

5. A Monograph of the Siliceo-fibrous Sponges. By J. S. BOWERBANK, LL.D., F.R.S., F.Z.S., &c.—Part IV.

[Received June 8, 1875.]

(Plates LVI. & LVII.)

Further observations on the anatomy and physiology of

ALCYONCELLUM SPECIOSUM, Quoy et Gaimard. (Plate LVI.)

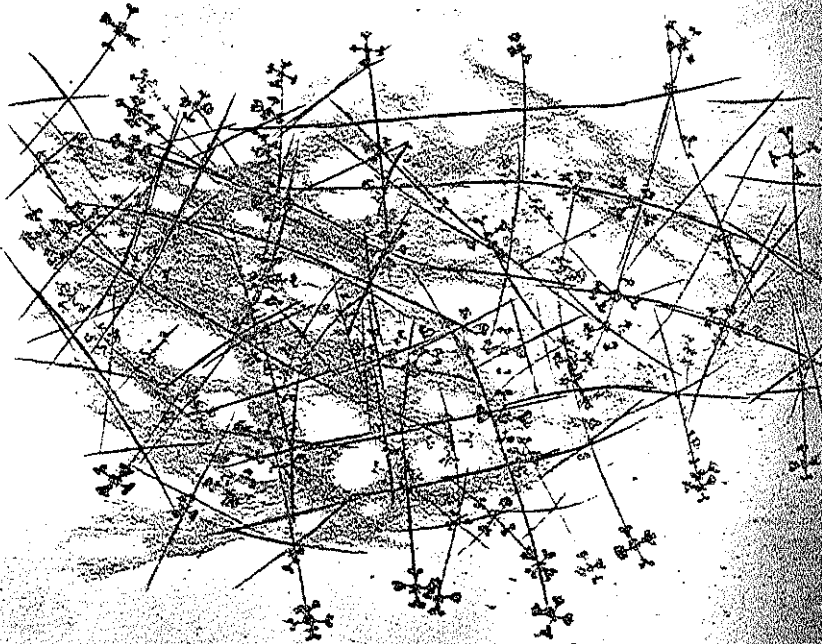
Euplectella aspergillum, Owen, Trans. Zool. Soc. iii. p. 203.

Euplectella cucumer, Owen, Trans. Linn. Soc. xxii. p. 17, pl. 21.

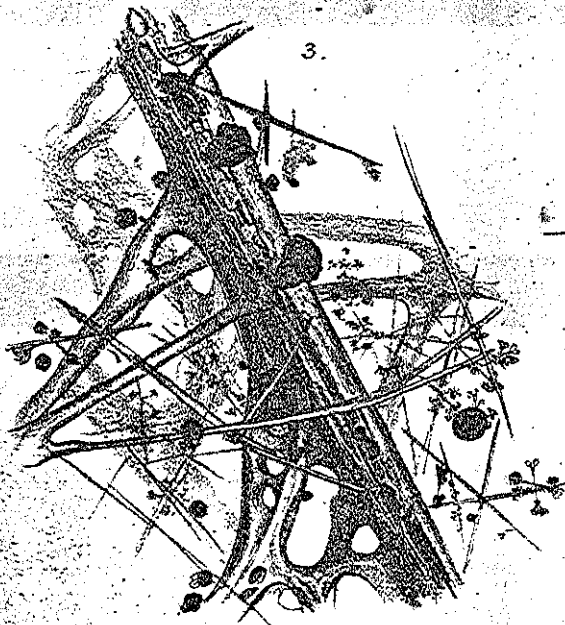
In my former observations on the anatomy and physiology of this singular and very beautiful Sponge, published in the Society's 'Proceedings' for 1867, p. 351, and for 1869, p. 346, I have stated that I had tried in vain to obtain a knowledge of the dermal structures of this sponge. In my paper of May 13, 1869, I detailed my examination of a very small fragment of what appeared to me to be the dermis; and subsequent examinations of other minute pieces of a similar description have confirmed the opinion I had then formed. Since 1869 I have made every possible effort to solve the problem of its dermal structure, but without any satisfactory result. What my best efforts could not attain, the good fortune of my friend Dr. John Miller, F.G.S. &c., has achieved by the acquisition of a specimen in which the skeleton of the dermal organization is in a perfect state of preservation; and I am much indebted to him for having kindly presented me with part of this beautiful and valuable specimen for examination and description. No portion of the sarcodous structures remain on any part of the dermis by gradual undisturbed decomposition, leaving its siliceous skeleton *in situ* in a remarkably perfect state of preservation; and not only so with regard to the dermal skeleton, but the rigid skeleton of the sponge appears to be precisely in the same state as when living, every portion of it appearing to occupy its appropriate position, so as to enable us to render a much more correct account of its general structure. Hitherto the only specimens available for examination have been in such a well-washed condition as to render it extremely difficult to determine the true positions of the unattached spicula found among those of the rigid skeleton; and in many cases the rectangulated sexradiate spicula of the dermis and the floricommo-sexradiate ones have evidently been washed into the interstices of the rigid skeleton.

On examining a portion of the sponge presented to me by Dr. Miller, mounted in Canada balsam, with a power of 100 linear, we find that at the inner surface of the specimen the large primary fibres of the skeleton are strikingly distinct; and in the irregularly shaped interstices of their reticulation there were numerous stout rectangulated sexradiate spicula, and a large number of the same form of various degrees of tenuity; their positions were mostly un-

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Acyoncellum speciosum.

conformable, both as regards each other and the large primary fibres of the skeleton; and I could not detect a single floricommo-sexradiate one among them. The simple rectangulated sexradiate spicula, when immersed amid the skeleton-fibres, usually had the whole of the six radii developed; but those at the inner margin of the great incurrent areas were frequently deficient of the distal axial ray, so that the four lateral rays were presented in the same plane as that of the inner margin of the great incurrent areas.

On examining the outer surface of the specimen we find a marvellously beautiful compound reticulated dermal skeleton elevated slightly above the general surface of the sponge-structures beneath. This exquisitely beautiful tissue is composed of a single layer of slender, simple, rectangulated sexradiate spicula, conformably arranged in the same plane, the long proximal ends of the central shafts being all pointed downwards towards the skeleton beneath, while the lateral radii of each spiculum glide over those of their next neighbours until the distal ends of their respective rays closely approach to the central shafts of each other, thus systematically interlocking with each other, and forming a beautiful quadrangular network in the dermal stratum. The distal portion of the central shaft of each simple rectangulated sexradiate spiculum has a single floricommo-sexradiate spiculum cemented to its apex, forming a uniform stratum at regular distances of these beautiful objects immediately beneath the outer surface of the dermal membrane.

The interstices of the quadrangular network are filled by a thin translucent membrane on which there are occasionally found, closely adhering to the membrane, groups of five or six minute quadrifurcate sexradiate stellate spicula, very similar in general structure to those of *Iphiteon Ingalli*, figured in the Society's 'Proceedings' for 1869, plate xxiii. fig. 2, p. 331—but with this difference, that the radii of those of *I. Ingalli* are spinulate, while those of *A. speciosum* are attenuated to exceedingly sharp distal terminations. These spicula are very slender and delicate in their proportions, and require a power of at least 400 linear to render them distinctly to the eye. A fully developed one measured as follows:—extreme diameter $\frac{1}{4\frac{1}{2}}$ inch; diameter of the sexradiate basal portion $\frac{1}{15\frac{1}{2}}$ inch; length of the furcating radii $\frac{1}{10\frac{1}{2}}$ inch; and the diameter of the thickest portion of furcating radii $\frac{1}{13\frac{1}{2}}$ inch.

Thus these beautifully constructed and elaborately arranged organs form most effective defences against minute annelids or other insidious enemies who may attempt to prey upon the soft gelatinous tissues of the sponge. A single mouthful of the minute sharp-pointed spicula of which their beautiful floral terminations are constructed would effectually deter these predacious little enemies from any further attacks upon the soft tissues of the sponge. A more complete or more effective mode of disposition of these wonderful defensive organs cannot possibly be conceived. These structures are amazingly beautiful to our eyes; but their admirable adaptation to their especial purposes infinitely surpasses their beauty in our estimation. To return to the peculiar mode of construction of the rectangulated net-

work of the dermis, we at once perceive that the spicula when thus united form a strong and elastic rectangulated network. This mode of combination of the simple sexradiate spicula is perfectly adapted to the power of dilatation and contraction that it appears should necessarily exist in all siliceous sponges, whatever their form may be, which have a rigid skeleton. We find these powers existing in all the species of *Dactylocalyx*, as represented in plates v. & vi., P. Z. S. 1869. But in these cases the expansion of the dermis is effected by various forms of ternate spicula, connected by the apices of their terminal radii, while their shafts are directed towards the body of the sponge, so as to allow, not only of a great amount of lateral expansion and contraction of the dermal membrane, but also of the separation of the dermis from the body of the sponge beneath it to a very considerable extent. In all the species of *Geodia* and *Pachymatisma* we find the same principle existing under various modifications. The expansile powers of the dermal tissues are also provided for, in the reticulated structures of *Isodictya* and *Halichondria*, by the conjunction and elastic adhesion of the terminations of the spicula forming the dermal rete, whether that organ be monospiculous, as in many species of *Isodictya*, or multispiculous, as in numerous species of *Halichondria* and several other genera; and where no such structures exist the dermal membrane alone is abundantly elastic, as exhibited in the protrusion of the large excurrent orifices in *Spongilla*, as figured in plate i. in the "Report on the Vital Powers of the Spongiadae," in the Reports of the British Association for 1857. All these beautiful appliances appear to be combined in the structure of the dermis of *Acyoncellum*; and in addition we have the floricommo-sexradiate forms terminating the distal apices of the dermal expansible arrangement of spicula, as defences of the external surface of the dermal membrane against the minute enemies; while the *chevaux-de-frise* forms beneath are an ample and effective defence against the more powerful depredators.

The spicula of the expansile dermal tissues vary in structure to a considerable extent in the different species of sponges in which they occur. In *Geodia Dysoni* they assume the form of simple patento-ternate spicula, their distal terminations being all in the same plane, their radii meeting and overlapping each other more or less, as represented in figs. 4 & 5, plate iii., P. Z. S. 1873; or they occur as bifurcated patento-ternate ones, as represented in figures 3 & 4, plate ii., P. Z. S. 1873, in the dermis of *Geodia perarmatus*. In the similar organs of *Dactylocalyx Pratti* their terminal radii are flattened and contorted to a considerable extent, as shown by figs. 9, 10, 11, plate v., P. Z. S. 1869; and in the same plate the radii of these spicula are expanded into beautiful foliations in the dermis of *Dactylocalyx M'Andrewii*, as represented in figures 2, 3, & 4. But however different their forms may be, their office in the expansile dermis of each sponge is precisely the same, and their long basal shafts are pendent, as represented in the section at right angles to the surface of *Dactylocalyx Pratti* in plate v. fig. 6a, P. Z. S. 1869. In all these cases the same design, with variations adapted

to the particular species, is apparent—that of allowing a considerable amount of expansion and contraction in the dermal system of the animal, so that, if the skeletons are rigid, the necessary expansions of the dermal organs of the animal may achieve inhalation and exhalation, as necessary to the sponge as to the higher classes of animals, of marine or land-living creatures; and this is precisely what takes place in the dermal system of *Alcyoncellum speciosum*, but in a more complicated and beautiful manner than in any other siliceo-fibrous sponge with which I am acquainted.

There are several other varieties of form of the remarkably constricted compound floricomous spicula which are figured in the 'Philosophical Transactions of the Royal Society' for 1857, plate xxvii., and also in plate viii. vol. i. 'Monograph of British Spongiadae,' but none of these forms are elevated on the distal portion of the shaft of a simple rectangulated sexradiate spiculum, as in *Alcyoncellum speciosum*.

In the portion of the specimen mounted in Canada balsam in the cabinet of Dr. Miller I found a considerable number of gemmules dispersed amidst the tissues; some were on the skeleton-fibres, while others were attached to the interstitial membranes. They were membranous and aspiculous, closely resembling the same description of organs in *Dactylocalyx pumicea*, as represented in the 'Philosophical Transactions of the Royal Society' for 1862, plate xxxiv. figs. 17 & 18, and also in 'Monograph of British Spongiadae,' vol. i. plate xxv. figs. 340 & 341. They varied in size to a much greater extent than those of *Dactylocalyx*. The largest one measured $\frac{1}{10}$ inch in diameter; another was $\frac{1}{20}$ inch in diameter; and the specimens ranging between these two sizes were comparatively numerous. Others, equally well developed, measured $\frac{1}{30}$ inch; and the smallest well-defined one was but $\frac{1}{40}$ inch in diameter.

Thus we have, by the aid of Dr. Miller's beautiful specimen, obtained a much more correct knowledge of the anatomy and physiology of this beautiful sponge than we previously possessed; and, in addition to these interesting facts, a letter published in the 'Times,' April 30, 1875, from Her Majesty's ship 'Challenger,' contains some interesting information regarding its habits in its natural state. "The regaderas," as the Spaniards call them, "are found at a depth of about 100 fathoms. The Indian lets down his bamboo arrangement with a strong fine line of Manilla hemp, and pulls it slowly over the ground. Every now and then he feels a slight tug; and at the end of an hour or so he pulls it in, with usually from five to ten 'regaderas' entangled on the hooks. *Euplectella* has a very different appearance, under these circumstances, from the cones of glossy network in the British Museum. Its silver beard is clogged with the dark grey mud in which it lives, buried to about one third of its height; and the network of the remainder of the tube is covered with a pall of yellowish fleshy matter, which gives it a heavy look, and greatly diminishes its beauty. The layer of flesh is not so thick as we expected, and only slightly masks the form of even the detailed sculpture of the sponge."

In my description of *A. speciosum*, in P. Z. S., May 13, 1869, p. 346, I described a small fragment of what was probably the dermal membrane of the sponge, beneath which the elaborate and beautiful defensive arrangement of spicula described in this paper would be situated. The account of this little fragment foreshadows the description of the investing animal tissues of the sponge described by the correspondent from the 'Challenger,' quoted above.

FARREA VALIDA, Bowerbank. (Plate LVII. figs. 1 & 2.)

Sponge-mass unknown. Dermis furnished with a stout, quadrilateral, smooth or, rarely, slightly tuberculated siliceo-fibrous network, armed at the angles externally and internally with short, stout, imbricated, conical spicular defences; areas square or slightly oblong, very regular, sides of the areas abundantly armed with rectangulated sexradiate defensive organs; radii spinous; spines acutely conical; fibres of the dermal rete cylindrical, very stout, equable in size, canaliculated; canals regular, strongly produced, confluent at the angles. Skeleton-rete quadrangular, areas larger than those of the dermal network. Fibre smooth, not more than one third the diameter of those of the dermis; canals large and well developed. Dermal membrane obsolete.

Colour, in the dried state, dark amber-brown.

Hab. Unknown.

Examined in the dried state.

All that I know of this sponge is a piece of the dermal network a quarter of an inch in length by one eighth of an inch in breadth. It is mounted in Canada balsam. Beneath the dermal rete there is a small portion of the true skeleton-rete *in situ*.

The specific characters derivable from the dermal structures are remarkably striking. The fibres of the dermal structure are comparatively very large; their average diameter measured $\frac{1}{20}$ inch, while those of the true skeleton averaged $\frac{1}{30}$ inch only, and the central canals in both measured $\frac{1}{30}$ inch. The fibres of the dermal structure are spineless; but there are occasionally a few low rounded tubercles dispersed on their surfaces. The mode of the reticulation is exceedingly regular; and the areas are all square or, to a slight extent, oblong, slightly curved at the angles. The conical spicular defensive organs at the angles are short, but very stout, and the imbricated scales are strongly produced. The most strikingly distinctive characters are the numerous rectangulated sexradiate defensive organs, based on the dermal fibres, and projected into the areas frequently to the extent of half their breadth. Their number is very considerable; and four or five are not uncommon in a single area. They vary in size and form to a very considerable extent, some being exceedingly stout, and abundantly and strongly spinous, while others are slender and delicately spinous. All these organs appear to be furnished with a central canal; but it is frequently rendered indistinct by the profusion of spines on the surface of the organ. The small portion of the true skeleton does not present

any remarkable characters. The fibres are usually quite smooth; occasionally, however, there are small and very immature rectangulated sexradiate defensive organs; but I did not see a single well-produced one. There were a few small portions of the dermal membrane in a good state of preservation, upon which there was a rather thick layer of sarcode; but I could not detect in it any thing in the shape of spicula. The specimen from which the above description has been made was in the possession of my late friend Mr. Henry Deane, who kindly obliged me with the use of it for description; and his son, Mr. James Deane, has kindly given me the specimen.

FARREA SPINOSISSIMA, Bowerbank. (Plate LVII. figs. 3 & 4.)

Sponge cup-shaped? Dermis, oscula, and pores unknown. Skeleton rectangulated, composed of three or four layers; fibres of the external ones of rather greater diameter than those intervening, more regularly disposed; areas variable in size and form, abundantly armed with very long, slender, defensive prickles, projected in various directions, more or less incipiently spinous, spines acutely conical—and also sparingly with rather small rectangulated sexradiate internal defensive organs. Skeleton-fibre rather slender, usually smooth, occasionally furnished with a few acutely conical spines; central canals variable in size, usually slender, occasionally obsolete. Sarcode, in the dried state, dark amber-brown.

Colour, in the dried state, dark amber-brown.

Hab. Unknown.

Examined in the skeleton-state.

I am indebted to my late friend Mr. Henry Deane for the only specimen of this species with which I am acquainted. It is a plate of skeleton-tissue 8 lines in diameter. It is curved to such an extent as would seem to indicate that it had formed part of a cup-shaped sponge two or three inches in diameter. In some parts of the structure there are as many as four layers of the skeleton-tissue; but the number most frequently seen is three. The prominent and most distinctive character is the long slender prickles projecting from the skeleton-fibres at right angles to their long axis; sometimes one only is thus produced, but more frequently two in opposite directions, or three are thus projected at about equal distances from a line encircling a fibre. They are always very slender; but they differ in length to a considerable extent: in some cases their length is about equal to the diameter of the fibre on which they are based; but they are frequently three or four times that length. I could not detect the slightest indication of dermal or interstitial membranes with a power of 80 linear; nearly the whole of the skeleton-fibres were more or less covered by a thin coat of dark amber-coloured sarcode; and the long defensive prickles were much more thickly coated with the sarcode than the skeleton-fibres; and this coating of the prickles was mostly thin at their proximal ends, and gradually increased in its thickness to their distal extremities, frequently becoming slightly clavate.

A few such prickles as described above occur in *F. spinifera*; but the greater size of the skeleton-fibres and their more compact and regular mode of arrangement, their large and very distinct canals, at once distinguish that species from *F. spinosissima*.

DESCRIPTION OF THE PLATES.

PLATE LVI.

- Fig. 1 represents a portion of the skeleton of the dermal system of *Alcyoncellum speciosum*, as seen *in situ* on a piece of Dr. Miller's specimen of the sponge mounted by him in Canada balsam, exhibiting the mode of arrangement of the slender rectangulated sexradiate spicula, with the floricommo-sexradiate defensive ones attached to the distal terminations of each of the reticulating spicula, $\times 36$ linear. In plate xxiv. P. Z. S. for 1869, fig. 11 represents one of the floricommo-sexradiate spicula $\times 666$ linear; fig. 10 one of the dermal simple rectangulated sexradiate spicula to which the floricommo-sexradiate ones are attached, $\times 108$ linear; and fig. 9 represents one of the slender attenuated rectangular sexradiate spicula of the skeleton interstitial structures, $\times 179$ linear.
- Fig. 2. Two of the slender rectangulated sexradiate dermal spicula as seen *in situ*, showing the mode in which the lateral radii pass freely over each other, so as to allow of the expansile action of the dermal system, $\times 80$ linear.
- Fig. 3. A small piece of the skeleton-fibres of the sponge immediately beneath the dermal system, with numerous gemmules in various stages of development, attached either to the fibres of the skeleton or to the translucent interstitial membranes, $\times 80$ linear.

PLATE LVII.

- Fig. 1 represents a small portion of the stout and beautifully regular dermal reticulation of *Farrea valida*, with its numerous rectangulated sexradiate defensive organs based on the fibres, with a portion of the slender reticulated skeleton beneath it, $\times 61$ linear.
- Fig. 2. A small portion of the dermal reticulation, exhibiting more distinctly the structure and mode of disposition of the rectangulated sexradiate defensive organs, $\times 80$ linear.
- Fig. 3 represents a small piece of the skeleton-structure of *Farrea spinosissima*, with its numerous attenuated defensive spinous prickles, $\times 36$ linear.
- Fig. 4. A small portion of the fibre of the sponge, more highly magnified, exhibiting the mode of disposition of the spinous defensive prickles coated with sarcode, $\times 80$ linear.

6. On the large Sheep of the Thian Shan, and the other Asiatic Argali. By Sir VICTOR BROOKE, Bart., F.Z.S., and BASIL BROOKE, F.Z.S.

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Captain Biddulph having shown (*antea*, p. 157) appreciable points of distinction between the large Wild Sheep obtained by the officers of the Yarkand Mission on the Thian Shan, described by Dr. Stoliczka as *Ovis poli* (P. Z. S. 1874, p. 425), and the true *Ovis poli* of Blyth from the Great Pamir, we have been induced to study