sponge as fig. 44, ×1060 linear: page 302.

Fig. 50. UNIPOCILLATED BIHAMATE, from *Halichondria Hyndmani*, BOWERBANK, MS., ×1060 linear: page 302.

Fig. 51. SIMPLE BIPOCILLATED BIHAMATE, from *Halichondria Hyndmani*, BOWERBANK, MS., ×1060 linear: page 302.

Fig. 52. CONTORT BIPOCILLATED BIHAMATE, from *Halichondria Hyndmani*, BOWERBANK, MS., ×1060 linear: page 302.

Fig. 53. UMBONATED BIPOCILLATED BIHAMATE, from *Halichondria Hyndmani*, BOWERBANK, MS., ×1060 linear: page 303.

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Fig. 58. DENTATO-PALMATE INEQUI-ANCHORATE, from *Spongia lobata*, MONTAGU, *Isodictya lobata*, BOWERBANK, MS., ×1060 linear: page 306.

PLATE XXV.

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Fig. 4. DENTATO-PALMATE INEQUI-ANCHORATE, first stage of development, ×260 linear: page 304.

Fig. 5. DENTATO-PALMATE INEQUI-ANCHORATE, second stage of development, ×260 linear: page 304.

Fig. 6. DENTATO-PALMATE INEQUI-ANCHORATE, third stage of development, ×260 linear: page 305.

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Fig. 10. CYLINDRO-STELLATE, from *Pachymatisma Johnstonia*, BOWERBANK, ×660 linear: page 307.

Fig. 11. CRASSATO-CYLINDRO-STELLATE, from *Tethea robusta*, BOWERBANK, MS., ×1060 linear: page 307.

Fig. 12. CLAVATED SUBSPHERO-STELLATE, from *Tethea Ingalli*, BOWERBANK, MS., ×1060 linear: page 307.

Fig. 13. CLAVATED SPHERO-STELLATE, from *Geodia Barretti*, BOWERBANK, MS., ×1060 linear: page 307.

Fig. 14. SUBSPHERO-STELLATE, from *Tethea Ingalli*, BOWERBANK, MS., ×660 linear: page 307.

Fig. 15. SPHERO-STELLATE, from *Tethea robusta*, BOWERBANK, MS., ×660 linear: page 308.

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Fig. 17. A SPHERO-STELLATE SPICULUM, exhibiting the central canals in the radii, ×660 linear: page 308.

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Fig. 31. The same spiculum as fig. 24, with three secondary rays forming two right angles with each other, ×90 linear: page 309.

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Fig. 34. SLENDER ATTENUATED RECTANGULATED HEXRADIATE, from *Euplectella aspergillum*, OWEN, ×90 linear: page 310.

Fig. 35. CYLINDRO-RECTANGULATED HEXRADIATE, APICALLY SPINED, from a specimen of *Euplectella* in the Museum of the Jardin des Plantes, Paris, ×130 linear: page 310.

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Fig. 38. BIFURCATED RECTANGULATED HEXRADIATE STELLATE, from the *Euplectella* in the Museum of the Jardin des Plantes, Paris, ×1060 linear: page 311.

Fig. 39. TRIFURCATED ATTENUATO-HEXRADIATE, from *Euplectella aspergillum*, OWEN, having the ray nearest the eye broken off at its base, ×1060 linear: page 311.

PLATE XXVI.

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Fig. 7. ATTENUATO-RECTANGULATED TRIRADIATE, APICALLY SPINED, from *Euplectella aspergillum*, ×90 linear: page 313.

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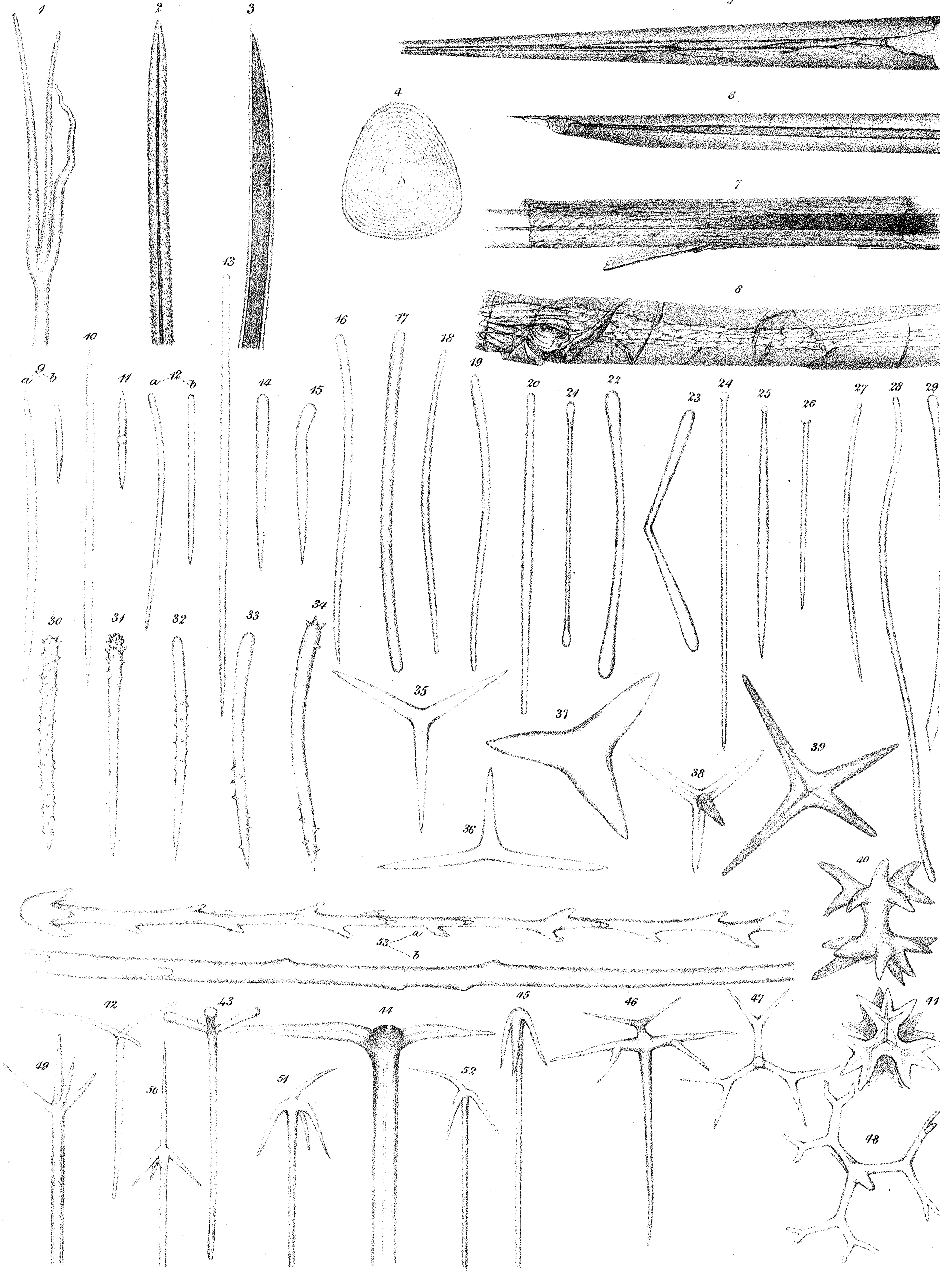

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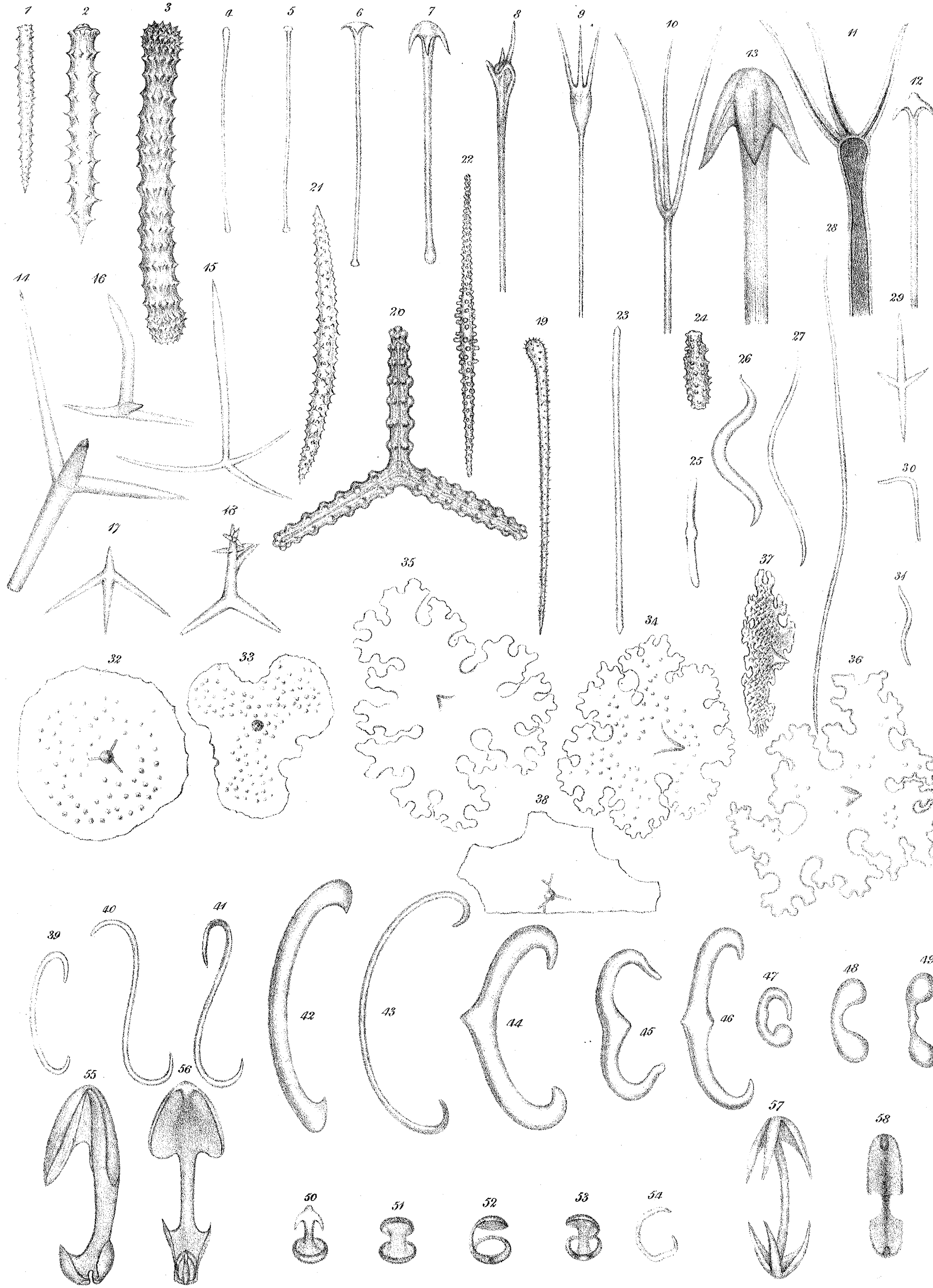

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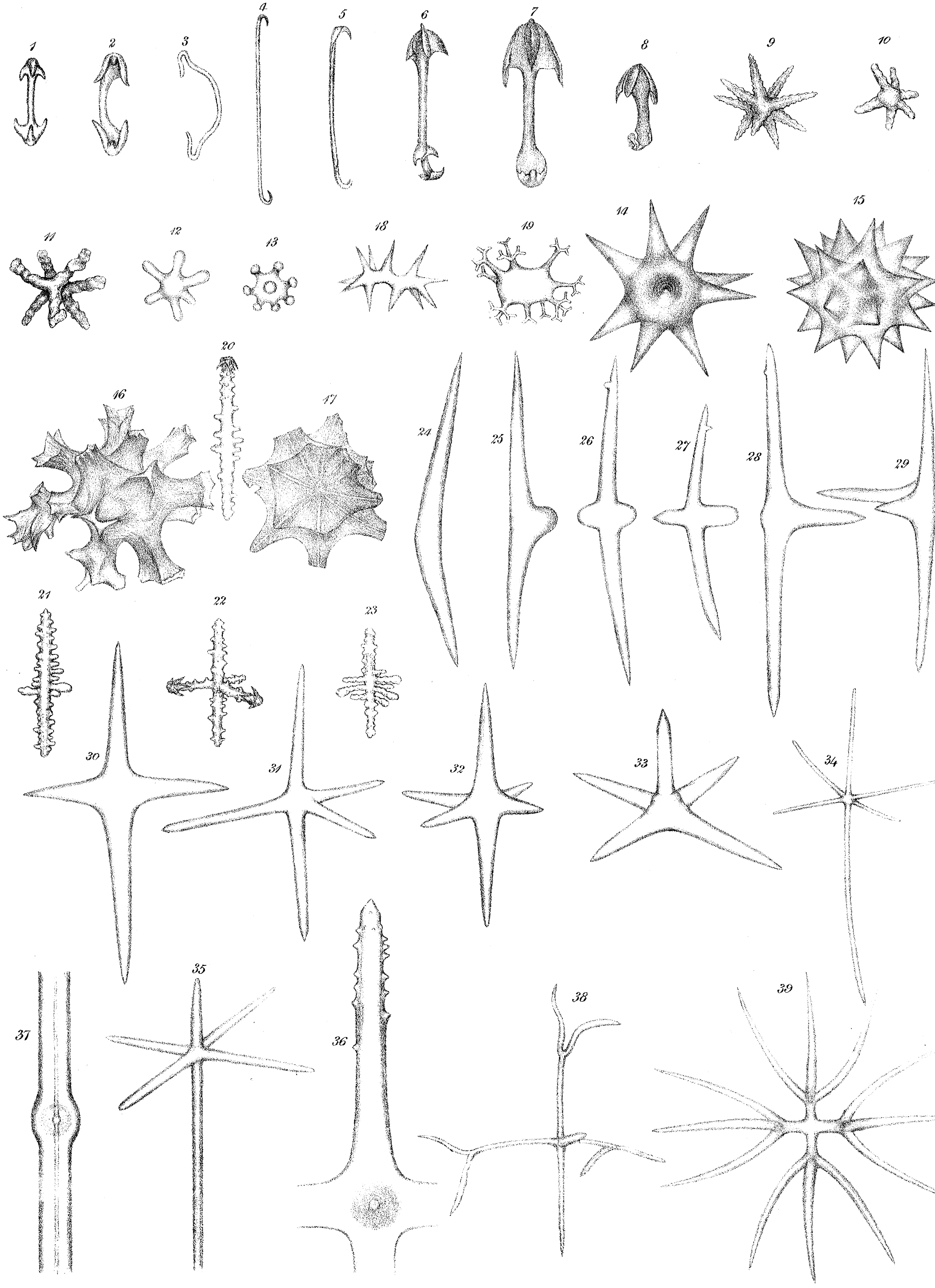

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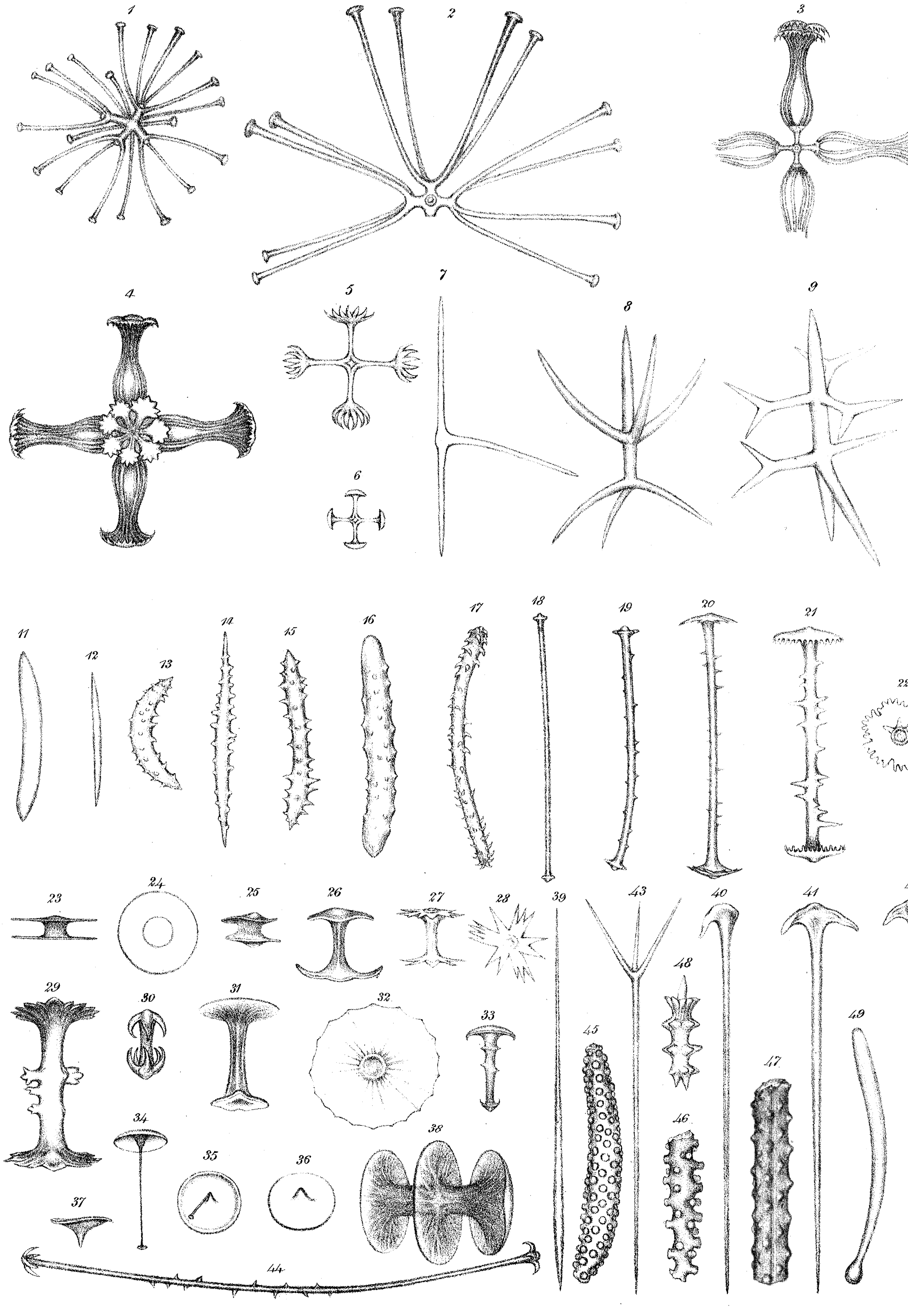

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