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THE ANNALS

AND

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[FOURTH SERIES.]

No. 71. NOVEMBER 1873.

XLIV.—*On the HEXACTINELLIDÆ and LITHISTIDÆ generally, and particularly on the Aphrocallistidæ, Aulodictyon, and Farreæ, together with Facts elicited from their Deciduous Structures, and Descriptions respectively of Three New Species.* By H. J. CARTER, F.R.S. &c.

[Plates XIII.—XVII.]

THIS paper was commenced with observations on some deciduous specimens of the Hexactinellidæ from the deep sea, in which the influence of an absorbing process (to be mentioned hereafter) had rendered the sexradiate spicules, on which the vitreous fibre had originally been deposited, again recognizable. It was then found necessary to study the Hexactinellidæ and Lithistidæ (that is, Dr. J. E. Gray's *Coralliospongia ex parte*) generally for a better understanding of this process, and particularly the *Aphrocallistidæ*, *Aulodictyon*, and the *Farreæ*, as it was in the deciduous fibre of such sponges that the facts desired were, if possible, to be ascertained. During this study much information hitherto unknown has been obtained, and three new species of vitreous sponges discovered.

I shall first, therefore, give the results of my investigations of Dr. Gray's *Coralliospongia* &c., under the heads respectively of "Hexactinellidæ" and "Lithistidæ"—afterwards an account of the specimens respectively to which I shall have to refer when the spicules of the *Aphrocallistidæ*, *Aulodictyon*, and the *Farreæ* in the *living state* have been described and I come to the identifying of them in the *deciduous* structures—and, lastly, a short summary of what these structures have

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revealed, together with a description of a new species of *Farrea* and a new genus of vitreous sponges.

I must here premise that whatever value the contents of this paper may possess is all due to the unceasing exertions of my friend Dr. J. E. Gray to place before me all the opportunities in his power, and afterwards to urge me to publish my observations.

In 1867, Dr. J. E. Gray proposed the term "*Coralliospongia*" for a certain group of sponges ("Notes on the Arrangement of Sponges," Proc. Zool. Soc. Lond. 1867, p. 505), as follows:—

"Order I. CORALLIOSPONGIA.

"Sponge hard, coral-like. Skeleton entirely formed of siliceous spicules anchylosed together by siliceous matter, forming a netted mass covered with sarcode."

Nothing can be more appropriate, both in name and definition, than this diagnosis. Dr. Gray had before him in particular the great, stony, shallow, expanded, stalked, dish-shaped masses of *Dactylocalyx pumiceus*, Stutchbury (P. Z. S. 1841, p. 86), and that of *MacAndrewia azorica* described by himself (P. Z. S. 1859, p. 438, pl. xv.), both in the British Museum, and each more than a foot in diameter.

In 1869, Dr. Bowerbank published his "*Monograph of the Siliceous Sponges*" (P. Z. S. May and June 1869, parts i. & ii. pls. xxi.–xxv. & pls. iii.–vi.), in which we find details of the same specimens, appearing respectively under the names of "*Dactylocalyx pumiceus*" and "*Dactylocalyx MacAndrewii*."

So far as the term "*Coralliospongia*" goes, Dr. Gray was right; but the details of Lens Aldous's figures in Dr. Bowerbank's monograph show that *MacAndrewia azorica* might be a family of that order, but could not be a species of *Dactylocalyx*—that is to say, that the elements of *Dactylocalyx pumiceus* are those of a sexradiate sponge, while those of *MacAndrewia azorica* belong to a quadriradiate system. (I call the "quadriradiate system" that in which the shaft of the spicule divides into *three* branches, as in the Geodinidæ, more typically shown in the four-armed spicule of *Pachastrella*, where, the arms being nearly equal in length, that which might be termed the "shaft" is often hardly distinguishable from the rest.) Yet Dr. Bowerbank has changed the name of "*MacAndrewia azorica*" to "*Dactylocalyx MacAndrewii*," thus erring both in grouping and nomenclature.

At the same time Dr. Bowerbank has distinctly shown in his figures, although he has not recognized the fact in his descriptions, that there are two systems, and that while sexra-

diate spicules characterize one, a trifold branching of the shaft or quadriradiate form characterizes the other system.

In 1868, Prof. Wyville Thomson's classification of these sponges appeared under the name of "*Vitreæ*," to which Prof. Thomson added what Dr. Gray had excluded from his *Coraliospongia*, viz. the sarcospiculous Hexactinellidæ (*ex. gr. Hyalonema* &c.)—that is, the Hexactinellidæ which are not vitreous (*Annals*, vol. i. p. 119, Feb. 1868).

But in his fifth genus Prof. Thomson also includes the two species mentioned under the head of "*Dactylocalyx*," viz. "*Dactylocalyx pumicea* [*pumiceus*?], Stutchbury, and *Dactylocalyx azorica*, Gray," = *MacAndrewia azorica*, Gray. (See also Prof. Wyville Thomson's "genus 4," *Phil. Trans.* 1869, pt. ii. p. 713.)

At length, in 1870, the results of Schmidt's examination of the deep-sea sponges sent to him from America were published ('*Grundzüge einer Spongienfauna des atlantischen Gebietes*'), in which the two systems are respectively recognized under the heads of "*Hexactinellidæ*" and "*Lithistidæ*"—the former for the sexradiate, and the latter for the triradiate type, our quadriradiate system. The result of this examination shows plainly how much more Schmidt would have done with these systems with more time and more material at his disposal.

I had noticed *this* distinction before seeing Schmidt's work, in my "*Fossil Spicules of the Greensand*" (*Annals*, vol. vii. pp. 117, 118, Feb. 1871), where, instead of the term "*triradiate*," I had proposed "*ternate*" &c.; but without reference to this in particular, it will be easily seen that if we are to call those sponges *hexactinellid* whose central canal at one point consists of six arms, the other group, whose central canal at one point consists of four arms (viz. that of the shaft and its three branches together), should be termed "*quadriradiate*" to be consistent. The term "*triradiate*" does not suffice for the latter, which must be either "*quadriradiate*" or, as I had before proposed, "*ternate*" or "*trifid*."

Then, again, if we adopt "*ternate*" or "*trifid*," to be consistent we must change "*hexactinellid*" to "*quinate*" or "*quinquefid*;" for in the larger-headed spicules of the Hexactinellidæ the shaft is often so marked that we have to describe it under this term, while the minute sexradiate spicules being for the most part *equiarmed*, no other term can be used for them than "*sexradiate*."

I have endeavoured to show that in the development of a sponge-spicule which is not equiradiate, the primary form is a straight line, from whose central canal branches are *subsequently* given off to form the rest of the spicule *proper*

(Annals, vol. ix. p. 430, pl. xxii. fig. 16, June 1872). The ornamental parts, such as spines &c., although no doubt in the original design, are not attended by any alteration in the central canal, and therefore do not belong to the "spicule proper." I call the "spicule proper" that fundamental form which is marked out by the central canal and its branches; and these do not run into the ornamental portions.

But whatever may be the terms finally adopted for the spicular systems of the Hexactinellidæ and Lithistidæ respectively, it is perfectly evident that in the grouping of these sponges we cannot include the sarcospiculous Hexactinellidæ, viz. *Hyalonema* &c., under either of the terms "Coralliospongia" or "Vitrea;" while the name "Hexactinellidæ" refers rather to the elements than to the general character of these sponges.

All sponges begin their development from the ovum in the form of a sarcodic embryo; after which come the spicules, and lastly the fibre, which converts the skeleton-spicules into an axis, whether this fibre be vitreous or horny. Hence, as the sarcodic precedes the vitreous state, the latter would rank as a superior development to that of the sarcospiculous Hexactinellidæ, in which the sarcode never passes into either horny or vitreous fibre, but remains simply hardened and amorphous.

So it seems to me desirable that we should discard this "order" altogether, and distribute the groups of the Hexactinellidæ among the divisions of the Spongiadæ in accordance with what I have proposed in the footnote to my paper on the points of distinction between the Spongiadæ and Foraminifera (Annals, vol. xi. pp. 355-356, May 1873).

To understand this suggestion, however, it is necessary to premise that the vitreous fibre of the Hexactinellidæ is merely horny fibre silicified, and that the spicules of the species are imbedded in this, after the same manner respectively as they are imbedded in the fibre of sponges generally. This being the fact, we might expect to find certain Hexactinellidæ with their spicules all confined to the interior of the silicified fibre, as the spicules in the horny fibre of my third division, viz. the "Chalinidæ"—then that the fibre in another group of the Hexactinellidæ is more or less echinated with spicules in addition to those contained in the interior, as in my fourth division, viz. the "Armata"—or the spicules supported by amorphous sarcode alone, as in the fifth division, viz. the "Renierinæ," wherein, too, would come our quadriradiate system, or Schmidt's "Lithistidæ," in which I think the filigreed terminations of the arms interlocking with each other, rather than the presence of vitreous fibre, chiefly bind the

whole structure together; for, indeed, if divested of this filigreed development, as is the case with the surface-spicules of *Dactylocalyx Bowerbankii*, Johnson (which are simply trifold-headed shafts with the shaft projecting internally and the trifold heads horizontally), they would be reduced to the state of similar spicules in the Geodinidæ and in *Pachastrella* (that is, held together only by the amorphous sarcode of the dermis), and would thus form a group in my fifth division.

We shall see by-and-by that, while the glassy skeleton of the Hexactinellidæ is formed by a vitrification of the sarcode or horny fibre, that of the Lithistidæ is formed by a vitrified extension of the spicule.

Assuming this, I shall for the present give lists respectively of the Hexactinellidæ and Lithistidæ which have already been described, grouping them, according to the best of my judgment, as their characters seem to indicate, and following each by a short commentary. After which I shall take the branched tube-net sponges (that is, the Aphrocallistidæ, in which we must include *Farrea* and *Aulodictyon*) for the special subject of this paper, returning to the other groups for more detailed description at a future time when it may be more convenient. I shall also, for the present, use the terms "sex-radiate" for the Hexactinellidæ, and "quadriradiate" for the Lithistidæ.

As the spicule of the Hexactinellidæ and Lithistidæ is, like that of all other sponges, developed from a single point or minute cell, which, by linear extension, becomes the central canal on which the vitreous layers of the spicule are subsequently built, we find that in the Hexactinellidæ the spicules are produced by a more or less uniform *radiation* from the central cell *immediately*; while in the Lithistidæ the spicules are formed by a more or less uniform *triradiation subsequently*, or from one extremity of the primary cell *after* it has undergone linear extension,—that is, that this *half* of the shaft is transformed into three arms, and that, too, probably commencing a little *beyond* the central cell, as an inflation of the shaft, often just below the head, leaving a kind of neck or more constricted portion, would seem to indicate. (See especially the large trifold spicules of the Geodinidæ &c.)

With reference to the Hexactinellidæ, it is also necessary to premise that there are here, as in most of the Spongiadæ, large spicules which are only concerned in the formation of the supporting structure or skeleton, which we shall term "skeleton-spicules," and minute spicules which belong entirely to the sarcode, which will be termed "flesh-spicules"—also that the latter here often afford a valuable character in conjunction with

others for specific distinction; but while the former remain under all circumstances in the dried specimen, the latter, unless accidentally included in the material which binds together the large spicules (a very rare occurrence), will, if the sarcode has passed into dissolution before the specimen is taken up for preservation, inevitably fall through the reticulated structure of the skeleton, as small pebbles through the meshes of a fishing-net. Hence the distinguishing character furnished by the minute or flesh-spicules will be lost or retained as the case may be; while, as some sponges have no minute spicule, its absence then must be determined by the presence of the sarcode, since if the sarcode be preserved the minute spicule will be in it if there be one, and if not the contrary. Thus it should be remembered that a sponge possessing the flesh-spicule in the natural state may not have it in the dried one, and that this remark applies to the Spongiadæ generally.

So far, all the Hexactinellidæ that have been made known possess a minute or flesh-spicule in the form of a "rosette," which may be defined to be an equiarmed, sexradiate spicule, from the ends of whose arms respectively proceed a certain number of rays which, although the same on each arm of the specimen, may vary in form, number, and arrangement with the species, but always project from the ends of the arms, which corresponding to the six sides of a cube, the whole, when the spicule is perfect, forms a more or less spherical rosette.

The term "rosette" first appears in Dr. Bowerbank's 'British Spongiadæ' (vol. ii. p. 189 &c.), as indirectly applied to a globular group of inequianchorate spicules well delineated in his plate xviii. fig. 297 (vol. i., *op. cit.*) as illustrations of an *Esperia* (*Hymeniacidon lingua*, B.). These are also flesh-spicules. Then Prof. Thomson, in describing *Askonema* ('Depths of the Sea,' p. 428), directly applies the term to the flesh-spicules of this sexradiate sponge. I now intend to apply it *generally* to the flesh-spicules of the Hexactinellidæ which possess this form, designating it according to its differences in a way which I hope will be found less oppressive to the memory, and therefore more practicable, than Dr. Bowerbank's "Terminology."

As before stated, we find in most sponges two distinct classes of spicules, viz. those which belong to the skeleton (skeleton-spicules) and those which belong to the sarcode (flesh-spicules). The skeleton-spicules sooner or later are all involved in the formation of this structure, while an enclosure of the latter is an exception so rare that the flesh-spicule may be said never to become united to the skeleton-structure. However remarkable it may be that the flesh-spicules should be inti-

mately mixed up with the skeleton-spicules of the sponge without ever being taken into the structure of the latter, such is the case.

Among the vitreous Hexactinellidæ, however, there is a sexradiate spicule of the skeleton-structure so minute and so plentiful that it might easily pass for a "rosette," were it not for the following differences, viz. that it never goes beyond the *simple* or *first sexradiate* division (that is, where the distinguishing form of the rosette, viz. the rays, commence), and is always more or less involved in or cemented to the vitreous skeleton (Pl. XIII. fig. 1). Thus it often appears in *Aphrocalistes Bocagei* and in the *Farrea*, as will hereafter be seen, where, although essentially a skeleton-spicule, it is so much smaller than that which formed the basis of the original fibre that I cannot help viewing it as an "afterformation." Be this as it may, it is so mixed up with the rosette in *Farrea infundibuliformis*, one of the "new species" to be described hereafter, that it is desirable to notice the existence of such a spicule in order that it may not be confounded with the rosettes in any sexradiate sponge, besides those mentioned, in which it may be found to occur (Pl. XVII. figs. 2-4).

From this we pass to a consideration of the "rosette" itself (in connexion with our illustrations), which is essentially a flesh-spicule of the kind above mentioned, but of course subject to modifications.

The simplest form appears to be that in which the six arms are *long* and respectively terminated by two divergent pointed rays (Pl. XIII. fig. 2); or the arms may be *short* with dual rays (fig. 3); or the arms short with a variable plurality of the same kind of rays (fig. 4).

(Here it should be noticed that, for the sake of perspicuity, the fifth and sixth arms (fig. 2, *c c*)—that is, the third axis—will not be introduced in the illustrations after fig. 2.)

Then the dual ray may be straight and capitate, when we get the form fig. 5, where the spines of the head are *few* and *long* (fig. 5, *a, b, c*); or the arms, still short, may have straight capitate rays in variable plurality (fig. 6), where the spines of the head are short and *numerous* (fig. 6, *a, b*); or the arms may be *long* with the same kind of rays (fig. 7); or the arms variable in length in different rosettes, and furnished with a multitude of straight capitate rays of unequal length in the same group (figs. 8 & 16):—the pappiform variety. Here the ends of the arms also are conically inflated and provided with tubercles, each of which supports a ray.

Or the rays may be sigmoid, capitate, and arranged *en fleur-de-lis* expanded generally (fig. 9); or the same *en fleur-de-*

lis contracted below and only expanded above (fig. 10); or sigmoid, clavate, capitate, and toothed outwardly, with the lower third or inward curve of the ray diminished to almost nothing, arranged *en fleur-de-lis* (fig. 11, *a*, *b*); or sigmoid and without head, subulate, with flexed extremity diminishing to almost nothing in the lower third or inward curve, also arranged *en fleur-de-lis* (figs. 12 & 15):—the pappiform rosette with flexed ray. Here, too, the ends of the *arms* are conically inflated and tubercled for the support of the rays generally, ending on the summit in a straight coarse spine (fig. 15, *c*). The lowest portion of the ray being stouter than that which follows it, is frequently left attached to the end of the arm both here and in the foregoing form, as shown in fig. 15, *d*.

Then there is the rosette with *elongated* axis, shaft-like and straight spines or rays, sometimes pointed, sometimes capitate (figs. 17 & 18), sparsely associated with the globular forms (figs. 6 & 7) which characterize *Aphrocallistes Bocagei*, and which, with fig. 19 from *Aphrocallistes beatrix*, whose spines are also sometimes capitate, appear to be the transitional forms between the globular rosette on the one hand and the large spined shaft (fig. 20) peculiar to *Aphrocallistes beatrix* on the other, the globular form being altogether absent in the latter.

Also the birotulate spicule (fig. 21), consisting of a straight subspined shaft with eight separate recurved blades, which is the flesh-spicule of *Hyalonema* &c., but not unfrequently assumes the sexradiate form (fig. 22), when it becomes a "rosette." There is also a four-armed variety, so that the birotulate spicule may be said to be two-, and occasionally four- or six-headed; while three similar forms occur in *Hyalonema* on which there are no heads, but where the ends (and sometimes the whole surface) are covered with thick short vertical spines. (See Dr. Bowerbank's Brit. Spongiadæ, vol. i. pl. vi. figs. 153–157.)

Lastly, as regards varieties of the "globular rosette," the rays are sometimes once-branched (fig. 13); sometimes the head of the ray is echinated generally with spines (fig. 13, *a*); in others the *arms* alone have become enveloped by a globular vitreous mass (figs. 23 & 24), which seems to be the transitional state to the stellate and siliceous ball of the Geodinidæ &c., also flesh-spicules. There are, again, many slight modifications of the illustrations themselves, but fundamentally no more distinct forms in the Hexactinellidæ that have as yet been brought to notice than those above described and delineated.

As regards size, there is of course not only a difference

between the young and the fully developed rosette in the same species, but the size differs with the form of the rosette and in different specimens. The largest I have met with are in a fragment of *Euplectella aspergillum* dredged up on board H.M.S. 'Porcupine.' Here the form represented in fig. 11 is 26-6000ths inch in diameter, while in the specimens from the Philippine Islands it hardly exceeds 20-6000ths. The pappiform rosette with straight capitate rays (fig. 8) is the smallest form; and this averages in its largest size about 8-6000ths.

Subject to such differences in size, it would of course have been impossible for me to draw all the illustrations which I have given upon the same scale; and therefore, to represent their respective peculiarities, they are for the most part all drawn of the same size.

Let us now proceed to a list of the Hexactinellidæ; and as it would be confusing to add to each species the place where it has originally been described and illustrated in the list itself, this will be given in a "footnote," to which the reader may refer if necessary. Also, for the same reason, the short commentary on the species contained in the list will be given subsequently.

Hexactinellidæ *.

General character. Spicules developed upon a sexradiate division of the central canal, held together by silicified fibre or amorphous sarcode, forming a reticulated structure whose interspaces are more or less polyhedral.

SPICULES HELD TOGETHER BY SILICIFIED FIBRE.

Species massive, excavated, shallow.

Rosette or flesh-spicule many-rayed; rays of equal length, straight, capitate, sometimes only pointed (Pl. XIII. figs. 4 & 6).

Dactylocalyx pumiceus, Stutchbury. Barbadoes. (1)

— *pumicea*, Gray. Malacca. (2)

Iphiteon panicea, Valenciennes. Porto Rico. (3)

* *Abbreviations.* P. Z. S., 'Proceedings of the Zoological Society of London.' Annals, 'Annals and Magazine of Natural History.' M. M. J., 'Monthly Microscopic Journal.' B.M., British Museum. Atlantisch. Spongienf., 'Grundzüge einer Spongienfauna des atlantischen Gebietes.'

1. B.M. 1841, P. Z. S. p. 86; and 1869, p. 77, pl. iii. fig. 1, Bk.

2. B.M. 1867, P. Z. S. p. 506, pl. xxvii. fig. 2, = *Iphiteon Ingalli*, Bk., P. Z. S. 1869, p. 331, pl. xxiii. figs. 1-3.

3. Mus. Jardin des Plantes, Paris. P. Z. S. 1869, p. 324, pl. xxii. fig. 1.

Rosette many-rayed : rays of equal length, straight, capitate (figs. 6 & 7), or with multitudinous rays of unequal length, straight, and capitate, "pappiform" (figs. 8 & 16); or occasionally of the first kind once-branched (fig. 13); or occasionally with echinated heads (fig. 13, a).

Dactylocalyx subglobosa, Gray. Malacca. (4)

Rosette many-rayed : rays of equal length, capitate, flexed, and grouped *en fleur-de-lis* (fig. 10); or occasionally with straight and capitate rays.

Myliusia callocyathes, Gray. West Indies. (5)

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4. B.M. 1867, P. Z. S. p. 506, pl. xxvii. fig. 1, = *Iphiteon subglobosa*, Bk. P. Z. S. 1869, p. 329, pl. xxii. figs. 10-12.
 5. B.M. 1859, P. Z. S. p. 439, (Radiata) pl. xvi., = *Iphiteon callocyathes*, Bk. P. Z. S. 1869, p. 333, pl. xxiii. figs. 4-7.
 6. B.M. 1869, P. Z. S. p. 335, pl. xxv. fig. 1.
 7. Trans. Zool. Soc. vol. iii. p. 203, pl. xiii.
 8. B.M. 1858, P. Z. S. p. 114, (Radiata) pl. xi.; Annals, 1868, vol. i. p. 123, Wyville Thomson, = *Iphiteon beatrix*, Bk. P. Z. S. 1869, p. 325, pl. xxi. figs. 2-4.
 9. B.M. Quart. Journ. Microscop. Sc. vol. x. n. s. (No. xxxvii.), p. 4, pl. i. (1870); Schmidt, Atlantisch. Spongienf. 1870, p. 17, pl. ii. figs. 1, 11, 12; Kent, M. M. J. 1870, Nov., p. 248, pl. lxxv. figs. 8-15.
 10. Atlantisch. Spongienf. 1870, p. 13, pl. ii. figs. 1-3; Kent, M. M. J. 1870, Nov., p. 247, pl. lxxv. figs. 2-7.
 11. B.M. M. M. J. 1870, Nov. p. 249, pl. lxiv. figs. 18-25.
 12. P. Z. S. 1869, p. 339, pl. xxiv. figs. 1-7; Owen, Trans. Linn. Soc. vol. xxii. p. 121, pl. xxi. figs. 8 & 9.
 13. Atlantisch. Spongienf. 1870, p. 16, pl. i. figs. 13-20, & pl. ii. fig. 10.
 14. B.M. 1873. *Vide postea*.
 15. Atlantisch. Spongienf. 1870, p. 15, pl. i. figs. 7-12.
 16. M. M. J. 1870, Nov. p. 245, pl. lxiv. figs. 1-9; Wyville Thomson, 'Depths of the Sea,' 1873, p. 429.
 17. B.M. Annals, 1872, vol. x. p. 112.
 18. Atlantisch. Spongienf. 1870, p. 14, pl. i. figs. 1-6.
 19. B.M. Annals, 1872, vol. ix. p. 414, pl. xxi.
 20. B.M. Annals, 1872, vol. x. p. 137.
 21. 'Depths of the Sea,' Wyville Thomson, 1873, p. 419.
 22. Quoy et Gaimard, 'Voyage de l'Astrolabe,' 1833, p. 302, Atlas (Zoophytes) pl. xxvi. fig. 3, = *id.* Gray, P. Z. S. 1867, pl. xxviii. fig. 1; Wyville Thomson, Annals, 1868, vol. i. p. 131, pl. iv. fig. 2, &c.
 23. Gray, P. Z. S. 1867, pl. xxviii. fig. 2; Wyville Thomson, Annals, 1868, p. 129, pl. iv. fig. 1.
 24. B.M. P. Z. S. 1835, p. 65, = *H. mirabilis*, 1857, p. 279.
 25. B.M. P. Z. S. 1864, p. 265, pl. xxii.
 26. Phil. Trans. 1869, p. 701, pls. lxxvii.-lxxi.
 27. M. M. J. 1869, June, vol. i. p. 367. American Naturalist, 1871, vol. iv. p. 17.
 28. B.M. M. M. J. 1870, Nov., p. 243, pl. lxiii. figs. 2-14.
 29. B.M. Annals, 1872, vol. x. p. 110.
 30. B.M. Annals, 1873, vol. xi. p. 275.
 31. Trans. Linn. Soc. 1857, vol. xxii. p. 117, pl. xxi. figs. 1-7.

Rosette many-rayed ; rays of equal length, straight, capitate (fig. 6).

Myliusia Grayi, Bowerbank. St. Vincent. (6)

Species tubular, unbranched, closed at the extremity.

Rosette many-rayed : rays of equal length, sigmoid, clavate, and dentate outwards, claw-shaped, flexed and grouped *en fleur-de-lis* (fig. 11, *a, b*) ; or with rays of equal length, straight and pointed (fig. 4) ; or occasionally with straight rays, few, and terminated by three or more spines at the free ends laterally (fig. 14).

Provided with long anchoring-spicules of two kinds, viz. smooth and spiniferous ; the latter terminating in an inflated head with several recurved spines arranged uniformly all round (Pl. XIV. fig. 5), or on one side of the head only (fig. 4) ; termination of the smooth spicule unknown.

Euplectella aspergillum, Owen. Philippines. (7)

Species tubular, branched ; branches closed at their free extremities ; wall thick, formed of polyhedrally reticulated fibre. Possessing a scopuline shaft.

Rosette (*small*) with *elongated* shaft-like axis, many-rayed : rays straight, pointed or capitate, thorn-like, chiefly situated in the middle and at the terminations of the shaft, arranged more or less verticillately (fig. 19) ; or (*large*) with microspined rays slightly curved and *not* capitate (fig. 20).

Scopuline shaft headed with four rays of equal length, slightly everted, microspined, and terminating in small globular heads (Pl. XV. fig. 2).

Aphrocallistes beatrix, Gray. Malacca. (8)

Rosette many-rayed : rays of equal length, straight, capitate (figs. 6 & 7) ; or with long shaft-like axis, like that of the "*small*" form in *A. beatrix*, with or without heads (figs. 17 & 18).

Scopuline shaft headed with four rays of equal length, flexed outwards *en fleur-de-lis*, microspined, and each terminating in a large conical end (Pl. XV. fig. 1).

Aphrocallistes Bocagei, Wright. Portugal. (9)

? Equal in the young form to *Lanuginella pupa*, Schmidt. (10)

Species tubular, branched ; branches closed (?) at the free extremities ; wall thin, formed of a single layer of subrectangular lattice-like fibre. Possessing a spino-capitate or umbrella-like headed shaft.

Rosette many-rayed ; rays of equal length, sigmoid, capitate,

slightly flexed outwards, and grouped *en fleur-de-lis* (figs. 9 & 10).

Umbrella-like headed shaft of two kinds, viz. one with large head and many small circumferential spines (Pl. XV. fig. 4), and the other with small head and few long spines; the latter microspined on the inner aspect (fig. 5); each form flatly convex, or umbonate, and both passing into each other by gradational varieties.

Aulodictyon Woodwardii, Kent. Portugal. (11)

Species tubular, branched; branches open and slightly expanded at the free extremities; wall very thin, only one layer thick.

Farrea occa, Bowerbank. Seychelles, &c. (12)

Note. All that is known of this species is that its skeleton is thin, tubular, branched, and composed of subrectangular lattice-like fibre, only one layer thick. Deciduous skeletons alone have as yet been found. (See an account, with illustrations, of what spicules have been discovered in the deciduous fragments, further on.)

The same: possessing both a scopuline and an umbrella-like headed shaft.

Rosette many-rayed: rays of equal length, sigmoid, capitate, flexed *en fleur-de-lis* (Atlantisch. Spongienf. Taf. i. fig. 19).

Scopuline shaft headed with several attenuated pointed rays, slightly divergent, brush-like (*ib.* Taf. i. fig. 18).

Umbrella-like headed spino-capitate spicule consisting of a straight shaft with convex head spined at the circumference (*ib.* Taf. i. fig. 20).

Farrea fecunda, Schmidt. Florida, Cuba. (13)

Species infundibuliform; wall compounded of subrectangular lattice-like, overrun by dendritic, branched, anastomosing fibre. Possessing the rosette only.

Rosette many-rayed; rays of equal length, sigmoid, capitate, expanded and arranged *en fleur-de-lis* (Pl. XIII. fig. 9, & Pl. XVII. fig. 4).

Farrea infundibularis, Carter, n. sp. Caribbean Sea. (14)

Species stalked, dichotomously branching; branches terminating in oviform heads, each with a terminal aperture.

Rosette many-rayed: rays of equal length, straight, capitate

(fig. 6) ; or rays multitudinous, of unequal length, without heads, flexed outwards and arranged *en fleur-de-lis* ; pappiform (figs. 12 & 15).

Sympagella nux, Schmidt. Florida. (15)

SPICULES HELD TOGETHER BY AMORPHOUS SARCODE.

Species sessile, vasiform, deeply excavated, possessing a rosette.

Rosette many-rayed ; rays of unequal length, straight, capitate (fig. 6).

Askonema setubalense, Kent. Portugal. (16)

Species stalked, goblet-shaped.

Rosette few- or many-rayed : rays few, of equal length, straight and pointed (fig. 2) ; or multitudinous, of unequal length, straight and capitate : pappiform (figs. 8 & 16).

Crateromorpha Meyeri, Gray. Cebu, Philippines. (17)

Species sessile, sac-shaped.

Rosette many-rayed ; rays multitudinous, of unequal length, straight, and capitate ; pappiform (Atlantisch. Spongienf. Taf. i. fig. 6).

Holtenia Pourtalesii, Schmidt. Florida. (18)

Species oblong, excavated, provided with anchoring-spicules.

Rosette few- or many-rayed : rays few, of equal length, straight, and pointed (fig. 3), or spino-capitate (fig. 5) ; or multitudinous, of unequal length, without heads, flexed outwards and arranged *en fleur-de-lis* ; pappiform (figs. 12 & 15) : or sometimes many-rayed with rays straight and capitate (fig. 6).

Anchoring-spicules all smooth, stout, and terminating respectively in heads formed of *four* equally stout recurved spines or hooks ('Annals,' 1872, vol. ix. pl. xxi. fig. 7, &c.).

Rossella antarctica, Carter. Antarctic Sea. (19)

— *philippinensis*, Gray. Philippines. (20)

— *velata*, Wy. Thomson. South side of Færoe Islands. (21)

Species tubular, unbranched, closed at the extremity.

Rosette the same as in *Euplectella aspergillum*.

Habrodictyon speciosum, Wy. Thomson. Moluccas. (22)

— *corbicula*, Wy. Thomson. —? (23)

Species solid, not excavated, provided with anchoring-spicules and a flesh-spicule, which is birotulate.

Birotulate spicule consisting of a straight subspined shaft terminated at each end by eight separate recurved blades (fig. 21) ; or sometimes four- and six-armed, with as many heads, thus assuming the form of a rosette (fig. 22) ; or without heads, and covered throughout or at the extremities with a number of short vertical spines.

Anchoring-spicules of two kinds, viz. smooth and spiniferous, twisted into the form of a cord which runs through the head. Free terminations of the spicules unknown.

Hyalonema Sieboldii, Gray. Japan. (24)

— *lusitanicum*, Bocage. Portugal. (25)

Species more or less globular, excavated, provided with anchoring-spicules, and characterized by the birotulate flesh-spicule above mentioned.

Anchoring-spicules of two kinds, viz. smooth and spiniferous, the latter terminating at its free extremity in a recurved double hook ; termination of the former unknown.

Holtenia Carpenteri, Wy. Thomson. Sea south of Färoe Islands. (26)

Pheronema Annæ, Leidy. Santa Cruz. (27)

— *Grayi*, Kent. Portugal. (28)

Meyerina claviformis, Gray. Cebu, Philippines. (29)

Species possessing the birotulate flesh-spicule in which the terminations of both kinds of anchoring-spicules are known.

Free termination of spiniferous anchoring-spicule much the same as that above mentioned ; termination of the smooth anchoring-spicule consisting of a double hook or arm, opposite, compressed, slightly recurved, and twice the size of the head of the spiniferous form (Pl. XIV. fig. 2).

Labaria hemisphærica, Gray. Cebu, Philippines. (30)

SPICULES HELD TOGETHER IN ONE PART BY VITRIFIED FIBRE AND IN THE OTHER BY AMORPHOUS SARCODE.

Species tubular, unbranched, closed at the extremity.

Body sarcospiculous ; lid vitreous. Provided with two kinds of anchoring-spicules and two forms of rosettes, the same as those of *Euplectella aspergillum*.

Euplectella cucumer, Owen. Seychelles. (31)

SHORT COMMENTARY ON THE HEXACTINELLIDÆ.

As considerable difference exists between the older and youngest portions of the vitreous Hexactinellidæ, it is necessary for specific distinction that fragments from both should be examined—first in their natural state, and then after boiling for a few moments in nitric acid or liquor potassæ; while the minute spicules of the sarcodæ, viz. the rosettes &c., which come off in the boiling, should, with any minute fragments of the skeleton that may remain, be well washed, dried, and mounted in Canada balsam for examination with a higher power.

The chief difference in structure between *Dactylocalyx pumiceus*, Stutchbury, and the following specimen, viz. *D. pumicea*, Gray, is that the latter is charged, especially towards the surface, with long linear spicules (slender, fusiform, slightly inflated and spined for some distance at each end), while there are none to be seen in *D. pumiceus*.

I say "none" advisedly, because I have repeatedly sought for them in the type specimen of *D. pumiceus* without success. Boiling in nitric acid completely frees *D. pumiceus* and *D. pumicea* from the rosette, because the rosette belongs entirely to the sarcodæ; but the long acerate spicule, although it also appears to be isolated, is retained in the latter by its bent position in the vitreous structure, thus fixing it there by its elasticity; so that, if these spicules had been equally common in *D. pumiceus*, S., each fragment should contain portions of them, as in *D. pumicea*, G. Had not Dr. Bowerbank figured the central (and thus unmeaning) portion of one in his illustrations of the type specimen of *D. pumiceus* (*l. c.*) without the most distant allusion to such spicules in his description, I should not have thought it necessary to write so much about it: as it is, I am compelled to the conclusion not only that such a spicule does not exist in *D. pumiceus*, but that Dr. Bowerbank has, as in other instances, introduced it as part of the illustrations of this species by mistake (to wit, the surface-spicule of *MacAndrewia azorica* with his illustration of *Myliusia callocyathes*, P. Z. S. 1869, pl. xxiii. fig. 6):

Independently, however, of this difference (and the rosette, which, although alike in other respects, is a little more robust in *D. pumicea* than in *D. pumiceus*), I find it so impossible, either in the general form of the specimens of these two sponges or in their reticulated structure respectively, to see the self-evident facts which should determine a specific distinction, that I can hardly consider them varieties, much less different species, as Dr. Bowerbank has made them.

With reference to Dr. Bowerbank's fancied differences, on which he states (P. Z. S. 1869, p. 333) that Dr. Gray "is in error" in identifying *Dactylocalyx pumiceus* with *D. pumicea* = *Iphiteon Ingalli*, Bk., because "none of the singular and beautiful forms of spicula which I have obtained from the type specimen of *D. pumiceus*, and have figured in plate iii., part i., are to be found in the tissues of the type specimen of *I. Ingalli*," it unfortunately happens that figs. 9 & 10 of these "singular and beautiful forms" belong to quite a different order of sponges, viz. to *Pachastrella abyssi*, Sdt.; fig. 11 probably to a sponge of the same kind; fig. 16 to a *Gummina*, Sdt.; and fig. 6, *a* & *b*, to sponges which are certainly not of the sexradiate system. Thus, with the exception of fig. 3, which (as before stated) appears to have been introduced by mistake, we have nothing left here by way of illustration but figures 2, 4, and 5, which are equally common to both *D. pumiceus* and *D. pumicea*.

With *Dactylocalyx subglobosa*, however, it is different; for although two of its rosette-forms are the same as those of *D. pumiceus* and *D. pumicea*, and there is a long acerate spicule present similar to that in the latter species, the large tubercles with flat muricate summits respectively on the joints of the reticulated structure in *D. subglobosa*, together with the third form of rosette (viz. the pappus-like or pappiform, with straight capitate rays), so far only observed in one other species (viz. *Crateromorpha Meyeri*), at once furnish the specific distinctions.

Here we may shortly revert with advantage to the long, linear, acerate, fusiform spicule with spined extremities, which, although not seen in *Dactylocalyx pumiceus*, forms such a prominent feature in *D. pumicea* and *D. subglobosa*, that particular mention of it is desirable. It pierces the reticulated structure of each of the two last-named sponges generally, forming by its free end on their surfaces respectively a fringe which, on account of the superior size of this spicule, is also most noticeable in *D. subglobosa*; but although it is microspined towards the ends and frequently throughout, it presents no circumscribed central inflation, no "cross" on the central canal, nor is it ever included with the rest of the spicules in the vitrified fibre, which it much exceeds in size; so that were it not so interwoven with the skeleton generally, its isolated condition and want of sexradiate character would lead to the conclusion that its presence was accidental. But what is equally worthy of notice is that a similar spicule pervades in a similar manner the structure of at least one of the Lithistidæ (viz. *Azorica Pfeifferæ*, n. sp.), as will be seen hereafter.

At first I thought, from the presence of these long fusiform spicules in great abundance and of large size in *D. subglobosa*, that the latter must be identical with *D. pumicea*; but the general globular cup-like form of *D. subglobosa*, together with the muricated summits of the tubercles on the joints and the pappiform rosette with straight capitate rays, all cause it so far to differ from *D. pumiceus* and *D. pumicea*.

Myliusia callocyathes differs from the foregoing in the thorny appearance of its fibre—that is, in the minute blunt spines which are scattered over the fibre of the foregoing species being much enlarged, elongated, and pointed,—also in the rays of the rosettes in most instances being sigmoid instead of straight, and arranged *en fleur-de-lis*, and in the absence of the linear fusiform spicules. Dr. Bowerbank's figure of its structure would be perfect were it not combined with a surface-spicule of *MacAndrewia azorica*, as before stated (fig. 6, l. c.), which of course is an oversight, the latter belonging to quite a different system of sponges, viz. the Lithistidæ.

Myliusia Grayi, both in general form and structure, has many distinguishing characters, especially that which consists in an octahedral lantern-like appearance of the joints, produced by the vitreous fibre stopping short of the joint and proceeding thence directly on from one arm of the sexradiate spicule to the other, so as to leave the centre intact and visible through the interstices. This is best seen in the younger portions of the fibre, as the older ones, by thickening, render the cross in the centre obscure. Schmidt's figure from a fossil species (Taf. ii. fig. 16, *op. cit.*) would illustrate this well, were it not for the absence of the sexradiate cross in the centre, which may have become absorbed in the deciduous specimen previously to fossilization, after the manner to be hereafter explained.

The spicules of *Euplectella aspergillum* are enveloped in ladder-like silicified fibre, such as is seen in some of the horny-fibred sponges; and the characteristic rosette for the most part has its rays arranged *en fleur-de-lis*, while the rays themselves present the peculiarity of being clavate with claw-shaped spines on the outer side of the head. The latter is repeated in *Habrodictyon speciosum* and *H. corbicula*, where the sarcode is not vitrified. It is also present in *Euplectella cucumer*, which appears to be a mixed species in point of structure; that is, while the general structure in the figure looks as if unaccompanied by vitreous fibre, the lid not only appears to be consolidated by it, but in the index to the plate is stated to be "soldered," the only time that this word is used in the whole paper. Thus, a fragment of a *Euplectella* of this nature, presented to the British Museum by "Admiral Sir W. Belcher,"

leads me to the conclusion that it must have belonged to a specimen of *Euplectella cucumer*. That described by Professor Owen and Dr. Farre I have never seen; but no one can have compared the specimens of *Euplectella aspergillum*, which are very common now, with the figures of *Euplectella cucumer* drawn on stone by that accurate artist Mr. G. B. Sowerby (*l. c.*), and those taken from photographs of *Habrodictyon speciosum* and *H. corbicula* obtained by Prof. Wyville Thomson (*l. c.*), without being convinced that *E. aspergillum*, *E. cucumer*, and *Habrodictyon*, if not distinct species, are very different forms of the same type.

Since writing the above I have carefully examined the specimen of *Euplectella cucumer* described by Prof. Owen, still in the possession of Dr. A. Farre, F.R.S., whose kindness on the occasion can only be exceeded by his continued desire for the further elucidation of this beautiful species. I have also examined the figure of *Alcyoncellum speciosum* (*Habrodictyon*, Wy. Thomson) given by Quoy and Gaimard in the Atlas to their Natural History of the Voyage of the 'Astrolabe' in 1826-29 (pl. xxvi. fig. 3, Zoophytes, 1833); and, through the kindness of my friend Dr. J. E. Gray, I am in possession of excellent photographs of this and *A. corbicula*, Val., of the natural size; so that, with specimens of my own of *Euplectella aspergillum*, I am altogether now able to state with certainty the principal differences that exist between these species.

1st. *Euplectella aspergillum* has its spicular basketwork, both of the body and lid, throughout cemented together by an envelope of vitreous ladder-like fibre, which "ladder-like fibre" in a *horny state* is also a peculiarity of some of the kerataceous sponges. The main lines of spicules are longitudinal and transverse, so that, cutting each other at right angles and at nearly equal distances, they leave a number of squarish areas in the intervals, occupied alternately by round holes and matted basketwork. Through this arrangement, the squares with holes and basketwork respectively form diagonal lines again crossing each other, but now obliquely and somewhat spirally round the body; while a number of compressed ridges or frills about a quarter of an inch high, and formed of the same kind of vitreous spicular structure as the rest of the sponge, run along in more or less continuous spiral lines obliquely through the squares of matted basketwork, leaving those with holes free between them, finally terminating above in one which encircles the lid-like end where the latter is joined to the body. The lower end, on the other hand, which is also closed but of a conical form, similar to the

end of a conical sac, is enveloped in a bunch of white horse-hair-like, long, anchoring-spicules, respectively smooth and spiniferous, with hooks at the free extremity of the latter.

2nd. *Euplectella cucumer* has the spicular basketwork of the *lid* alone cemented together by an envelope of vitreous ladder-like fibre, while all the spicules of the basketwork of the *body* below are cemented together by *sarcode only*. The main lines of spicules &c. are the same as in *E. aspergillum*; but there are no ridges or frills, their place being supplied by robust vertical spines one eighth of an inch long, respectively situated in the centre of each square of the matted basketwork, so that the spiral lines of holes are between rows of spines, which thus replace the ridges in *E. aspergillum* (Pl. XIV. fig. 10, *aa a*). Indeed there is a special form of sexradiate spicule produced for this purpose, in which the projecting spine or ray is far more robust than any of the rest, the opposite continuation or internal arm being more or less aborted, and the four horizontal ones extended diagonally along the squares of basketwork to meet the corresponding arms of their neighbours. This spicule is delineated in the original description of the sponge by Prof. Owen (Trans. Linn. Soc. 1857, vol. xxii. pl. xxi. fig. 5), and its position pointed out in the explanation of the plate, but does not appear in the figure of the sponge itself. In other respects *E. cucumer* is generally like *E. aspergillum*, but possesses a number of minor differences, which it is not requisite to mention now.

3rd. *Alcyoncellum speciosum* and *A. corbicula* (*Habrodictyon*, Wy. Thomson) have no vitrified fibre in their composition. The spicules of which their basket-like structure is composed are stated by Prof. Thomson, who examined the specimens, to be *cemented* together by a "small quantity of mucilaginous sarcode" only ('Annals,' 1868, vol. i. p. 126); and it is evident from the photograph that the main spicules present no regularity in their arrangement like those of *Euplectella aspergillum* and *E. cucumer*—that is, that they do not for the most part cross each other at right angles, in consequence of which neither the holes nor the interspaces are regular either in size or direction, while the interspaces present neither "ridges" nor "spines." Neither does either of these specimens possess any anchoring-spicules; while, as evidence of their sessile growth, *Alcyoncellum speciosum* still retains at its base a portion of the rock to which it was attached. On this difference, however, I do not wish to lay any particular stress, because I have a specimen of *Euplectella aspergillum* (fragment of the base) in the same condition—that is, sessile, on a fragment of *Lophohelia prolifera* dredged up on board H.M.S. 'Porcupine' on this side

of the Atlantic Ocean, probably somewhere between the west coast of Ireland and the Færoe Islands; so that it seems reasonable to infer that when there is a tuft of long anchoring-spicules present it is indicative that the *Euplectella* has grown in mud—and when absent, that it has grown upon some hard object.

Alcyoncellum speciosum and *A. corbicula* appear to me to belong to one and the same species; and when we find Prof. Thomson, who examined them carefully and got photographs made of them, stating respecting their differences, "I am not quite satisfied on this point even now" ('Annals,' l. c. p. 129), one wonders that he made any difference in their designation.

As regards size, *E. aspergillum*, *E. cucumer*, and *Habrodictyon* are almost all equal: hence it cannot be assumed that either is a young form of the other; and while it may reasonably be inferred that the two specimens of *Alcyoncellum* might reproduce each other, it by no means appears likely that either of the three species above differentiated could do this.

Hence, although in general form all three are alike and all possess the characteristic rosettes of *Euplectella* (Pl. XIII. figs. 4 & 11, *a*, *b*), yet between these two extremes there are the differences above mentioned, together with many other minor ones, which indicate that they are three distinct species.

Here I would take the opportunity of mentioning that Mr. Kitton, of Norwich, informs me that he possesses a specimen of *Euplectella aspergillum* in which there is a netted diaphragm—which is so far interesting as it still more nearly allies the structure of this sponge to that of the Aphrocallistidæ, where the diaphragm is a normal and constant occurrence.

As *Aphrocallistes*, *Farrea*, and *Aulodictyon* will be particularly described in the after part of this paper I shall say nothing more of them here.

In *Sympagella nux*, Sdt., there is the same ladder-like vitrified fibre as in *Euplectella*, but not the form of the rosette peculiar to the latter. Of the two forms of rosette, one is the common one (Pl. XIII. fig. 6), and the other the pappus-like or pappiform rosette with flexed rays, no heads, and arranged *en fleur-de-lis* (figs. 12 & 15), noticed in one other genus only, viz. *Rossella*. The ladder-like fibre is well illustrated by Schmidt (Atlantisch. Spongienf. Taf. i. figs. 9–12).

We come now to the *sarcospiculous* Hexactinellidæ, or those whose spicules are held together by unvitrified sarcode, of which the first is *Askonema setubalense*.

Of this sponge, as I have had nothing for examination but a fragment brought from Lisbon to the British Museum by

Mr. S. Kent, I can only state that microscopical observation of portions of it shows that, although *Askonema* possesses small sexradiate spicules, whose arms are covered with short spines, it does not possess that with one arm spined feather-like, which abounds in the *Aphrocallistidæ* &c.; and thus, as will hereafter appear, I have been able to distinguish the minute young sponge of the former from the latter, which otherwise might have been almost impossible, the rosette being of the same form in both.

In *Askonema* the small sexradiate spicules with short-spined arms (of which the vertical one on one side is often deficient) and found together in groups recall to mind the same kind of spicules (which form a rectangularly reticular network) on the surface of *Crateromorpha Meyeri* and *Rossella velata*. Indeed, so far as this goes, *Askonema* might be considered a sessile, vase-like representative on the coast of Portugal of the cup-like head of *Crateromorpha* found about the Philippines only. While the latter is about $2\frac{3}{4}$ inches high and $3\frac{1}{2}$ inches broad, the specimen of *Askonema* dredged up on board H.M.S. 'Porcupine' on the coast of Portugal, off Cape St. Vincent, was 2 feet high and 3 feet broad at the top ('Depths of the Sea,' Wyville Thomson, p. 428). In short, like most things in the west, if the Hexactinellidæ do not surpass in beauty, they do in size, for the most part, those of the east.

For the further description and illustration of *A. setubalense*, I must refer the reader to Mr. Kent's description and figures of this remarkable sponge in the 'Monthly Microscopical Journal' (l. c.), merely adding that the spicules represented in his figures 10 and 11 do not belong to the sexradiate system, but appear to me to have come from a species of *Pachastrella*, viz. *P. abyssi*, Sdt. That this should be the case is not extraordinary, seeing that the *Pachastrellæ* are great wanderers, and seem to grow wherever they can find any thing to rest upon, especially in the deep sea. I possess a portion of coral-detritus from the island of Cuba, which has been burrowed through by a *Cliona*, associated with which, in the burrow, is a *Pachastrella* possessing spicules, as my mounted specimen shows, exactly like those of our British species *Dercitus niger*, Gray, = *Hymeniacidon Bucklandi*, Bk.

The long-stemmed goblet-like form of *Crateromorpha Meyeri* would be sufficient in itself to distinguish this sponge from all other species, had it not also the peculiarity of possessing a complicated, tubuliferous, felt-like structure of the stem, sheathed by a layer of shortish, robust, smooth, fusiform spicules, in the central canal of which the "cross" may always be seen, although there may be no corresponding inflation outside. The cup, too, is covered by a rectangular lattice-like structure or

veil formed of the overlapping arms of a small spiniferous sex-radiate spicule, whose outer vertical arm being undeveloped renders it nail-like by the corresponding one projecting inward like those just mentioned in *Askonema*. It is charged also with rosettes of two kinds, one of which is the pappus-like or pappiform one with straight capitate rays, as yet only noticed in two other species, viz. *Dactylocalyx subglobosa* and *Holtenia Pourtalesii*, Sdt.

The details figured by Schmidt of *Holtenia Pourtalesii* (l. c.) seem to me to ally it much more nearly to *Rossella* than to *Holtenia Carpenteri*, the type species of the *Holtenie*, since the former has not the birotulate spicule which is characteristic of *Holtenia* and its associates. The pappus-like rosette last mentioned is also characteristic of *Holtenia Pourtalesii*; but there is no rosette (at all events of this kind) in *Holtenia Carpenteri*, &c. Again the large nail-like spicule of the surface (l. c. Taf. i. fig. 4) is spined like that of *Rossella antarctica*. Lastly, if the pappiform rosette with straight capitate rays be equally characteristic of *Crateromorpha*, the latter also has many points of resemblance in its structure to *Rossella* with the rectangular lattice-like dermal veil &c., well seen in *Rossella velata*, Wy. Thomson.

Then the distinguishing character of *Rossella* is, that all its anchoring-spicules are smooth, and all armed with four robust recurved spines opposite ('Annals,' l. c.). It is also covered (that is, *R. velata* and *R. philippinensis*) with the rectangular lattice-like veil mentioned; and besides the common forms of rosette, it is charged with the pappus-like or pappiform one with multitudinous flexed rays of unequal length without heads, and arranged *en fleur-de-lis*, seen only in one other species, viz. *Sympagella nux*.

The arms of the large nail-like spicules of *Rossella antarctica* are covered by a layer of microspines, with here and there large curved spines, inclined outwards ('Annals,' l. c.).

Habrodictyon speciosum and *H. corbicula* = *Alcyoncellum speciosum* and *A. corbicula* have been noticed under *Euplectella aspergillum*. They are inserted here on account of their spicular structure being enveloped in amorphous sarcode instead of vitreous fibre. If the glassy fibre be considered of no specific value, then they can be removed back to *Euplectella aspergillum* at any time.

Hyalonema, from its twisted cord-like stem, composed of long anchoring-spicules, passing through the head (*Carteria*, Gray) so as to appear in a conical projection on the summit of the latter, whereby the central portion of the sponge, which thus hangs upon it, is rendered solid (instead of hollow, like

that of the rest of the species characterized by the birotulate spicule before mentioned), thus stands apart from all the other sarcospiculous forms of Hexactinellidæ possessing this spicule.

Here I take the opportunity, in connexion with illustrations, of correcting a mistake which I made respecting the anchoring-spicules of *Hyalonema* ('Annals,' vol. xi. p. 280, 1873), viz. that the specimen "half an inch long," which I took to be *Hyalonema*, I now find to be hollow, and, therefore, that it cannot be one of *Hyalonema*, but is probably one of *Holtenia Carpenteri*. Hence, I still have not yet seen the free termination of either the spiniferous or smooth anchoring-spicule of *Hyalonema*; while those described (*l. c.*) in the young *Holtenia* supposed to be *Hyalonema* show, as illustrated by Prof. Thomson (*l. c.*), that the terminations of its spiniferous anchoring-spicules are of two kinds, viz. one (the common form) in which the flukes are double and opposite, and the other in which they are double or treble and all on one side, somewhat resembling the laterally spined one of *Euplectella* (Pl. XIV. fig. 4).

Then, again (at p. 284, *l. c.*), I might have added what Dr. Gray had sketched for me in a note long ago, viz. that the broken spiral "bracket-like" line round the rough anchoring-spicules of *Hyalonema* was crowned with short spines before the latter became rubbed off (Pl. XIV. fig. 9); while they are of the same nature as the spines on the shafts of the long anchoring-spicules of *Euplectella*, *Holtenia*, and *Meyerina*, in which species, as their spiral continuation disappears, the spines become larger and more isolated.

The spines on the anchoring-spicules of *Hyalonema* are so small and so easily detached (fig. 9, *f*) that we do not wonder at their being for the most part absent on the exposed portions of these spicules; but on examining (this time) an undoubted specimen of *Hyalonema* about $1\frac{1}{2}$ inch long in the body, through which the cord passed, I found the spiral lines on those parts of the spicules which were within the body all fringed with the spines, and immediately mounted some in Canada balsam for more deliberate examination, the result of which went to show that the attenuated end of the spicule in the conical part of the twisted cord which projects above the sponge is smooth and nearly straight—that the spicule then becomes undulated, and upon each bend appears a group of minute points—that these, on descending, soon pass into short spines, and that these become more prominent and supported respectively on the bracket-like processes (Pl. XIV. fig. 9), which, as before stated, form a broken spiral line, here and there more or less continuous round the spicule (fig. 9, *d*)—till at last

the spicule disappears under the parasitic polype (*Palithoa fatua*) which afterwards, for some distance down, covers the cord like a bark. Finally, the spicules again make their appearance, but now with the spines gone and the bracket-like processes alone remaining in the form of a rough more or less continuous spiral line round the spicule, which, together with the free extremities of the smooth anchoring-one, also are always broken off, so that their free terminations are gone: this is the state in which these spicules appear for the most part in the trade specimens.

I have now described the anchoring-spicules of the specimen of *Hyalonema* above mentioned, whose body is about $1\frac{1}{2}$ inch long; and throughout the spicule, all the spines and blunt ends of the bracket-like processes both within and without the body are directed upwards—that is, towards the sponge at the summit of the cord.

Had I not been misled by the observations of others to regard the mounted specimen of the young *Holtenia Carpenteri* “half an inch long” in the first place as a young *Hyalonema*, the mistake to which I have above alluded would not have occurred. But finding it out, and having therefore had to examine more particularly these anchoring-spicules in an undoubted specimen of *Hyalonema*, I am enabled not only to correct the error, but to add more authentic information on the subject than was previously possessed, as well as to point out decisive marks for distinguishing between young *Holtenie* and young *Hyalonemata* another time.

The transition from the sparsely spined anchoring-spicule of *Holtenia Carpenteri* through that of *Meyerina claviformis* to that of *Hyalonema* is represented in Pl. XIV. figs. 7, 8, & 9, where also a comparative view of the heads or free terminations of the anchoring-spicules of *Labaria hemisphærica* (figs. 1 & 2), *Meyerina claviformis* (fig. 3), *Euplectella* (figs. 4 & 5), and *Holtenia Carpenteri* (fig. 6) is also given, to which I have alluded in the “Observations” appended to my description of *Labaria* (‘Annals,’ vol. xi. p. 280, &c., 1873).

Holtenia Carpenteri, *Pheronema Annæ*, *P. Grayi*, and *Meyerina claviformis* all probably possess the same kind of birotulate spicule as *Hyalonema* (Pl. XIII. fig. 21). I say “probably” with reference only to Prof. Leidy’s hasty description of this sponge, in which this spicule appears to have been overlooked. As in *Hyalonema*, so also probably in all the other Hexactinellidæ characterized by the birotulate flesh-spicule, this is not infrequently found in a sexradiate form, which at once identifies it with the rosette (fig. 22); that is, it may consist of three birotulates joined together in the centre, and thus present six

heads; or it may consist of two birotulates joined together in the form of a cross, and thus present four heads. All the sponges just mentioned, too, possess anchoring-spicules of two kinds, viz. spiniferous and smooth, of which the free or anchoring end of the former terminates in two recurved spines or hooks opposite. But these spicules in all are free, and flow from all parts of the base, not twisted into a compact cord like those of *Hyalonema*, which also traverses the body of the latter, as before stated, in the same form, rendering it solid in the centre, which solidity is replaced, in all the other sponges above mentioned, by a central excavation more or less cylindrical, large, and deep.

In *Pheronema Annæ*, however, this cavity is not wide as in *Holtenia*, but narrow as in *Meyerina claviformis*, and in like manner branches off at the bottom, which is some distance above the base of the sponge. Prof. Leidy describes it as a "canal," whose orifice is only four lines in diameter, descending in the axis of the sponge for "almost half its depth," when it appears to divide into several branches. This is very like the cavity in *Meyerina claviformis*. (For a description and figure of *Pheronema Annæ*, see 'Month. Microscop. Journ.' June 1, 1869, vol. i. p. 36; and 'American Naturalist,' 1871, vol. iv. p. 17.)

Labaria hemisphærica, although possessing the birotulate spicule, is, in addition to the bird's-nest form of its body, distinguished from all the rest by the terminations respectively of its spiniferous and smooth anchoring-spicules, especially the latter (Pl. XIV. figs. 1 & 2). While that of the former consists of a tumid head armed with two round recurved spines opposite like the flukes of an anchor (fig. 1), that of the smooth spicule consists of a compressed head and two compressed spines or arms expanded in the form of a crescent or leather-cutter's knife to double the breadth of the spines on the head of the spiniferous spicule (fig. 2). *Labaria* is the only sponge possessing the two kinds of anchoring-spicules in which I have seen the termination of the *smooth* form.

Euplectella cucumer, which finishes my list, has already been noticed in connexion with *E. aspergillum* and *Habrodictyon*.

[To be continued.]

XLV.—On three new Species of Birds from Chefoo (North China). By ROBERT SWINHOE, H.B.M. Consul at Chefoo.

1. *Golden-sided Grey Thrush.*

This thrush was shot on the 14th May, on Lighthouse Is-