XI.—*The Sponge-fauna of Norway; a Report on the Rev. A. M. Norman's Collection of Sponges from the Norwegian Coast.* By W. J. Sollas, M.A., F.G.S., &c.

[Plate VI. & VII.]

In the spring of the year (1879) my friend the Rev. A. M. Norman placed in my hands for description the fine collection of sponges which he had dredged the previous year from the coast of Norway.

This rich material placed completely at my disposal, unhampered by restrictions, has proved so fertile in interesting results that, even with the expenditure of the whole of my leisure time, I have as yet succeeded only in making a beginning to the work of its investigation. It would be useless, however, to defer publication till the investigation is complete; by that time many of the new species which occur in the collection would in all probability have been discovered and described by others, as, indeed, in one or two instances has happened already, and a large part of the labour which has been spent upon them would thus be entirely thrown away.

As regards the general conditions under which the specimens lived, and the circumstances under which they were obtained, I cannot do better than quote nearly entire the graphic description by Mr. Norman himself; he says *, "The district embraced was, speaking roughly, for I do not know the exact mileage, from 15 miles north to 15 miles south of Bergen—the Fiord chosen to the north being Oster Fiord, and the dredging in the south terminating at Kors Fiord.

"The weather was remarkably warm for the time of the year (May), and the circumstances for dredging altogether most favourable.

"Dredging in the Norwegian Fiords is a very different matter from what it is in the ocean round Shetland. In the latter case great expense must be incurred. Exposed to every wind which springs up, in the open sea, with an almost constant heavy Atlantic swell, the employment of a yacht or steamer is absolutely necessary, at least when dredging 20–40 miles from land. After tossing about in such a vessel for a week at sea it often happened that hardly twenty hours' dredging was practicable; and the greatest depth never exceeded 170 fathoms. Compare with this dredging in Norway. A small boat with four men will suffice for our purpose, if fur-

* "The Mollusca of the Fiords near Bergen, Norway," by the Rev. A. M. Norman, M.A., in the 'Journal of Conchology,' Jan. 1879.

nished with suitable apparatus for lightening the labour of hauling in the dredge. In this we lie calmly on the lake-like surface of a narrow Fiord, where we are never more than about a mile from land, and let down the dredge to find a fauna unknown at Shetland, and approximating to that of the deeper parts of the North-Atlantic Ocean. It fairly astounds us at first, after what we have been accustomed to during five-and-twenty years' dredging in our own shallow seas, to drop the dredge over the boat-side and see 400 fathoms of line run out before a resting-place is found at the bottom, and this so near to shore that, letting out as much line again, it is actually possible to pull to shore from this great depth while the dredge lies still where it was let go, to land and haul it in from the rocks, and, if it does not catch (which it probably will do as it mounts the precipice), there to bring it in. It seems incredible until we have proved it, that in pulling over those few hundred yards of smooth surface to the shore we have passed over a precipice of more than 2000 feet, which lies hidden by the calm water which ripples against our bows."

Present condition of the Sponges.—The specimens have been all excellently preserved, some by drying, some by immersion in spirits—the latter still retaining so many details of their original histological character that I found it possible to obtain considerable information with respect to the nature of their soft parts.

Mode of Preparation.—In preparing specimens for microscopical examination I followed the ordinary methods for obtaining the spicules in the free state; but in cutting and mounting "sections" I adopted the processes which have hitherto, in this country at least, been confined to the examination of quite soft tissues. A piece was cut from the sponge large enough to contain a representative of each of its different tissues; this was then soaked in distilled water till its contained alcohol was as nearly as possible all extracted; it was then transferred to a strong solution of gum, in which it was allowed to stand for an hour or so; finally it was placed in the well of a freezing-microtome and frozen in the usual way. From the frozen specimen slices could be cut of any required thinness, the razor, strange to say, passing through the soft tissues and hard spicules with apparently equal ease.

The slices so obtained were variously treated: some stained, and some not, were mounted in glycerine of various degrees of strength; others were treated first with absolute alcohol, then with carbolic acid and turpentine and mounted in Canada balsam.

"Teasing" was resorted to in the case of some tissues with success, especially when it was found desirable to observe the behaviour of the tissue with reagents.

Altogether the various methods pursued have, I believe, succeeded in eliciting nearly all the information that could be extracted from the specimens; and that this is very far from being so complete as could be wished is to a great extent owing to the imperfect manner in which histological characters are exhibited in sponges which have been preserved in spirits without any previous treatment. Mr. Norman's specimens are perfect as spirit-specimens; they were not preserved with a view to submitting them to detailed histological examination. And here it may be worth while suggesting that if in the future it should be desired to preserve sponges with this object, a preliminary soaking in osmic-acid solution of ·02 or ·03 per cent. should be given to them before placing in spirits; this will effect nearly every thing that may be desired. With osmic-acid-treated specimens and the help of a freezing-microtome no difficulty should be experienced in obtaining an almost complete knowledge of the minute structure of any sponge.

We may now proceed with the work of determining and describing species, selecting to begin with the family Tetractinellidæ.

Tetractinellidæ.

Genus Stelletta, Sdt.

Species *Stelletta Normani*, nov.

Sponge (Pl. VI. fig. 1) more or less spherical in shape, becoming depressed cake-like with age, sessile, attached: in size an ellipsoidal form measured $1\frac{6}{10}$ inch in length, $1\frac{1}{10}$ in breadth, and $1\frac{1}{10}$ in height; a cake-like form 2 by $1\frac{1}{2}$ by $\frac{3}{4}$ inch. From the surface of the sponge the distal ends of long acerate spicules project erectly, rendering it hispid; trifid spicules accompany the acerates, and, expanding into triradiate heads with simple or bifurcated rays at about one and the same level, form a network-like covering concentric with the surface and about $\frac{1}{25}$ inch above it. Entangled among and adhering to the ends of these spicules are numerous Foraminifera, Annelids, and other organisms, as well as mineral particles; these give a dark greyish colour to the sponge, while its actual surface is of a yellowish-white colour. Oscules not apparent. Pores numerous, dispersed, minute.

Skeleton.—The skeleton consists of long-shafted spicules, minute hair-like spicules, and stellates. The long-shafted spicules may be divided into two groups, the robust and the slender.

Thick long-shafted Spicules.—(i) a simple fusiform, straight or slightly curved, sharply pointed acerate, 0·235 inch long, 0·0025 inch broad (Pl. VI. fig. 4); (ii) trifid spicule with simple rays, shaft 0·16 inch long, 0·0025 broad, arms 0·03 inch long (Pl. VI. fig. 5); (iii) trifid spicule with bifurcated arms, shaft 0·11 inch long, 0·00375 broad, arms 0·0375 inch long (Pl. VI. figs. 6, 8).

Thin long-shafted Spicules.—(i) a long, slender, sharp-pointed acerate, 0·23 inch long (Pl. VI. fig. 11); (ii) trifid spicule with forward-directed arms, 0·215 inch long (Pl. VI. fig. 10); (iii) trifid, with arms recurved, anchor-like, 0·216 inch long (Pl. VI. figs. 9, 15); (iv) trifid spicule with forward-directed arms, 0·0625 inch long (Pl. VI. fig. 7). All these spicules are about 0·00125 inch broad. No. iv is no. iii of the preceding group in miniature.

Stellates.—These are of two kinds:—one somewhat larger, 0·0013 inch in diameter, with fine pointed rays (Pl. VI. fig. 13); the other smaller, 0·0004 inch in diameter, with blunt-ended rays and less regular in form (Pl. VI. fig. 12). Bowerbank's term "cylindro-stellate" may be adopted for the latter.

Hair-like Spicules or Trichites.—The "trichites," as these fine, immeasurably thin, hair-like spicules may be termed, are usually collected together in cylindrical sheaves or bundles, from 0·0016 to 0·002 inch long, and 0·0008 inch broad (Pl. VI. figs. 14, 16): each sheaf appears to represent a cell, and the spicules siliceous rhaphides within it; the unmetamorphosed protoplasm of the sheaf is chiefly accumulated in a layer at each end; one of these layers contains a nucleus with a spherical nucleolus. With age the trichites appear to become separate and are freed from their surrounding envelope. Their length is the same as that of the bundle which they form.

Hab. Marine.

Loc. Kors fiord, Station 23, depth 180 fathoms.

In transverse section the sponge is seen to consist of an internal "mark" (body-substance), separated by a layer of crypt-like cavities from an external well-marked cortex (Pl. VI. fig. 2). The cortex is about $\frac{1}{15}$ inch thick; its lower half consists of a layer of bluish-white translucent tissue of great toughness and elasticity, and bearing a superficial resemblance to cartilage.

The "mark" is of a yellowish-grey colour, and traversed by canals which branch and become smaller towards the subcortical crypts. The crypts are separated from each other by a number of fleshy pillars traversed by the shafts of long acerate and trifid spicules; they communicate laterally, to form a subcortical layer of winding passages.

Under the microscope the transverse section shows an outermost structureless membrane succeeded by a layer of minute stellates*, the two together having a thickness of 0·0004 inch (Pl. VII. fig. 18, *a*). A layer of connective tissue with scattered stellates and of variable thickness succeeds.

The next layer, 0·03 inch thick, consists chiefly of trichite sheaves arranged in packets—the spaces around and between the packets, but not about the separate sheaves, being filled up with gelatinous connective tissue, the corpuscles of which are fusiform (Pl. VII. fig. 18, *b*).

The cartilaginous-looking layer (Pl. VII. fig. 18, *c*) before mentioned next succeeds; it is about 0·03 inch thick, and consists of long fusiform transparent hyaline fibres with a more refringent, faintly bluish, axial thread: these appear to be muscle-fibres, and form variously oriented fasciæ lying chiefly in a plane parallel to the general surface of the sponge (Pl. VI. fig. 3).

Just within the proximal edge of the preceding or muscular layer is a discontinuous row of large cells, variable but chiefly elliptical in form, and provided with a large oval nucleus containing some fluid and a spherical nucleolus (Pl. VII. figs. 18, *f*, & 26).

The inner or proximal face of the muscular layer is covered by an epithelial membrane bearing round nuclei.

The "mark" has a very different appearance from that of the gelatinous connective tissue which forms a large part of some sponges; it consists of finely granular protoplasm, which readily stains with reagents: about the borders of the canals it appears fibrous, owing to the presence of a number of granular fusiform corpuscles arranged in parallel order; further away from the canals nuclei present themselves similar in appearance to those which occur in the cells on the innermost face of the muscular layer; and in some cases the outlines of large elliptical cells can be traced about these nuclei; but more often the borders of the cells are obscure (Pl. VII. fig. 24).

The pillars of the crypts are chiefly continuations upwards of the mark; but they also contain muscular fibres, lying longi-

* Whether the external membrane represents a layer of plate-like epidermis, or whether it and the stellates together constitute the epidermis, is by no means clear. The stellates have much the appearance of being the contents of epidermal cells.

tudinally, which have found their way down from the muscular layer. It is through the pillars that the long-shafted spicules pass on their way to the surface.

The large elliptical cells of the underside of the muscular layer are continued out of it down the sides of the pillars and under the floor of the crypts.

The cortex is traversed by the "intermarginal cavities" of Bowerbank, or, as I shall term them, the "cortical funnels" or "chonæ"*. They consist essentially of a tube divided by a sphincter into a shorter proximal and a longer distal part, the "ectochone" and "endochone" respectively (Pl. VII. fig. 18, *e*). The ectochone is cylindrical or acutely conical for the greater part of its length, its proximal end being either the hemispherical termination of the cylinder or the rounded apex of the cone; its distal end is greatly expanded beneath the dermal layer, and produced laterally into canals from which smaller canals proceed and terminate in the pores of the surface, either immediately or after once more subdividing into still smaller canals. The endochone is a more or less hemispherical dome, which may be prolonged downwards as a very short cylindrical or conical tube, and which opens freely into the subcortical crypt. Generally each crypt is furnished with two or more funnels. The distal half of the ectochone lies in the layer of trichite sheaves; its proximal half and the whole of the endochone lies in the muscular layer of the cortex. The funnels are lined by an epithelial layer, outside which is a layer of concentric muscle-fibres; but when the ectochone traverses the layer of trichite-sheaves, the concentric muscles are replaced by gelatinous connective tissue containing fusiform corpuscles with nuclei.

Arrangement of the Spicules.—The long-shafted spicules which occur in the mark are chiefly robust acerates, gathered together into loose fibres, which exhibit no regular arrangement; on approaching the cortex, however, the fibres arrange themselves along radii more or less at right angles to it, pass through the pillars of the crypts, traverse the cortex, and project beyond it. At the same time trifid spicules put in an appearance, their distal triradiate ends lying imbedded at all levels in the cortex, or expanding at some distance outside it. Where the fibres pass out of the sponge their constituent spicules have so much diverged from one another that the fibre-like form is lost; the dermal layer of the sponge is slightly raised, tent-like, about the fibre where it emerges. The small trifid spicules (Pl. VI. fig. 7) are almost con-

* χώνη, a funnel.

fined to the upper corners of the crypts, to which they serve as a kind of groin; the arms of large trifids sometimes occur in the same position, and where both are absent their place is sometimes supplied by a projecting spur produced from the shaft of one of the robust trifids (Pl. VI. fig. 8).

Stellates.—The cylindro-stellates are most abundant in the dermal layer, where the sharp-rayed forms are rare; both kinds of stellates are thickly strewn around the walls of the crypts, and both are rare in the interior of the mark. The sharp-rayed forms preponderate in the mark.

Trichites.—The trichite sheaves occur as the chief constituents of the outer half of the cortex; they accompany the large spicules through the pillars of the crypts, and are abundantly dispersed throughout the general substance of the mark.

Foreign Bodies.—The mark contains a surprisingly large number of foreign bodies imbedded in its substance. The nature of these included bodies is very various; but, for the most part, they consist of tests of Foraminifera, Radiolaria, and Diatoms, and the calcareous and siliceous spicules of a variety of other sponges, including an occasional *Geodia* globule.

Observations.

1. *The Muscular Layer.*—Before proceeding to describe this a little more fully than we have yet done, it may be worth while giving a short account of observations which have been already made by others on the occurrence of muscular tissue in the sponges.

Lieberkühn * appears to have been the first to draw attention to the resemblance between certain sponge-tissues and unstriated muscle-fibre, as in his description of the fibrous layer of the cortex in *Tethya lyncurium*, where he says that the fibres of this layer may be regarded as related to the so-called organic muscle-fibre of the higher animals.

Oscar Schmidt † follows, quoting Lieberkühn, confirming his observations, and extending them to other species, *ex. gr. Ancorina cerebrum*, Sdt.

Kölliker ‡ likewise describes the muscular tissue of certain rind-sponges.

O. Schmidt § again discusses this subject, confirming, by his own observations on the intermarginal cavities of *Geodia gigas*, Sdt., those made by Bowerbank on his *Geodia Baretti*,

* Leiberkühn, 1859, Archiv f. Anatomie u. Physiologie, p. 523.

† O. Schmidt, 1862, Die Spong. d. Adriatischen Meeres, p. 43, pl. iv. fig. 1, *a*, *b*.

‡ Kölliker, 1864, Icon. Histolog. i. Heft, p. 48.

§ O. Schmidt, 1866, Adriat. Spong. ii. Supplem. p. 3.

from which it appeared that the iris-like diaphragms extending across these cavities are capable of spontaneous contraction and expansion, so as to vary at will the size of the central lumen; and hence he draws the obvious inference that the fusiform fibres composing these diaphragms are not only morphologically similar to muscle-fibres, but physiologically as well; from this he proceeds to the conclusion that the fibres of *Tethya* and other rind-sponges are likewise muscle-fibres.

Häckel * does not deny that the fusiform fibres are both irritable and contractile, in the sense of shortening in the long and broadening in the transverse direction; but he maintains that true muscle cannot be evolved without a simultaneous differentiation of nerve-tracts; and since specialized nerve-tracts do not exist in sponges, he would call the contractile fibres in question "neuro-muscles."

Carter † describes the fusiform cells, referring to his figures in the Ann. & Mag. Nat. Hist. 1872, vol. x. pl. vii. figs. 9, 10, in illustration. These cells are less specialized than those to be met with in many other instances (they resemble fusiform connective-tissue corpuscles); but Carter decides to regard them provisionally as muscular.

F. E. Schulze ‡ figures and describes fusiform cells also from an *Aplysina* (*A. acrophoba*); he follows Häckel in refusing to designate them as muscle-fibres, preferring the term "contractile fibre-cells."

Carter §, in his account of *Axos spinispiculum*, Carter, describes some fibrillated fibres which he conjectures may be muscular, especially as they lie parallel to each other and are not united as in elastic tissue.

In *Stelletta Normani* the fibres are the best marked I have yet met with in any sponge, and they likewise most closely resemble the organic muscle-fibres of the higher animals; they are about 0·0066 inch long and 0·0003 broad, fusiform, hyaline, colourless, and of sharply marked contour; their nucleus or axial thread, as it may be more correctly termed, is fusiform, homogeneous, faintly bluish in colour, highly refringent, and 0·0035 inch long (Pl. VII. fig. 20). With polarized light the fibres behave like uniaxal crystals. Treated with acetic acid or boiled in water they undergo no appreciable change; but potash and nitric acid produce well-

* Häckel, 1872, Die Kalkschwämme, p. 414.

† Carter, 1875, Ann. & Mag. Nat. Hist. ser. 4, vol. xvi. p. 36.

‡ Schulze, 1878, Zeitschrift f. wiss. Zool. p. 394, pl. xxii. fig. 13.

§ Carter, 1879, Ann. & Mag. Nat. Hist. ser. 5, vol. iii. pp. 287 and 290, pl. xxv. figs. 6–8.

marked effects. Thus on adding a 5 or 10 per cent. solution of potash to a fragment of the teased-out tissue, the fibres at once became swollen, those which were previously curved straightened themselves out, and simultaneously the axial thread almost completely disappeared; on then adding a 10 per cent. solution of nitric acid the fibres at once contracted, and the axial thread became more visible than it had been before; again adding potash the fibre expanded; again nitric acid, and it contracted; and as often as one or the other reagent was applied, so often the same results were produced. With strong acid the outlines of the fibres appeared to vanish, and a homogeneous substance remained behind, in which the axial thread remained wonderfully clear and distinct; on adding magenta, the threads stained deeply, but the matrix was not affected. The fibres can best be separated from their tissue by macerating thin slices for a few days in baryta-water or 1 per cent. chromic-acid solution, and then teasing out.

The muscular layer passes at its distal margin insensibly into gelatinous connective tissue with fusiform corpuscles. The change seems to be accomplished by the loss of a distinct border to the muscle-fibres, and the growth of the fusiform axial thread at the expense of their hyaline portion; at the same time a distinct but small nucleus and nucleolus become clearly visible in the axial thread, which has also acquired a granular character (Pl. VII. fig. 17).

The muscles of the sphincter are darker than those of the rest of the muscular layer, owing to the increased size and proximity of their axial threads and to the development of fine granules in their hyaline exterior.

With carmine or magenta the axial threads of the muscle-fibres are easily stained, but the hyaline part not at all; hence when a section of the muscular layer is stained, the sphincters are made very prominent, since their abundant nuclei lead them to acquire a very dark colour.

We have applied the term muscle-fibres to the structures just described, because they are morphologically similar to the fibres occurring in other animals to which no one hesitates to apply the term "muscular;" and the fact that, slightly modified, they enter into the composition of the sphincters of the cortical funnels seems to show that they are functionally muscles as well. If, then, functionally and morphologically they resemble the organic muscles of other animals (and Kölliker, Oscar Schmidt, Häckel, and F. E. Schulze all seem agreed upon this point), one sees no good reason for withholding from them the name muscular. The specialization which converts an indifferent cell into a muscular fibre consists simply of a limitation of its contractility to a particular direction, so that it contracts in a longitudinal and broadens out in a transverse direction; its irritability is by no means suppressed; and, as is well known, both striated and unstriated muscles are capable of responding to thermal, chemical, and mechanical stimuli, quite independently of any nervous stimulus. This being so, all muscles, both those connected and those not connected with a nervous apparatus, may be regarded as neuro-muscles; and I, for my part, do not see what is to be gained by introducing this term into our nomenclature; it seems to imply that in the muscles of the higher animals something, some property, has been lost which was present in the muscles of such animals as are without a nervous supply; while we know this not to be the case. Of course a nerve is in a very different case; the tissue which has been converted into a nerve has not only gained an enhanced irritability, but has lost all trace of contractility; and if we found a nerve possessing contractility we might begin to think of coining some new term to distinguish it from the more highly specialized tissue. The inconvenience which would attend the recognition of muscles and "neuro-muscles" as distinctly different tissues may be illustrated by the observation of Engelmann, who states that the middle third of the ureter of the rabbit contains no discoverable nervous structures, and yet exhibits automatic and rhythmical contractions*. Surely we cannot be expected to call the muscles of this part of the ureter by a different name from those otherwise quite similar ones of the rest of that structure.

Whatever our opinions with regard to nomenclature may be, the difficulty of explaining the manner in which the muscular layer of our sponge receives its stimuli remains the same; it is so important a tissue of the sponge, so perfectly differentiated, that one can hardly believe associated nerve-structures to be absent; and yet I have not been able to discover any trace of the presence of such structures. The large elliptical cells underlying the muscular layer and surrounding the subcortical crypts are wonderfully like ganglionic cells; but though they sometimes are elongated in one or other direction into a tear-drop shape, yet they are never prolonged into any distinct thread which might be regarded as a nerve. They do not seem to be nerve-cells; and perhaps they may be "ova;" but without tracing their development it is impossible

* Foster, Text-book of Physiology, 1878, p. 83.

to say. On the whole I am disposed to regard them as the ordinary cells of the mark rendered very distinct by their occurrence in a tissue of markedly contrasted character. The spicules which extend beyond the surface of the sponge might perhaps suffice to convey a mechanical stimulus to the muscular layer, though this view is certainly attended with serious difficulties.

2. *Cortical Funnels or Chonæ.*—As the nomenclature of these organs is somewhat varied, one might almost say "poikilitic," a short account of the various terms in use may not prove superfluous. Most authors have founded their terminology on their ideas of the homology of these organs with the intermarginal cavities of Bowerbank; and while this plan has its special merits it suffers from the serious drawback that ideas as to homology are liable to change with advancing knowledge, the nomenclature must perforce change with them, and changes in nomenclature are most undesirable. Carter* abstains from committing himself and merely terms these tubes the hourglass-shaped openings or hourglass cavities. Bowerbank† and Oscar Schmidt‡ regard them as corresponding to the intermarginal cavities of other sponges, such as *Chalina* and *Spongilla*, though they do not say why the "cortical funnels" and "subcortical crypts" should not both together be regarded as representing the intermarginal cavities. Häckel§ appears to share the views of Bowerbank and Schmidt, but is anxious above all things to make it clear that the intermarginal cavities are nothing more than modifications of the ordinary "Astcanäle," one of the bladders of the "blasenförmige" type of "Astcanal" which has become specialized; and he prefers to call them "subdermal cavities," a term synonymous with Bowerbank's intermarginal cavities. Perhaps I am wrong in thinking that the homology of these cavities is not quite clear; but, however this may be, and without wishing "to ascribe any essential significance to them whatsoever," I still think they are sufficiently specialized parts of the canal-system and sufficiently different from other subdermal cavities to deserve a distinct name; and as "cortical funnel (*chone*)" is expressive without involving theoretical considerations, I have ventured to make use of it. Häckel compares the sphincters of the funnels to the transitory sphincters which are formed by the closing of the dermal pores and gastral ostia of some calca-

* Carter, Ann. & Mag. Nat. Hist. 1869, ser. 4, vol. iv. p. 13.
† Bowerbank, Brit. Spong. vol. i. p. 101.
‡ O. Schmidt, Adriat. Spong. ii. Suppl. p. 4.
§ Häckel, Kalkschwämme, p. 236.

reous sponges. That an analogy exists is indubitable; but the sphincters of *Geodia* and the like are not transitory, any more than those of the ostia of some sponges, and they are besides composed of far more highly specialized muscle-fibres, arranged in a much more complex layer than is the case with the fusiform contractile cells which serve to close the dermal pores or ostia of any sponge which I have examined.

The following table gives the equivalent terms used by different authors, in four columns: the first gives the terminology of Bowerbank, O. Schmidt, and others; the second that of Carter and partly of Johnston; the third of Häckel; and the fourth that adopted here.

1.	2.	3.	4.
Pores.	Apertures.	Hautporen.	Pores.
Distal end of intermarginal cavity.	Pores.		
Intermarginal cavity.	Hour-glass cavity.	Subdermal cavity.	Cortical funnel (chone).

3. *The Trichites.*—These spicules form a layer which is completely homologous with the layer of globates in *Geodia* and the like; and we may regard the trichite sheaf itself as homologous with the globate spicule: in the one the trichites have a radiate arrangement, and are fused together in a round ball; in the other they remain separate from each other and, lying parallel one with another, form a cylindrical bundle.

Certain structural differences distinguish the trichite-layer from the globate, independently of differences in the spicular elements themselves; thus in the *Geodia*-type of rind the globules are united by ligaments of fine sarcodic (muscular?) filaments, while in our *Stelletta* the trichite sheaves are not connected with each other by any intermediate tissue, but simply lie loose in "pockets" of their layer. In both the globate and trichite layers, however, certain spherical cells lie amidst the spicules; in the trichite layer these cells are very similar to colourless blood-corpuscles, and possess a nucleus with a round nucleolus; the corresponding cells in the globate layer are of a somewhat different character, as will be noticed in our description of the *Geodia* rind.

In examining sections of the trichite layer one constantly meets with examples like that shown in Pl. VI. fig. 16, where the trichites remaining conjoined at one end have separated and diverged at the other, and, dividing the sarcode of this end between them, appear capitate with minute bead-like particles of it.

Trichite sheaves are common in a variety of sponges, especially among the Esperiadæ. Oscar Schmidt * has described the structure of those which occur in *Esperia lucifera*, Sdt.; he, however, represents the nucleus as occurring at the side of the sheaf, and not at the end, as shown in my drawings. The enclosing cell-membrane is also more distinct in his figures than I have yet seen it. Possibly his specimens represent an earlier stage in the history of the sheaf than mine, and the nucleus may subsequently become transferred from the side to the end of the cell. In Schmidt's fig. 21, which represents a mature cell, this, however, does not appear to be the case, and we must probably fall back on inherent differences in the spicule-sheaves of the two sponges.

4. *Foreign Particles.*—The congregation of foreign particles on the exterior of the sponge, and their abundant distribution within it, are very striking facts, though not by any means confined to this species or genus; as one observes the numerous remains of organisms imbedded in the sarcode of the mark one can scarcely refrain from regarding them, like the wings of flies in a spider's web, as the remnants of previous feasts. The cortex is so admirably adapted for preventing the entrance of foreign bodies, especially of the size of those under consideration, that it is difficult in the extreme to see how those within the mark can have found their way there unless through the cooperation of the sponge itself. If this theoretical view be the true one, then we may further regard the forked ends of the projecting spicules as serving not only for a means of defence, but as actual traps for capturing prey and so securing a constant supply of highly proteinaceous food for the sponge.

5. *Classification.*—Of all the various species of the genus, *Stelletta Normani* is provided with the most complete equipment of spicules; and no difficulty is likely to be encountered in its identification.

The following list of the already published species of *Stelletta* may prove useful for reference. I have not included in it those species of Bowerbank's *Ecionema* and *Tethya* which may probably turn out to be *Stelletta*, because I think this genus cannot last much longer without undergoing modification, and I am anxious not to transfer Bowerbank's species to it till both it and they have been subjected to revision.

* Zoologische Ergebnisse der Nordenfahrt vom 21. Juli bis 9. September 1872, p. 120, pl. i. figs. 19–21.

Table of the Species of Stelletta.

I. Species possessing ternate spicules with furcate rays.

S. immunda, Sdt. 1862, Spong. d. Adriat. Meeres, Taf. iv. fig. 3. Syn. *S. Wageneri*, Sdt.

S. Helleri, Sdt. 1864, Suppl. Spong. d. Adriat. Meeres, Taf. iii. fig. 8.

S. aspera, Carter, 1871, Ann. & Mag. Nat. Hist. ser. 4, vol. vii. pl. iv. figs. 7–13.

S. lactea, Carter, 1871, Ann. & Mag. Nat. Hist. ser. 4, vol. vii. pl. iv. figs. 17–21.

S. mucronata, Sdt. 1868, iii. Suppl. Spong. d. Adriat. Meeres, Taf. iv. fig. 2.

S. scabra, Sdt. 1868, iii. Suppl. Spong. d. Adriat. Meeres, Taf. iv. fig. 5.

S. agariciformis, Sdt., is *Thenea* (Gray) *Wallichii* (Perceval Wright).

S. discophora, Sdt., and *S. mammillaris*, Sdt., are probably *Geodiæ*.

II. Species without furcated ternates, with ternate anchor-like spicules.

S. dorsigera, Sdt. 1864, Suppl. Spong. d. Adriat. Meeres, Taf. iii. figs. 6, 7. (Doubtful whether genuine recurved rays.)

S. Grubii, Sdt. 1862, Spong. d. Adriat. Meeres, Taf. iv. fig. 2. (Rays "*raro furcatis*").

S. pachastrelloides, Carter, 1876, Ann. & Mag. Nat. Hist. ser. 4, vol. xviii. pl. xv. fig. 40.

S. pumex, Sdt. 1864, Suppl. Spong. d. Adriat. Meeres, Taf. iii. fig. 9.

III. Species without either furcate or anchor-like ternate spicules.

S. Boglicii, Sdt. 1862, Spong. d. Adriat. Meeres, Taf. iv. fig. 3.

S. pathologica, Sdt. 1868, iii. Suppl. Spong. d. Adriat. Meeres, Taf. iii. figs. 3, 4.

S. anceps, Sdt. 1868, iii. Suppl. Spong. d. Adriat. Meeres, p. 31.

NOTE.—*S. euastrum*, *geodina*, and *intermedia* of Schmidt appear to belong to *Geodia*. O. Schmidt * would regard as

* III. Suppl. Spong. d. Adriat. Meeres, pp. 20, 21.

Geodiæ only those sponges which contain globates, but no stellates, either in the rind or parenchyma; it is to be feared that the genus *Geodia* would be denuded of the majority of its species if this definition were rigidly carried out.

EXPLANATION OF THE PLATES.

Plate VI.

Fig. 1. *Stelletta Normani*, sp. nov. A very little larger than natural size. (From a photograph.)
Fig. 2. Transverse section (× 2). From a photograph.
Fig. 3. Tangential section of the muscular layer, showing the arrangement of its fasciæ: *a*, sphincter; *b*, *c*, transverse section of spicules.
Fig. 4. Robust acerate spicule.
Fig. 5. Robust simple ternate spicule.
Fig. 6. Bifurcated ternate spicule.
Fig. 7. Small simple ternate spicule.
Fig. 8. Bifurcated ternate, with a lateral spur.
Fig. 9. Slender anchor-like ternate.
Fig. 10. Slender ternate spicule, a variety with only two rays.
Fig. 11. Slender acerate spicule. Figs. 4–11 are all magnified 20 diameters.
Fig. 12. Cylindro-stellate spicule.
Fig. 13. Sharp-rayed stellate.
Fig. 14. Trichite sheaf, mounted in Canada balsam. Figs. 12–14 are multiplied 435 diameters.
Fig. 15. Head of anchor-like ternate (× 140).
Fig. 16. Trichite sheaf, mounted in glycerine, showing the divergence of the trichites, which are tipped with sarcode (× 571).

Plate VII.

Fig. 17. Fusiform corpuscle containing nucleus and nucleolus, from the connective tissue of the cortex (× 435).
Fig. 18. Transverse section of the cortex: *a*, epidermal layer, with stellates; *b*, trichite layer; *c*, muscular layer; *d*, subcortical crypt; *e*, ectochone; *f*, layer of large granular cells (× 15).
Fig. 19. Axial thread of a muscle-fibre from teased-out tissue which has been treated with strong nitric acid and then stained (× 435).
Figs. 20, 20 *a*. Muscle-fibres isolated after treatment with lime-water by teasing (× 435).
Fig. 21. Trichite sheaf in glycerine: *a*, terminal layer of sarcode, containing nucleus and nucleolus (× 435).
Fig. 22. The frayed end of a teased-out bundle of muscle-fibre which had been treated with chromic acid (× 435).
Fig. 23. Cells of the mark, surrounding a small canal (× 217).
Fig. 24. Wall of a large canal, showing connective tissue with fusiform corpuscles and scattered stellates on the exterior, and granular cells further in (× 217).
Fig. 25. Transverse section of a bundle of muscle-fibre (× 315).
Fig. 26. Granular cells, with nucleus and nucleolus, from the lower face of the muscular layer (× 435).

[To be continued.]

Rhabdopleura by differences probably ordinal in value, and which in some of its characters and in general appearance resembles the ordinary Phylactolæmata.

It is unnecessary to insist on the interest that must attach to such a form should it exist. I trust that this notice may meet the eye of some one who may have the opportunity of searching the locality from which my father's specimen was obtained, and to whom the point to be solved may appear of sufficient importance to warrant a thorough investigation.

XXV.—*The Sponge-fauna of Norway; a Report on the Rev. A. M. Norman's Collection of Sponges from the Norwegian Coast.* By W. J. SOLLAS, M.A., F.G.S., &c.

[Continued from p. 144.]

[Plates X., XI., XII.]

Order TETRACTINELLIDA, Marshall.

Tribe **PACHYTRAGIDA**, Carter.

Group *GEODINA*, Carter (Family *Geodiidæ*, O. Schmidt).

Genus 1. GEODIA, Lmk. Type *G. gibberosa*, Lmk.
(*Pyxitis*, Sdt.)

2. CYDONIUM, Fleming. Type *C. zetlandicum*, Johnst.
(*Geodia*, auct.)

3. PACHYMATISMA, Bwk. Type *P. Johnstoni*, Bwk.

4. CAMINUS, Sdt. Type *C. Vulcani*, Sdt.

5. PLACOSPONGIA, Gray. Type *P. melobesioides*, Gray.

The sponges belonging to the group Geodina have been known to naturalists for nearly two centuries, though for the greater part of this time they were lost in that chaotic assemblage which formed the genus *Alcyonium*. It was in 1815 that Lamarck* defined, under the name of *Geodia*, the first genus of the Geodine group; but so powerful a hold had the imaginary Alcyonian character of these sponges upon the minds of the zoologists of those days, that even after the generic distinctness of *Geodia* was perceived it was still retained,

* Mém. du Mus. d'Hist. Nat. i. p. 333, 1815.

even by Lamarck himself, in close connexion with *Alcyonium*, and was regarded as a member of the same family. Lamarck's description of his genus is as follows :—"Polyparium liberum carnosum tuberiforme intùs cavum et vacuum, in sicco durum; externâ superficie undiquè porosâ. Foramina poris majora, in areâ unicâ orbiculari et laterali acervata." On page 334 (*loc. cit.*) he concludes his observations with the remark, ". . . . la forme d'une géode close et la facette orbiculaire, et en crible que l'on observe sur les Géodies, constituent leur caractère générique." A single species, *Geodia gibberosa*, Lamk., is given as the type.

In 1828 Fleming * took from the *Alcyonia* another Geodine genus, and gave it the name of *Cydonium*. His definition is thus given :—"A coriaceous skin, internally carneous, with numerous straight-ridged spicula perpendicular to the surface; polypi with a central opening, and an orifice at the base of each of the eight pinnated tentacles." His type is given as *Cydonium Mülleri* (*A. cydonium*, Müll. Zool. Dan. t. 81. f. 3, 4, 5, *a*, and Jameson, Wern. Mem. i. p. 563). In his observations he states that the skin consists of animal matter cementing innumerable siliceous grains, and that the spicules, which are collected in bundles and radiate from the centre, become in many cases trifid or tricuspidate immediately under the skin.

Nothing could be clearer from this description than the fact that Fleming had before him a genus of genuine Geodine sponge. There can be no doubt about this; but if there were it would be immediately dispelled by a reference to the figure given by Bowerbank † of Fleming's original type, which is a typical *Geodia zetlandica*, Johnston.

It is remarkable that Fleming should have attached to this sponge the characters of an Alcyonian polype; nor can it be explained by easily-made references to the vigorous imaginations of the early naturalists; it seems more likely that the explanation may be of the following nature. The spicular characters of *Cydonium* Fleming had observed for himself; the Alcyonian characters he could not have observed, because they did not exist; but he identified his sponge with *Alcyonium cydonium* in Müller's Zool. Dan. (*loc. cit.*), which, from Müller's clear and apparently faithful drawings, is evidently a true *Alcyonium*. Fleming next proceeded to add the characters of Müller's specimen to those of his own, and thus produced the curious hybrid we find in *Cydonium Mülleri*. Such cases of mistaken identification are not, I believe, altogether

* British Animals, p. 516.

† Bowerbank, 'British Sponges,' iii.

unknown at the present day. Nor was Fleming wholly to blame for this blunder; for his type specimen was handed to him by Prof. Jameson *, who had previously erroneously identified it with Müller's *Alcyonium cydonium*. Müller further contributed his share to the confusion, as appears from the following remarks by Montagu †:—"Müller has also figured what he considers the Linnæan *Alcyonium cydonium* (Zool. Dan. iii. tab. 81); but this is clearly an *Alcyonium* bearing innumerable polypi; and we cannot, therefore, think it is the same as the *Alcyonium cotoneum* of Pallas, which may be the Linnæan *Cydonium*, and is probably a *Spongia*" ‡.

But, apart from this curious mistake of Fleming's, one fact stands out in the clearest manner; and that is, the marked distinction which separates Fleming's genus *Cydonium* from Lamarck's genus *Geodia*. Both were regarded by their authors as allied to *Alcyonium*; but while Lamarck's was characterized by a depressed cribriform area and a hollow cavity within, Fleming's was carneous internally and with a few congregated oscules on the exterior. Had Fleming's genus possessed the same characters as Lamarck's, the name *Cydonium* might have been cancelled; as it is, the two genera are independent of each other, and the names *Geodia* and *Cydonium* must be equally retained. Fleming's specific description is altogether inadequate, and the appellation *Mülleri* has no more value than a MS. name; it must therefore yield to that attached to the first adequate description; and this certainly is *zetlandica*, Johnston.

In 1834 Blainville§ adopted with hesitation Fleming's genus *Cydonium*, though, with his usual inaccuracy, he assigned it to Jameson. He placed it, as its describer's definition necessitated, close to *Alcyonium*. Blainville also adopted Lamarck's genus *Geodia*; but this he placed with the sponges (Amorphozoa), as Deshayes and Milne-Edwards like-

* Mem. Wern. Soc. i. p. 563, 1811. † Ibid. ii. p. 117, 1818.

‡ [The clear-sighted Montagu was quite right; the *Alcyonium cotoneum* of Pallas and the *Alcyonium cydonium* of Linné are names given to the Geodine sponge so admirably figured by Donati, on whom Linné conferred the well-deserved epithet "OCULATUS Donati." Of this sponge Donati figures, 1750 (!), the external facies, exhibiting the hollow in which would lie the great cribriform oscule (an admirable section), and the spicula in their proper position and separately. The crust of globates, the dermal porrected spicula, the porrecto- and patento-ternates which support the crust, and the acerates of the body of the sponge are all excellently drawn. The minute stellates the microscope of those days would not reveal; but there cannot be a doubt that Donati's sponge, which is Linné's *Alcyonium cydonium*, is most closely related to *Cydonium zetlandicum*.—Rev. A. M. NORMAN.]

§ Man. d'Act. pp. 525, 534.

wise did in a note to the genus in their edition of the Anim. s. Vert. of 1836.

In 1842 Johnston* redescribed Fleming's specimen of *Cydonium Mülleri*, and, not recognizing the distinction between *Cydonium* and *Geodia*, placed it in the latter genus with the specific name *zetlandica*.

In 1862 Bowerbank † reconstructed the genus *Geodia*, taking as the basis for his characterization *Geodia Barretti*, Bwk., which, as it happens, possesses the specially Lamarckian character of numerous oscules congregated in a deeply depressed area, though Bowerbank makes no mention of this fact in his generic definition. Through this omission, and the fact that *G. Barretti*, Bwk., is solid and not hollow within, there is nothing in the character of Bowerbank's *Geodia* to distinguish it from *Cydonium*, if we choose to disregard, as we must, the fictitious Alcyonian characters which Fleming erroneously added to his definition of *Cydonium*.

In the same year (1862) Oscar Schmidt ‡ also defined afresh the Lamarckian genus *Geodia*, and, by leaving out the characters which Lamarck expressly stated were typical of his genus, caused it to include the *Cydonium* of Fleming. Schmidt described four new species, all of which appear to be true *Cydonia*. He also described (p. 43 *loc. cit.*) a new genus of *Geodiidæ* under the name of *Caminus*. It differs from *Cydonium* (*Geodia*, Sdt.) in the absence of trifid spicules, and of a needle-down covering the rind, and also by the presence of a single large osculum.

In 1864 Duchassaing de Fonbressin and Gio. Michelotti § published a description with admirable illustrations of the type species of Lamarck, *Geodia gibberosa*; they also described and figured an allied species, *Geodia cariboa*, D. & M.

In 1866 Bowerbank ||, having examined Fleming's type specimens, enters into a long discussion respecting the conflicting claims of the names *Cydonium* and *Geodia*. I quote his summing up :—" The history of this sponge (*Geodia zetlandica*) presents a singular sequence of errors. In the first place, Müller is distinctly wrong in the designation of his species, which undoubtedly is *Alcyonium* of Ray and Linnæus. Prof. Jameson, perhaps misled by the stellate mantlings on the surface, believed the sponge from 'Fullah and Unst' to be the same as Müller's specimen and an *Alcyonium*. Dr.

* Hist. of Brit. Sponges, p. 195.
† Phil. Trans. p. 1098.
‡ D. Spongien d. Adriat. Meeres, p. 49.
§ Spongiaires de la Mer Caraïbe, p. 104, pl. xxv. figs. 2, 8.
|| Monograph Brit. Sponges, ii. p. 50.

Fleming, at the time of the publication of his 'British Animals,' appears to believe it to be not an *Alcyonium*, but still identical with Müller's specimen, and accordingly gives it both a new generic and specific name. At last Johnston, seeing that it is not the type of a new genus, sinks both Dr. Fleming's generic and specific names, and, correctly assigning the specimen to *Geodia*, renames it *zetlandica*."

In 1866 * Oscar Schmidt, in discussing the synonymy of Bowerbank's genera, expressed his doubts as to the position of *Geodia M'Andrewi*, Bwk., and stated that it might perhaps be a *Caminus*. He adopts Bowerbank's genus *Pachymatisma*, and suggests that *Geodia*, Bwk., is equivalent to *Geodia*, Sdt., *plus* (with a query) *Caminus*, Sdt.

In 1867 Dr. Gray †, for the first time since its institution, asserted the claims of Fleming's genus to an independent existence. Earlier in the year Dr. Gray had described and figured a new and curious Geodine sponge in which the cortex is divided into a number of distinct plates, and which possesses a central axis of globate spicules. This he made the basis of a new genus, *Placospongia*, and, indeed, of a whole new family, the *Placospongiadæ*. Dr. Gray's arrangement of the Geodine sponges is as follows:—

Fam. 1. **Geodiadæ.**

Genus 1. Pachymatisma, Bwk. *P. Johnstoni*, Bwk.

2. Geodia, Lmk. *G. gibberosa*, Lmk.

3. Cydonium, Fleming. *C. Barretti*, Bwk.

4. Erylus, Gray. *E. mammillaris*, Sdt.

5. Triate, Gray. *T. discophora*, Sdt.

6. Caminus, Sdt. *C. Vulcani*, Sdt.

Fam. 2. **Placospongiadæ.**

Genus 1. Placospongia, Gray. *P. melobesioides*, Gray.

In 1868 Bowerbank ‡ commented on Dr. Gray's reinstatement of Fleming's genus as follows:—"Dr. Fleming describes his genus as having polypi with a central opening and an orifice at the base of each of the eight pinnated tentacles, showing either that he had greatly mistaken the nature of

* Zweites Suppl. d. Spong. d. adriat. Meeres, p. 11.
† Proc. Zool. Soc. 1867, pp. 127, 492.
‡ Proc. Zool. Soc. 1868, p. 131.

G. zetlandica, Johnst., or that he had described the orange-coloured variety of *A. digitatum*, Johnst. (Brit. Zooph. ed. 2, vol. i. p. 174). *The latter appears the most probable.*" The italics are mine; and it is scarcely conceivable that Bowerbank can have written this after what he said in 1866, and after an examination of Fleming's type specimens, which he then stated were *Geodia zetlandica.* It will be observed also that Bowerbank says nothing here of the presence of the trifid spicules and globates, which Fleming mentions as occurring in his *Cydonium*, and which by themselves are sufficient to prove that Fleming can have had no other than a Geodine sponge before him.

In 1869 Carter* described a new species of *Cydonium* as *Geodia* (*Cydonium*, Gray) *arabica*; and he added afterwards that his *G. arabica*, being closely allied to *G. zetlandica*, appears under Dr. Gray's third genus, viz. that termed "*Cydonium.*"

In 1870 O. Schmidt † gave an account of the characters of the Geodinidæ, added some remarks on the genus *Geodia*, Sdt., and established a new genus, *Pyxitis*. This new genus is characterized by the occurrence in most of its members of a large body-cavity, and in all by the localization of a pore-area for the outflowing water-currents—the very characters seized upon by Lamarck as typical of his *Geodia*! But, worse than this, Lamarck's type *Geodia gibberosa* is appropriated by Schmidt as the type of his genus *Pyxitis*. It is certain that this kind of nomenclature will never be tolerated by impartial naturalists. A genus may be subdivided any number of times that may be necessary; but it is always understood that that subdivision which retains the type species shall also retain the original name ‡. If Schmidt thought it necessary to distinguish those Geodine sponges in which "durch Localisirung eines Porenfeldes für die Ausströmung so bestimmt &c.," from others in which such is not the case, he might, with some show of justice, have given a new name to the latter, but certainly not to the former, which belong inalienably to Lamarck's genus *Geodia*. This distinction, made by Schmidt in 1870, existed, however, in our nomenclature as early as the year 1828, the date of Fleming's genus, and was again distinctly enforced by Gray in 1867, three years prior to Schmidt's publication of it. Yet Schmidt, who, when Nardo is in question, is such a champion of priority, calmly ignores the observations of both his predecessors and pro-

* Ann. & Mag. Nat. Hist. ser. 4, vol. iv. p. 4, pl. i. figs. 9–16.

† Spong. Fauna d. atlantischen Gebietes, p. 68.

‡ See Rule § 4 of the Stricklandian Code.

ceeds, without altering the essential characters of Lamarck's genus, to give it a new name. No wonder that complaints of an overburdened nomenclature are becoming chronic!

In the years 1872–74 numerous descriptions of new species belonging to the genera *Cydonium*, *Geodia*, and *Pachymatisma*, accompanied by beautiful drawings, were published by Bowerbank *.

In 1874 likewise appeared the 3rd vol. of Bowerbank's 'British Sponges,' containing a fine figure of that typical specimen of *Geodia zetlandica* which had previously been examined and described by Fleming and Johnston.

In 1873 Grube † described and figured a specimen of *Pachymatisma Johnstoni*, Bwk., under the name of *Caminus osculosus*. It came from the coast of St. Malo.

In 1876 ‡ Carter described, with many interesting observations, two new species of *Geodia*—one with cribriform depressions (*G. nodastrella*), and the other with a single vent (*G. megastrella*).

The table given at the commencement of this paper represents the classification as it at present stands. The genera appear to me to require fresh examination and revision; but this is a subject to which I hope on a future occasion to recur.

Geodia Barretti, Bwk. §

The specimen under description differs only in trifling details from *Geodia Barretti*, and must necessarily be included in that species.

In form it is almost spherical, 1 inch in diameter, free, with a small Halichondroid sponge attached to it, the surface of attachment measuring $\frac{1}{4}$ inch square. It possesses a single circular oscule (Pl. X. fig. 3) $\frac{1}{16}$ inch in diameter, situated in the centre of a low dome-shaped elevation, 0·15 inch in diameter, which rises from a shallow annular depression. The surface is smooth except for the protrusion of a few long fusiform acerate spicules at one or two particular spots, and of a large number of minute acerates generally, which render it finely hispid.

The spicules (see figures on Pl. XI.) do not differ in character from those already described by Bowerbank; but it may be as well to call attention to the great length of the shafts of

* Proc. Zool. Soc. 1872–74.

† Mittheil. ü. St. Malo u. Roscoff &c. p. 132, Taf. 2. figs. 3, 3 *a–e*.

‡ Ann. & Mag. Nat. Hist. ser. 4, vol. xviii. p. 397, pl. xvi. figs. 45–47.

§ Phil. Trans. 1862, pl. xxxii. fig. 2; Hist. Brit. Sponges, i. 1864, p. 167, pl. xxviii. fig. 354; and Proc. Zool. Soc. 1872, p. 198, pl. xi.

the slender porrecto- and recurvo-ternate spicules (Pl. XI. figs. 8, 9, and 16), as these are not completely represented in Bowerbank's illustrations. In addition to the cylindro-stellates mentioned by Bowerbank there are also present in the mark a number of sharp-rayed forms, of which an instance is represented in Pl. XI. fig. 20. The cylindro-stellates of the mark often attain a much larger size than those of the cortex, which are exceedingly minute.

The arrangement of the spicules has also been excellently described by Bowerbank, so that I need now only call attention to the distribution of the stellates. The cylindro-stellates are confined to the rind and the mark immediately surrounding the crypts, the sharp-pointed forms commence immediately below the crypts, and are found throughout the rest of the mark. They never occur in the rind. This distribution is identical with that existing in *Stelletta Normani*, and probably in most Pachytragous sponges possessing two varieties of stellates.

The Canal-system.—The single oscule opens into a cylindrical tube with a rounded termination (Pl. X. fig. 1); it is 0·15 inch long and 0·1 inch wide; its walls are smooth, but rendered finely hispid by the projecting ends of small acerate spicules, which cannot be seen with the naked eye. Ending against the apparently imperforate walls of this tube, two canals are seen in a transverse section of the sponge; they are 0·1 inch wide, and descend from the oscular tube in a curved direction more or less concentric with the outer surface of the sponge. Although only these two tubes are shown in a single transverse section, there can be no doubt that others exist and would be revealed by fresh sections taken in different directions. The interior of these large excurrent tubes or main trunks of the excurrent system (for such they are) has a smooth glistening surface, which is concentrically striated by fine circular ridges and furrows, reminding one in general appearance of the "valvulæ conniventes" of the small intestine, though of course they are of very diminutive size (Pl. X. fig. 2, *r*). Similar folds, but possibly not quite so regular, exist in Mr. Carter's sponge *Axos spinipoculum*, and have suggested the same comparison to him (Ann. & Mag. Nat. Hist. ser. 5, vol. iii. pl. xxv. figs. 4, 5, p. 287). A number of sharply defined circular openings are seen in the walls of the excurrent trunks, the commencement of secondary canals which proceed from them and branch repeatedly in the substance of the sponge.

Under a low-power magnification and by reflected light the oscular tube exhibits two or three small circular openings, which place it in free communication with the excurrent trunks. These visible openings, however, are but one or two out of a great number unseen, and which are not seen because they are closed by sphincters; they can readily be made out, however, in sections by transmitted light.

We shall recur to them in describing the histology of the sponge in detail; it is sufficient to state now that the excurrent trunks, which break up into small canals in the interior of the sponge, communicate with the oscular tube by means of sphincters, and thus can be shut off from or put into communication with the exterior as circumstances may determine. The incurrent canals can best be studied in thin sections (Pl. X. fig. 6, and Pl. XII. fig. 34); the pores of the dermis lead into chones, which open each by a sphincter into the subcortical crypts; from the floor of each crypt a cylindrical tube of sharply defined outline (Pl. X. fig. 6, *i*, and Pl. XII. fig. 34) extends downwards for a variable distance into the mark, and, branching below like a bronchus, ends in fine canaliculi. Its walls are more or less finely perforated by openings from which minute canaliculi proceed. Lying parallel with these incurrent tubes and between them are others of a different character; they are generally wider, less regular in form, with more widely perforated walls, and are occasionally traversed by an irregular trabecular network (Pl. X. fig. 6, *e*, and Pl. XII. fig. 34). From the perforations in their walls canals proceed, which, after branching once or twice, and sometimes anastomosing, end in fine canaliculi. The position of these excurrent tubes with respect to the incurrent tubes is inverse; *i. e.* their open extremity is turned towards the centre of the sponge, their more or less closed end towards the rind, while the incurrent tubes lie with the closed end towards the centre and the open end towards and in free communication with the crypts. The floors of the crypts open into narrow short canaliculi like those proceeding from the incurrent canals; and in both cases these fine canaliculi open, somewhat abruptly, into ciliated chambers, the outflow-canals from which constitute the canaliculi of the excurrent tubes. These excurrent tubes, the primary twigs of the branched excurrent system, communicate with larger canals, which run concentrically with the exterior surface of the sponge (Pl. X. fig. 6, *c*). From these concentric canals other canals with trabecular walls proceed and extend deeper into the mark (Pl. X. fig. 6, *e'*), branching till they end in fine canaliculi. These canaliculi end in ciliated chambers, which are connected by shorter canaliculi with other tubes resembling in general character the primary incurrent canals. At first sight the representation of the canal-system shown in figure 6 gives one the idea that the canals marked e' are distributive and not collective in function, in which case the water, which had already passed from the incurrent into the excurrent canals, would be again distributed through a fresh set of ciliated chambers, and thus be used twice over. This does not appear probable. The tubes e' have all the characters of excurrent tubes—widely perforated trabecular walls with dichotomous canals opening into them; while the tubes i' are equally incurrent in character and give off canaliculi, which enter the ciliated chambers in the abrupt fashion so characteristic of incurrent canaliculi. To complete our representation of the canal-system we must therefore suppose that the incurrent canals i' are connected in a roundabout way by concealed canals with the subcortical crypts. By this supposition a double using of the incurrent water is avoided. In the centre of the sponge one observes sections of canals cut across in every possible direction; but even here the distinctive characters of the excurrent and incurrent canals, as described above, appear to be maintained.

The general course of the water-circulation of the sponge would appear to be as follows:—The water finds access through the dermal pores or ostia to the chones, whence it finds it way into the subcortical crypts and the incurrent canals; from these it is distributed by multitudinous little canals to the ciliated chambers, the seat of the energy on which the working of the water-circulation depends. From these chambers it passes out by fine canaliculi, which, after uniting together once or twice or oftener, empty themselves into the trabecular excurrent tubes; from these the water flows unobstructed into the large excurrent vessels, which deliver it through sphinctral apertures into the oscular tube, whence it passes freely to the exterior.

Histology.

1. *The Cortex.*—The exterior of the sponge is covered by a thin membranous film, immediately beneath which is a single layer of minute cells (Pl. XII. fig. 26), each containing a minute cylindro-stellate spicule, and having an average diameter of from 0·0002 to 0·0003 inch. The superficial membrane appears to be a mere secretion of the underlying cells, and with them forms the epidermis of the sponge (Pl. XII. fig. 26, *e*).

The epidermis is succeeded by a layer of curious tissue (Pl. XII. fig. 26, *c*), which presents a striking but superficial resemblance to the parenchymatous tissue of plants. It consists of an irregular network of very refringent, faintly bluish, transparent, narrow trabeculæ, enclosing clear transparent cavities, each of which is provided with a round nucleus and nucleolus lying on the side of one of the trabeculæ (Pl. XII. fig. 24). This is its character in its most completely specialized state; when less specialized its constituent cells can be easily made out (Pl. XII. fig. 25, *a* to *e*). They are 0·001 inch in diameter, of a round, oval, or irregularly polygonal form, and consist of an outer thick hyaline thread-like border or cell-wall, enclosing a large clear vacuole, and a small quantity of finely granular colourless sarcode, in which is imbedded a round nucleus with its nucleolus. They appear to be produced by the metamorphosis of the ordinary protoplasmic cells of the mark, and, by the fusion of their outer borders where these touch one another, give rise to the parenchyma-like tissue just described, to which the name of "vacuolated connective tissue" may be applied. The layer which this tissue forms beneath the epidermis is of variable thickness, on an average from 0·002 to 0·003 inch; it is distinguished by the entire absence of cylindro-stellate or other spicules, the only spicules which occur in it being the small fusiform acerates, which penetrate at one end the subjacent globate layer, and project at the other beyond the surface of the sponge. It may be as well to give this layer of tissue a distinct name; and though the term "dermis" is not altogether free from objection in its application here, it has, at least, the merit of convenience.

The next layer of the cortex, 0·01 inch thick, is that of the globate spicules (Pl. XI. fig. 7, *c*). The characters of these have most of them been already described by other observers. It is a fact, however, worthy of special mention, that some of these spicules contain within a well-marked pit-like hilum a distinct oval nucleus with a spherical nucleolus.

The globates do not lie loosely aggregated together, but are regularly conjoined by short thick fibrillated ligaments. The ligaments pass directly from the side of one globate to the opposed face of its nearest neighbour; and since in the plane of a single transverse section one globate may be seen surrounded by five or six others, so there will also be seen five or six ligaments proceeding from it, like the spokes of a wheel, one for each of its surrounding fellows. As the surrounding globates are also joined to each other by ligaments, so a number of triangles are produced, having the ligaments for their sides and a globate lying on each angle. The centre of the triangle, which is left vacant by the ligaments, is occupied by a cell or cells, which, with their nuclei and nucleoli, exactly resemble one of the vacuolated cells of the dermal layer. The attachment of the fibres of the ligament is provided by the tubercles of the globate; and when a globate is torn out from the cortex it carries its ligaments with it, as a hair-like coating of radiating fibres.

The fibres are exceeding fine threads, mere lines in thickness, and consist of altered protoplasm, which stains but very slightly with carmine. Small refringent granules occur amongst them; and in places they appear to pass into the fibres of the succeeding cortical layer (Pl. XI. fig. 7, *f*). This, which in describing *Stelletta Normani* (Sollas) we called the muscular layer, is comparatively thin, varying from 0·0015 to 0·0035 inch in thickness. It consists of fibres similar to those of *S. Normani*, arranged in variously oriented fasciæ, in a layer which is closely opposed to the inferior face of the globate layer; intermingled with the fibres are a considerable number of vacuolated connective-tissue cells, which are frequently aggregated together in groups, and sometimes form a distinct stratum on the lower face of the muscular layer, which, most exteriorly, is always covered by an epithelial membrane with associated cylindro-stellates. The trifid heads of the ternate spicules which appear to support the cortex are also imbedded in the muscular layer, the fusiform fibres generally surrounding the spicular rays concentrically. This arrangement is shown on the left-hand side of the endochone in fig. 7 (Pl. XI.).

2. *The Chones.*—The ectochone of the cortical layer has generally the form of an inverted bell, covered by a thin dermal layer above and closed by a muscular sphincter below. From its upper and outer angle canals extend themselves horizontally into the dermis, and, widening out, give rise to a shallow dermal cavity, the roof of which is united to the floor by small columns of connective tissue. The layer of tissue covering the ectochone and that above the dermal cavities are perforated by a number of very short tubes or ostia, which place the cavity of the chone in communication with the external medium. The endochone is a shallow dome-shaped cavity which communicates freely with the subcortical crypt. The surface of the chone and its canals is continuously lined throughout with an epithelial membrane containing numerous cylindro-stellate spicules. The roof of the chone consists of fine fibrous tissue lined below with the stellate-bearing epithelium, which is continued over the sides of the ostia into the layer of epidermis which covers the roof of the chone above (Pl. XII. fig. 33). The fibres of the chonal roof surround the ostia sphinctrally. The ectochone, when it lies in the globate layer, is surrounded by vesicular connective tissue, while the

walls of the endochone consist almost entirely of muscular tissue. From the various states in which the endochone occurs in different cases, sometimes almost entirely obliterated by the closure of its muscular walls, sometimes continuous in one and the same straight line by the widely open state of the intervening sphincter, one may infer that it behaves as a part of the sphinctral muscle: when the upper portion alone of this muscle contracts we have the condition of things represented in Pl. XI. fig. 7; when the whole contracts, that represented in Pl. XII. fig. 30, where the endochone has become constricted to a mere narrow tube; while, should the sphincter remain altogether relaxed, we have the form shown in Pl. XI. fig. 23.

The muscular fibres of this sphincter have here, as in *Stelletta Normani*, a character very different from that of the other fusiform fibres of the cortex; the axial threads are much thicker, the hyaline exterior is reduced in quantity, and the whole muscle has a less transparent and much greyer appearance than in the other case. Moreover the fibres of the lower face of the cortex do not stain deeply with carmine, while those of the sphincters acquire an intense colour with this tinction-reagent. Finally, the latter are so arranged that they can and evidently do contract, and thus are true muscles both by function and structure; while the former occur in such places and arranged in such a manner that it is difficult to understand how, in this sponge at least, they could contract, or what purpose i would serve if they did. Thus, altogether, I begin to doubt how far it is justifiable to extend our ideas as to the nature of the sphinctral fibres to those of the lower cortex, and am much more inclined to regard the latter as forming a kind of fibrous connective tissue, and the former alone as true muscles.

Before leaving the subject of the chones it would be but fair to the memory of Bowerbank to bear our testimony to the striking fidelity which characterizes his representation of the structure of these organs—a fidelity which is the more striking when we consider the comparatively small size which they possess in this species, and recollect the imperfect methods which this much-abused observer had at his disposal.

3. *The Subcortical Crypts.*—Compared with those of *Stelletta Normani*, the crypts beneath the general surface of the sponge are of very trifling dimensions; but beneath the surface which gives attachment to an adhering foreign sponge they become abnormally large, attaining a length four or five times that of the average. This probably is a pathological peculiarity due to the disturbance of the normal water-circula-

tion, produced by the probably commensal parasite. The crypts are lined by an epithelial membrane containing numerous cylindro-stellate spicules. The pillars of the crypts are traversed by the long-shafted spicules, and consist partly of mark-substance, and partly of vacuolated connective-tissue cells, which sometimes form a distinct layer beneath the epithelium (Pl. XII. fig. 27). Sometimes the mark-cells of the pillars are elongated into spindle-shaped fibres, which do not generally differ, except in shape, from ordinary mark-cells, but sometimes become hyaline and vacuolated (Pl. XI. fig. 15, *g* and *v*).

4. *The Incurrent Tubes.*—The tubes are simple excavations in the mark, lined by epithelium, which consists of a single layer of flattened cells, furnished with a round nucleus and nucleolus, but with indistinct or invisible cell-borders.

5. *The Excurrent Tubes.*—The smaller canals (Pl. XII. fig. 32) of the excurrent system do not differ from the corresponding incurrent tubes in structure; but the larger tubes have walls of a much more complex character. The large vessels, for instance, which open into the oscular tube are first lined by an epithelial membrane containing fine fibrils and round or oval nuclei with their nucleoli; beneath this follows a colourless transparent layer, which scarcely stains with carmine, and attains a thickness of 0·0007 inch. It consists of fine fibres (Pl. XI. fig. 15, *f*) of considerable length, with a swollen middle part, in which a central round granule or small nucleus may sometimes be discerned, and of vacuolated connective-tissue cells, which, when they lie immediately under the epithelium, sometimes contain a sharp-rayed stellate spicule. The rugæ of these vessels consist of an extension of the fine fibrillar layer covered by the epithelium. Globate and small acerate spicules occur in the walls of these vessels.

6. *The Oscule and Oscular Tube.*—The wall of the oscular tube below the cortex (Pl. X. fig. 2) is 0·02 inch thick, and consists for the most part of fibrous tissue, which does not stain with carmine, and is traversed by a number of small acerate spicules, which project from it erectly, and thus produce the hispid appearance of its surface previously mentioned. Vacuolated connective-tissue cells occur intermingled with fibres on both the inner and outer face of the wall; and the outermost layer consists of epithelial membrane. On the inside of the wall the epithelium is associated with minute cylindro-stellates like those of the epidermis, on the outside with larger sharp-rayed stellates like those of the mark. In places the fibrous tissue of the wall passes into true muscular

fibres, which form the sphincters already mentioned. These sphincters are well exposed by a tangential section of the oscular tube-wall; in such a section (Pl. X. fig. 4) the wall is seen to be divided into a number of polygonal areas, the boundaries of which are marked by a few globate and acerate spicules, while the greater part of the area of the polygon is occupied by one of the sphinctral muscles, which, in carmine-stained sections, have a deep red colour, strongly contrasting with the uncoloured tissue of the polygonal boundary.

In the cortex (Pl. X. fig. 5) the oscular tube is lined by epithelium bearing stellates, and overlying first a finely fibrous layer, and then a thin stratum of vacuolated connective tissue, which covers the globate-layer, here very much increased in thickness, as also is the underlying cortical fibrous layer. The roof of the oscular tube consists of a thin fibrous layer, without globates, but traversed by acerate spicules and covered by a layer of cylindro-stellates above and below.

7. *The Ciliated Chambers.*—The spherical outline of these chambers, which measure 0·001 inch in diameter, bears upon its inner surface a number of small, round, highly refringent nuclei with minute nucleoli, set at regular intervals from each other; but the outlines of complete cells cannot be made out, any more than can the cilia. A sharply marked circular aperture furnishes an abrupt passage from the interior of the chamber to the incurrent canal, on which the chambers are set, while the opening into the excurrent canal, on the other hand, appears to be much more gradual and prolonged (Pl. X. fig. 6 A, and Pl. XII. fig. 36).

8. *The Mark.*—The substance of the mark, independent of the tissues which enter into the composition of the canal-system, consists of finely granular sarcode, with large oval nuclei, containing nucleoli (Pl. XII. fig. 31) scattered throughout it. It stains with carmine, but not so intensely as its imbedded nuclei. The nuclei (Pl. XII. fig. 29), which are sometimes round as well as oval, have a well-marked double contour, 0·0002 to 0·0003 inch in diameter, and contain a clear unstained space, within which is the deeply stained round nucleolus 0·0001 inch in diameter. The mark-tissue might be taken for a "syncytium," were it not that in some cases distinct cells can be made out in it, having nuclei of precisely the same characters as those just described, and consisting of granular sarcode just like the ground-mass of the mark. These cells (Pl. XII. figs. 28, 32), 0·0008 inch in diameter, have a very faint external contour; and one can readily understand how, in a sponge not specially prepared for histological examination, the borders of such cells would

become altogether undistinguishable in the majority of cases, and so, by a deceitful appearance of confluence, give rise to the notion of a syncytium. Connective tissue like that of the medusoid disk is not discoverable in this sponge; in *Thenea Wallichii*, Wright, however, the greater mass of the mark consists of it.

9. *The Spicules.*—The long-shafted spicules are enveloped in a sheath which somewhat resembles the epithelial membrane, and are accompanied by longitudinally arranged fibres like those of the cortex; they are also frequently closely surrounded by concentric fibres of a very simple appearance, consisting merely of thin flat fusiform hyaline strips with a small round central granule or nucleus.

The globates of the cortex are all full-grown forms; but those dispersed through the mark are to be met with in all stages of development. In their earliest state they consist of minute trichites, radiately arranged to form a sphere, the centre of which is either empty or occupied by some transparent substance like that of the axial thread of a long-shafted spicule. The outer ends of the trichites penetrate a thick double-contoured cell-wall, which is at first transparent and almost colourless (Pl. XII. fig. 37). On one side of this cell-wall is imbedded an oval nucleus, which strikingly resembles the nuclei of the mark-cells. With growth a deposit of silica is formed about the inner ends of the trichites, cementing them together into a transparent siliceous globule; the outer diverging ends remain unenveloped, and are easily detached from the central sphere. A hilum is for some time absent; but presently the growth of the trichites beneath the nucleus becomes slow compared with that outside it (Pl. XI. fig. 18), and as a result a conical cavity is left under the nucleus and forms the hilum of the adult spicule. The nucleus, when viewed face on, appears to rest, like a biconvex lens, over the upper end of the hilum; but a lateral view presents it as completely filling the cavity of the hilum. The cell-wall enlarges with the growth of the globate, and very early acquires a very granular appearance and a deep grey colour; it then stains deeply with carmine. Probably the preceding statement should in one point be reversed, and we should say that the trichites increase in length with the growth of the cell-wall. Finally the trichites become thicker and acquire rounded conical ends, which at length assume the characteristic adult form.

It is singular that no immature forms are met with in the cortex; and this leads one to infer that the fully-grown globate travels in some manner unknown from the mark to the lower face of the cortex, where its dense sarcodic coating becomes metamorphosed into fibrous ligaments; only in some such manner as this can the additional globates needed for the increased area of the cortex, consequent on the growth of the sponge, be explained. It is, moreover, suggested by the fact that in embryonic *Geodiæ* the globates are at first absent in the cortex, and make their earliest appearance within the mark.

The stellate spicules, as we have already stated, are produced within the interior of cells; they may frequently be observed within a cell resembling one of the vacuolated connective cells, with transparent sarcode filling up the angles between their rays (Pl. XI. fig. 22).

Classification.—It may be thought singular to refer to *Geodia* a sponge which apparently possesses neither the cribriform oscular area nor the large body-cavity which characterize that genus. But it is to be recollected that we have been describing a young specimen, the structure of which is in all respects so similar to that of *Geodia Barretti* that no one could refuse to refer it to that species, and, next, that, according to Bowerbank's descriptions, *Geodia Barretti* clearly belongs to the genus to which we have assigned it; for, setting aside the absence of a large body-cavity, which is not really essential to *Geodia*, we have the genuine *Geodia* character displayed by Bowerbank's specimens in the possession of a large cribriform oscular area. In our sponge this area is represented by the walls of the oscular tube, which may, with growth, become a mere shallow depression, or may enlarge, as Bowerbank's descriptions show, into a cavity as much as two inches in depth.

Locality. Kors Fiord, Station No. 23. Depth 180 fathoms.

EXPLANATION OF THE PLATES.

Plate X.

Fig. 1. The cut face of a young specimen of *Geodia Barretti* divided longitudinally through the oscular tube (nat. size).

Fig. 2. Transverse section through the wall of the oscular tube below the cortex: *s*, sphincters; *e*, excurrent vessel, cut across obliquely; *r*, rugæ of its walls (× 11).

Fig. 3. Upper surface of the sponge, showing the single oscule at the summit (nat. size).

Fig. 4. Tangential section through the wall of the oscular tube, showing sphincters, *s*, in the middle of polygonal areas (× 11).

Fig. 5. Transverse section, showing one side of the oscular tube in the cortex, the greatly thickened globate-layer, and the thin dermal roof (× 11).

Fig. 6. Transverse section through the mark and cortex, showing the arrangement of the water-canals: *ch*, *ch*, chones; *cr*, crypts;

i, incurrent tube; *e*, excurrent tube; *c*, concentric canals; *e'*, a deeper-seated excurrent tube; *i'*, a deeper-seated incurrent tube (× 24).

Fig. 6 A. Ciliated chambers in longitudinal optical section and from a view face on (× 435).

Plate XI.

Fig. 7. Section through the cortex, showing the structure of the chone and the ligamentous connexions of the globates (*c*): *f*, the fibrous layer (× 104).

Figs. 8, 9. Porrecto- and recurvo-ternate spicules with long slender shafts.

Fig. 10. Fusiform acerate spicule.

Fig. 11. Bifurcated ternate spicule.

Fig. 12. Globate spicule.

Fig. 13. Small acerate from the cortex.

Fig. 14. Small ternate from the upper angle of one of the crypts. Figs. 8–14 all magnified 21 diameters.

Fig. 15. Fusiform fibres of different kinds: *g*, granular mark-cell from pillar of a crypt; *v*, vacuolated cell from same place; *s*, axial thread of a muscle-fibre from a sphincter; *f*, fibres from the wall of one of the large excurrent tubes (× 435).

Fig. 16. Porrecto-ternate spicule (× 21).

Fig. 17. Cylindro-stellate from the mark (× 315).

Fig. 18. Globate spicule, showing the nucleus at one side (× 435).

Fig. 19. Young globate as seen in Canada balsam (× 435).

Fig. 20. Stellate with sharp-pointed rays, from the mark (× 315).

Fig. 21. Cylindro-stellate from the epidermis (× 435).

Fig. 22. Stellate-cell with its contained spicule (× 435).

Fig. 23. Section of a chone with widely opened sphincter (× 30).

Plate XII.

Fig. 24. Vacuolate connective tissue from the dermis (× 435).

Fig. 25. An unaltered mark-cell occurring associated with vacuolated connective-tissue cells: *a–e*, various stages in the development of these cells (× 435).

Fig. 26. Section across the outer part of the cortex, showing—*e*, epidermis and *c*, dermis, resting upon the globate-layer.

Fig. 27. Wall of a crypt, taken from one of its upper corners, showing epithelium overlying a layer of vacuolate connective-tissue cells (× 217).

Fig. 28. A typical mark-cell, showing nucleus and nucleolus imbedded in fine granular sarcode (× 435).

Fig. 29. Nuclei which occur dispersed through the granular substance of the mark (× 435).

Fig. 30. Section of a chone, showing obliteration of endochone through the contraction of its muscular walls (× 26).

Fig. 31. A trabecula of one of the excurrent canals, to show the general character of its constituent mark-substance (× 435).

Fig. 32. A transverse section through a small canal in the mark; the surrounding mark-cells are distinguished by faintly defined outlines (× 435).

Fig. 33. A transverse section through a dermal ostium, showing stellate-bearing external layer and central fibrous layer (× 217).

Fig. 34. Section through cortex and mark, in which the incurrent canals are more characteristically represented than in Pl. X. fig. 6 (× 30).

Fig. 35. One of the fusiform fibres that are sometimes found lying longitudinally upon the side of a small acerate spicule (× 435).

Fig. 36. Section along an incurrent canal lying in the middle of the mark, showing ciliated chambers and the small outflow-tubes leading towards an excurrent canal (× 140).

Fig. 37. A very early form of globate spicule, from a preparation in glycerine (× 435).

[To be continued.]

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.

January 21, 1880.—Henry Clifton Sorby, Esq., LL.D., F.R.S., President, in the Chair.

The following communications were read:—

1. "On the Genus *Pleuracanthus*, Agass., including the Genera *Orthacanthus*, Agass. & Goldf., *Diplodus*, Agass., and *Xenacanthus*, Beyr." By J. W. Davis, Esq., F.G.S.

The author commenced with an historical account of the supposed genera of fishes founded on remains occurring in Carboniferous and Permian strata, mentioned in the title of his paper. The teeth described by Agassiz under the name of *Diplodus* have been already shown by Sir Philip Egerton to be associated with spines of the *Pleuracanthus* type; and this identification was accepted by the author, who also showed that *Xenacanthus*, Beyrich, is identical with *Pleuracanthus*, and that, on the ground of priority, which there is no reason for disregarding, the latter name ought to be retained. With regard to *Orthacanthus*, he indicated that in the type described by Agassiz the two rows of denticles are placed close together along the posterior face of the spine, while in his *Pleuracanthus* the denticles are situated as far as possible apart on the sides of the spine. In the new Carboniferous species described in the present paper, and in those described and figured by the officers of the United-States Survey, the denticles occupy almost every intermediate position between these two extremes; and hence the author was inclined to unite *Orthacanthus* with *Pleuracanthus*. *Compsacanthus*, Newb., is also probably nearly related to *Pleuracanthus*. The author described in some detail the characters of the genus *Pleuracanthus*, and discussed its scientific position, with regard to which he inclined to the adoption of Dr. Rudolph Kner's opinion that the Pleuracanths constitute a type of fish intermediate between the Elasmobranch and Teleostean fishes, but more nearly approaching the latter, probably through the Siluroids.

XXXVII.—*The Sponge-fauna of Norway; a Report on the Rev. A. M. Norman's Collection of Sponges from the Norwegian Coast.* By W. J. Sollas, M.A., F.R.S.E., F.G.S., &c.

[Continued from p. 259.]

[Plate XVII.]

Group *Geodina*, Carter (*continued*).

Genus Isops *, nov. Type *I. Phlegræi*, sp. nov.
(*Geodia* auct.)

Diagnosis.—Excurrent and incurrent apertures similar, being the freely open ends of simple cylindrical tubes, which sink directly into the rind of the sponge and end at its inner surface in sphinctral muscles.

Observations.—The ostia of the canal-system are of very various sizes, forming a series in which the largest pass into the smallest by almost insensible gradations. The larger apertures serve as excurrent and the smaller as incurrent ostia.

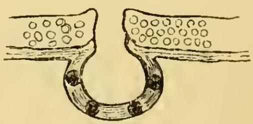
The simple nature of the ostia and the identity in structure of the incurrent and excurrent ostia and ostial tubes constitute a good distinction between this genus and its allies—*Geodia*, *Cydonium*, and *Pachymatisma*.

The incurrent ostial tubes of *Isops* may be regarded as equivalent to the chones of the preceding genera deprived of their perforate (poriferous) roof.

The excurrent ostial tubes differ from those of *Geodia* in being simple and dispersed, the cribriform area or ostial tube with many sphincters of *Geodia* being possibly due to the integration or coalescence of a number of simple tubes similar to those of *Isops*, thus:—

1

2



1. Ostial tubes of *Isops*, closely congregated.
2. Excurrent tube of *Geodia*, formed by the coalescence of similar ostial tubes.

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* ἴσος, equal; ὤψ, an eye (hence a hole).

How far other distinctive characters will be found constantly associated with those given as diagnostic of the genus *Isops*, one cannot at present say. As yet only a single representative of the genus (*I. Phlegræi*) is known to me; between it and *Geodia Barretti*, however, very characteristic differences exist. Thus the former does not possess any of the small acerate spicules, which, projecting erectly from its surface, form the fine superficial down of *G. Barretti*; they appear to be entirely replaced by the large long-shafted spicules which form the externally projecting fascicular ends of the internal spicular fibres. The trifid heads of the long-shafted spicules, moreover, do not, as in *G. Barretti*, apply themselves with horizontally extended rays to the inner surface of the globate layer, but, projecting forwards, penetrate and terminate within the globate layer. At present, however, it is uncertain whether these characteristic differences are generic or specific merely.

Isops Phlegræi *, n. sp.

Sponge more or less spherical, about 1 inch in diameter; surface hispid (when unworn) by the protrusion of long-shafted spicules for about 0·15 inch beyond it; when the spicules are worn away the surface is smooth and of a faint greyish colour. Excurrent and incurrent ostia simple, numerous, scattered. Each ostium a small round or oval opening, situated on the summit of a conical elevation, which is very variable in size, but always minute, the largest measuring 0·125 inch in diameter at the base, and 0·025 inch at the summit; in some cases the elevation may be almost entirely absent, the ostium then lying flush with the general surface of the sponge. Over some parts of the surface small white spots occur, some of which are really and some only apparently imperforate, the latter showing a minute central aperture on magnification. These are the smallest ostia present; between them and those of the largest perforate monticule we have others of every intermediate size.

Skeleton.—The skeleton consists of long-shafted spicules, globates, and stellates.

Thick long-shafted Spicules.—(i) a simple, sharp-pointed, fusiform acerate, 0·24 inch long by 0·0025 inch broad (Pl. XVII. fig. 5); (ii) a trifid spicule with simple, forward-projecting rays, shaft 0·16 inch long, 0·0017 inch broad, rays 0·025 inch long (Pl. XVII. fig. 7); (iii) a trifid spicule, with

* In reference to the ostial elevations of its surface, reminding one of the Campi Phlegræi.

irregular bifurcated rays, shaft 0·13 inch long, rays 0·034 inch long (Pl. XVII. fig. 9).

Slender long-shafted Spicules.—(i) a simple sharp-pointed acerate, 0·0004 inch thick; (ii) a trifid spicule with rays recurved anchor-like, 0·0008 inch thick (Pl. XVII. fig. 6); (iii) a trifid spicule with rays directed forwards, 0·0008 inch thick (Pl. XVII. fig. 8).

Stellates.—(i) a sphæro-stellate with a large body and numerous short conical rays, 0·0005 inch in diameter (Pl. XVII. fig. 12); (ii) a stellate with small body and a few long rays, usually about 0·0008 inch in diameter (Pl. XVII. fig. 13), but often becoming exceptionally large, as much as 0·0015 (Pl. XVII. fig. 10), or rarely even 0·0027 inch in diameter.

Globates.—Oblate and prolate ellipsoids, the latter with one minor axis shorter than the other; covered superficially by erect tubercles, having a more or less flattened polygonal summit, from the corners of which minute short slightly recurved spines are produced. Diameter 0·0036 inch (Pl. XVII. fig. 14).

Locality. Kors Fiord, Station No. 23: 180 fathoms.

Observations.—A section across the sponge shows a thin rind (0·025 inch thick) enclosing a greyish-yellow mark, which is traversed by numerous canals of various sizes. Those large enough to be plainly visible to the naked eye have smooth glistening walls, concentrically striated by fine rugæ: some take a concentric, others a radiate course, the same canal being concentric in one part of its course and radiate at another. The crypts are very irregular in size, some being markedly larger than others; they have lost the characters which distinguish them in *Stelletta Normani*, and appear to be the cut ends of concentric canals, precisely similar to those occurring in the mark, and only differing in being situated immediately beneath the rind; indeed it occurs to one to suggest that both in this instance and in *Geodia Barretti* the concentric canals are merely the cryptal canals left behind in the progressive increase of the sponge.

Histology.

1. *The Cortex.*—The *epidermis* consists of a very distinct transparent, colourless, and apparently structureless cuticle, lying quite separate from the succeeding dermal layer; no nuclei nor cell-borders are observable in it (Pl. XVII. fig. 11, *c*). The *dermal layer* consists of very definite colourless, granular, oval cells, lying quite separate from one another, and forming a layer of variable thickness; sometimes it thins out altogether and lets down the epidermis into immediate contact with the globate layer; sometimes, on the other hand, it thickens out

so as to become three or four cells deep; but usually it consists of a single layer of cells only. Just below the epidermis sphæro-stellates occur between the dermal cells, their rays projecting against the epidermal membrane (Pl. XVII. fig. 11, *d*).

No vesicular nor gelatinous connective tissue is observable in the dermis.

The Globate Layer.—The structure of this does not differ from that described as existing in *Geodia Barretti*, except by the absence of vesicular connective-tissue cells from the triangular spaces left between the fibrillar ligaments; these cells are replaced here, as elsewhere in *Isops Phlegræi*, by gelatinous connective tissue. The most exterior, and therefore oldest, of the globates of the rind are very often hollow within, the small central cavity which exists in the ordinary adult globate having become enlarged to a great but variable extent. This occurs as the result of an absorption which begins at the inner ends of the trichites, and, extending radiately outwards, reproduces the early form of the young globate as a hollow cast within the old one; the same result is brought about by exposing the solid mature globates to the action of boiling caustic potash, as described by me in a previous communication to this Magazine (Ann. & Mag. Nat. Hist. ser. 4, vol. xx. p. 292).

Subcortical Layer (Pl. XVII. fig. 4).—The purely fibrous part of this (fig. 4, *f*), which lies immediately beneath the globate layer, is very thin, and passes below into gelatinous connective tissue (fig. 4, *c*), in which fibres like those of the fibrous layer lie loose and more or less apart from each other, and being consequently well defined are easily studied *in situ*. They are hyaline and fusiform, with attenuated ends, sometimes greatly prolonged; a central axis is rarely visible; more usually the interior is occupied by an axial cavity; generally it would appear empty, but sometimes contains a small refringent spherule, which I take to be a nucleolus, and is sometimes filled with colourless granular material. The axial cavity may be relatively very small, a mere slit in the centre of the fibre; or it may be large, perforating the whole length of the fibre, and converting it into a genuine tube. The tube so formed is liable to split open at one end; when this happens the slit wall uncurves and spreads out into a thin lamina. The hyaline wall of the fibre frequently also becomes fibrillated and sometimes apparently laminated; it then becomes liable to exfoliation or defibrillation, as the case may be.

The gelatinous connective tissue consists of a colourless, structureless, soft matrix, containing numerous dispersed oval nuclei surrounded by a small quantity of granular colourless protoplasm, from which in many cases very fine fibrils are prolonged irregularly in various directions. Here and there greyish granular oval cells (Pl. XVII. fig. 16), which have a very distinct outline, and stain deeply with carmine, occur in the matrix. Each one generally occupies a corresponding cavity in the matrix, from which it is completely separated except at one or two points of contact; this separation is probably the result of contraction after placing in spirit. These cells are often pointed at one end, which differs from the rest of the cell in being hyaline and more refringent. The pointed end is sometimes produced into a fine structureless fibre (Pl. XVII. fig. 15).

2. *The Mark.*—The substance of the mark consists of minute granules abundantly dispersed throughout a structureless colourless matrix, forming a greyish tissue, in which small oval nuclei occur at intervals. It stains generally with carmine, but not so deeply as the corresponding tissue of *Stelletta Normani* and *Geodia Barretti*.

It never presents any appearance which might suggest that it consists of a number of separate but closely apposed cells, although, from the remarkably perfect manner in which other delicate histological features of the sponge are preserved, one would expect evident signs of such a constitution if it existed; and as, on the other hand, it is not a mere gelatinous connective tissue like the mark of *Thenea Wallichii* and many other sponges, we may at least provisionally regard it as a genuine syncytium.

3. *The Skeleton. Long-shafted Spicules.*—The long acerates lie longitudinally side by side, forming spicular fibres, which take chiefly a radiate direction from the centre of the sponge towards the rind. On approaching the rind the constituent spicules of each fibre diverge from each other and pass out of the sponge in the form of a fascicle; at the same time trifid spicules put in an appearance, the coarser forms having their heads within, below, and outside the rind, the finer, grapnel-like and slender fork-like forms bearing their heads exclusively outside and at some distance from the rind. In *Geodia Barretti*, it will be recollected, all forms of trifid spicules were exclusively confined to the interior of the sponge, their heads occurring just beneath the rind. The frequent irregularity in the form of the bifurcated ternate spicule of *Isops* is caused by the obstruction of the globates in which it is imbedded, these obstacles hindering its free growth. With each spicular bundle or fibre is associated a tract of tissue very similar to, and, indeed, almost identical with, that of the subcortical layer; it consists of (i) finely granu-

lar cells, which do not differ in general characters from the isolated definite oval cells which have already been mentioned as occurring here and there in the mark and subcortical layer: many of them, indeed, are identical with these in all respects; but most differ in form, becoming much elongated in the direction of the spicular bundle, and thus acquiring a more or less fusiform outline. The nucleus is involved in this change of form, becoming also elongated and fusiform; but the nucleolus is unaffected and retains its spherical form.

These fusiform cells, by becoming gradually hyaline, afford an easy passage into (ii) ordinary hyaline fibres of precisely the same nature as those of the subcortical layer; they lie parallel to the spicules of the spicular bundle, to which they form an enclosure. Sometimes a surrounding band of concentric fibres occurs around the bundle. Finally, (iii) a small quantity of gelatinous connective tissue is in places associated with the spicular bundles.

Where the spicular bundles enter the cortex the fusiform hyaline fibres can be easily followed, diverging from the spicules in a gentle outward curve and entering the subcortical layer, which therefore may be regarded as an extension of the tissue of the spicular tract, modified by increase of growth and change of direction. The change of direction is in accordance with that of the long-shafted spicules, the trifid ends or distal rays of which tend, on reaching the rind, to become more concentric and less radiate in direction. Just below the place where the fibre curves from the spicules to the cortex a number of granular cells, like those described in the same position in *S. Normani*, are often found accumulated.

In addition to a tissue of the bundle there is the tissue of each individual spicule, each being invested in an excessively thin structureless membrane containing small round nuclei surrounded by fine granules and very thin structureless fibrils (Pl. XVII fig. 2, *s*). Now and then one finds isolated hyaline fibres encircling a spicule like a girdle (Pl. XVII. fig. 2, *z*); the meaning of this feature, which is to be found in other related sponges, is not apparent.

Globates.—The structure and development of these spicules can be studied with great facility in this sponge. The earliest form consists of a cell (Pl. XVII. fig. 21, *s*) of the same size as the common, isolated, oval, granular cell of the mark (Pl. XVII. fig. 21, *m*); it contains the little sphere of radiate trichites, which are united together at their inner ends about a small, central, spherical space; externally they terminate in a layer of hyaline sarcode or cell-wall. On one side of the cell is imbedded a round or, more commonly, oval nucleus with its contained spherical nucleolus. By treating with a 5-per-cent. solution of caustic potash, the cell-wall expands and separates from the contained globates completely (Pl. XVII. fig. 19). With age a hilum is formed, as previously described in the case of *G. Barretti*; but the nucleus merely occupies and does not completely fill the hilum (Pl. XVII. fig. 18), as erroneously stated in the previous description (Ann. & Mag. Nat. Hist. ser. 5, vol. v. p. 256). The external ends of the trichites grow much thicker with age, and assume a sharp conical form; the sharp ends of the conical spines then become rounded off and pass into rounded conical tubercles; these finally become flattened and spined round the summit, and the globate is complete. Absorption next ensues. The adult globate always exhibits in section a small central cavity with fine radiate canals proceeding from it; the effect of absorption is to enlarge this cavity and its radiate canals, so that the globate becomes eventually a mere thick-walled shell, its walls being perforated by radiate canals of wide diameter which extend along the axes of the exterior tubercles, and almost but not quite open to the exterior (Pl. XVII. fig. 24).

It appears that the layer of tubercles is liable to separate as a thin shell from the rest of the globate spicule.

Stellates.—The same kind of distribution of the stellates occurs here as in *G. Barretti* and *S. Normani*; none but the sphæro-stellates occur immediately beneath the epidermis; elsewhere the second kind of stellates (Pl. XVII. fig. 13) are chiefly found; the sphæro-stellates occur in the mark immediately beneath the rind, but less abundantly than the other forms. The small-bodied stellates occur lining the interior of the sphinctral canal, in the subcortical layer, and generally through the mark, but especially in the wall of the water-canals.

4. *The Water-canal System.*—The characters of the incurrent and excurrent ostial tubes have already been referred to; as they appear to represent the chones of other Corticatæ, it will be convenient to distinguish them as incurrent and excurrent chones. The two kinds of chones differ only in size, both being freely open distally and closed below by a sphincter, which protrudes downwards into a canal which here represents the crypt (Pl. XVII. figs. 1, 3, 20). Thus there is no endochone, and the chones are the equivalents of the ectochone alone.

The incurrent chone leads into a canal which extends parallel to the surface just below the rind for a variable distance, giving off one or more branches, which descend radiately into the interior, and break up into still smaller canals.

These canals are all exceedingly well defined, and all but the very smallest are provided with a distinct wall, which is transversely ridged by concentric rugæ. Short narrow canaliculi lead from the walls of these incurrent canals, main trunks, branches, and twigs alike, and open abruptly into the surrounding ciliated chambers. At a point generally opposite that at which the incurrent canaliculus enters, the ciliated chamber is gradually produced into an excurrent canaliculus, which is somewhat wider and less well defined than the corresponding incurrent vessel. The excurrent canaliculi join gradually together to form a trabecular tube, which, joining with others of a similar character, at length lead into a large canal with very definite and transversely rugate walls. This canal finally opens into an excurrent chone through a sphincter, and so communicates with the exterior.

There is a great difference in the way in which the ultimate canals of the excurrent and incurrent tubes are connected with the larger canals: in the former, as previously mentioned, the junction is gradual, the ultimate canals enlarging a little towards the point of junction, and then flowing together at an acute angle; in the latter the ultimate branches are given off abruptly and, remaining of about the same diameter, end abruptly; they also make rather a right than an acute angle with the larger branches. The figures of the annexed woodcut show the difference in character of the ultimate canals of the two systems very plainly.

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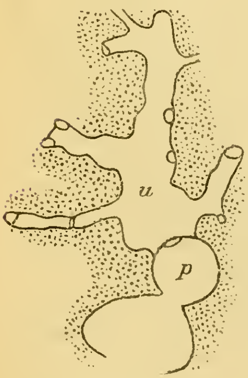

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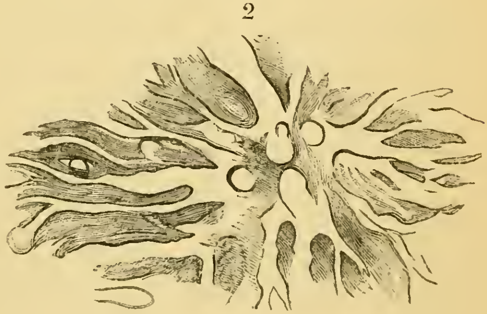


1. The ultimate end (*u*) of an *incurrent* canal, proceeding from the penultimate branch (*p*), which is vesicular and provided with diaphragms to the end (× 70).
2. The ultimate ends of an excurrent tube gathering to form a penultimate trabecular tube, which has been cut across transversely.

The Chones (Pl. XVII. figs. 1, 3).—These, as well as the whole of the canal-system, with the exception of the ciliated chambers, are lined by a delicate epithelial layer.

Their walls are chiefly composed of concentrically arranged fusiform fibres, very similar to muscle-fibre, but staining much less intensely with carmine. Near the lower end of the chone this layer becomes continuous with the thick conical muscle which "plugs" the bottom of the chone and protrudes its apex into the subjacent crypt. The mass of the muscle consists of true, fusiform, muscular fibres concentrically arranged around a central canal, which is lined by epithelium and associated sharp-rayed stellates. The subcortical layer, where it joins the muscle, frequently dovetails with it, thrusting a small wedge of gelatinous connective tissue (*c*) into its side and receiving on its lower face a short superficial extension of the muscle-fibres, while its upper strictly fibrous portion (*f*) passes gradually into the muscle, the muscle having very much the appearance of being an over-development of the subcortical fibrous layer: this appearance is probably very near the truth, both structures having most likely been derived from a primitively indifferent fibrous layer, which on the one hand became modified into connective and on the other into muscular fibres. The chones are clearly the modified outermost vesicles of their associated canals, and their sphincters the modified rugæ of these canals. Hence the canal-walls contribute a share to the formation of the fibrous layer of the cortex.

The Canals.—The ultimate ramifications of the canal-system, as well as the smaller trunks into which they collect, are simple excavations in the mark lined by epithelium, which gives them, especially those having an incurrent function, a very sharp and definite outline. In the case of the larger canals the mark immediately surrounding them becomes a little less granular than elsewhere, and stains a little less deeply with carmine; hyaline fusiform fibres and sometimes granular fusiform cells appear in it, sometimes lying separate from each other, sometimes accumulated side by side and with overlapping ends forming a fibrous band. They are arranged both longitudinally and transversely with respect to the axis of the canal; but in the trabecular excurrent canals their position is governed by that of the trabeculæ, which they traverse more or less longitudinally. The structure of a canal-wall when fully developed exhibits, in transverse section, first, on the inside, a layer of epithelium, next a layer as much as 0·00125 inch thick of fibrous tissue, and then a layer of gelatinous connective tissue adjoining the mark.

The canals, especially the incurrent ones, are ridged transversely by circular rugæ, which are simply thin lamellar extensions of the wall, composed of epithelium and a small quantity of a tissue containing numerous very fine fibrillæ, which are arranged concentrically in each ruga and are slightly more abundant along its edge than elsewhere. The rugæ are often so greatly developed as to form iris-like diaphragms extending almost halfway across the canal; and as the canal is also constricted around the origin of the diaphragm, it thus becomes divided into a series of bladder-like compartments. This vesicular character occurs in many other sponges, but in none so markedly as in *Thenea Wallichii*, which will be described subsequently. In *Isops* the vesicular character is most pronounced in the incurrent tubes, if not confined to them, and the rugæ or diaphragms likewise are chiefly characteristic of these tubes, occurring in all, from the largest down to those having a diameter of only $\frac{1}{200}$ inch or less; in the excurrent tubes they are never so numerous nor extended so far across the canal, nor do they occur in tubes of such small diameter as in the incurrent system; it appears to me that they never occur in excurrent tubes unless of considerably over $\frac{1}{100}$ inch diameter.

The physiological explanation of this difference in structure between the excurrent and incurrent tubes appears to lie in the fact that the water expelled into the former is under a slight excess of pressure, which is sufficient to keep them widely open; it is propelled by a *vis a tergo*. The water in the incurrent tubes, on the contrary, is drawn through them by a *vis a fronte*, and is thus under a slightly diminished pressure; they would therefore tend to be compressed by the water in the surrounding tissues; and it is possibly to prevent this that their walls are strengthened by the concentric rugæ.

Ciliated Chambers (Pl. XVII. fig. 23).—These organs are almost spherical in form and 0·001 inch in diameter; they consist of a structureless membrane, covered on the inner surface by roundish nuclei, surrounded by granular protoplasm, and disposed at very regular distances apart. Cilia proceed from these nucleated patches, radiating from the walls towards the centre of the chamber. They thus clearly represent, as far as they could be preserved, the collared cells of other sponges.

As previously mentioned, the ciliated chambers everywhere surround in close proximity the walls of the whole of the incurrent canals, large and small alike (Pl. XVII. fig. 27). Short narrow canals, usually about 0·0006 to 0·0009 inch long and 0·00025 inch in diameter, open abruptly into them and connect them with the incurrent system. On the other hand they are gradually prolonged into the small ultimate canals of the excurrent system (Pl. XVII. fig. 25); they are the expanded ends of these canals, which unite together into larger trabecular tubes, having no direct communication with ciliated chambers, except that furnished by these tributary ultimate canals.

Herein lies the great distinction between the incurrent and excurrent system. The tubes of the former communicate directly at every part of their course with ciliated chambers; the tubes of the latter only communicate with the chambers at the end of their ultimate ramifications, just as a tree only bears leaves at the end of its twigs.

This observation, in connection with the difference in the mode of connexion (first pointed out by F. E. Schulze) of the excurrent and incurrent canaliculi with the ciliated chambers, is very suggestive. The cells of the ciliated chambers, together with the epithelial lining of the excurrent canals, are the adult representatives of the endoderm of the larval sponge; the epithelium of the incurrent tubes, together with the epidermis, are the descendants of the original ectoderm. In course of growth the ectoderm and endoderm have increased more rapidly than the intermediate tissue, which F. E. Schulze terms mesoderm; and the result has been an involution in two opposite directions—the endoderm developing like a racemose gland in one direction, the ectoderm undergoing a simpler involution in the other; such, at all events, appears to me the origin of the canal-system in *Isops* and *Geodia*.

Our observations might, however, be brought into accordance with Häckel's theory of the canal-system, if we consented to regard our incurrent canals as forming an intervascular system, and the excurrent only as a genuine gastrovascular system. At the same time this is a purely theoretical view; and I cannot see how one reasonable man can blame another for choosing to consider the canal-system of such a sponge as *Isops* or *Geodia* as having a so-called "bipolar" arrangement, which, as a matter of observation, independent of all theory, it *has*. In saying this I am far from expressing any difference of opinion from Häckel, whose general conclusions are clearly in the main correct, but simply desirous of adding my testimony to the value of Carter's observations, which are always faithful and accurate, and worthy a more generous estimate than that awarded them by his opponent.

While speaking of the canal system I would take the opportunity to point out the fact that the vesicular character of the incurrent canals is of a totally different nature from that described by Häckel as distinguishing his "blasenförmige" type of "Astcanäle" in the Leucones, and conjectured by him to exist also in the rind-sponges; one has but to compare the description given of this structure in the Leucones ('Die Kalkschwämme,' p. 235) with that given here as regards *Isops*, to see that there is no real resemblance between them.

Pathology.

The exterior of the sponge is covered by various attached foreign bodies, such as young sponges, both calcareous and siliceous, minute Hydrozoa, Algæ, and Foraminifera. A small *Waldheimia* is also rooted into the sponge at one point, without apparently causing much harm. The larger attached Foraminifera are covered marginally by a thin brownish film, which has extended onto their upper surface from the dermis of the sponge. At its extreme edge this film only contains stellate spicules; but further on a few globates make their appearance. It would appear that the sponge is making, in these cases, an effort to overgrow and enclose the foreign bodies. On touching one of the Foraminifera with a sharp-pointed instrument, however, it separates from the sponge with the greatest facility, bearing with it on its under surface a number of attached globates, and leaving behind an irregular pit in the cortex. If the removed globates, or those immediately surrounding the pit left in the rind, be examined under the microscope, it will be found that they have entirely lost their fibrillar connective ligaments, which have degenerated into a quantity of granular material, probably of the nature of pus.

In the interior of the sponge foreign bodies also frequently occur—diatoms, Radiolaria, foreign sponge-spicules, Foraminifera (both calcareous and arenaceous), and the fibres of the *Waldheimia*-peduncle.

The siliceous inclusions and the fibres of the Brachiopod are simply imbedded in the mark, without producing or suffering any apparent change; the calcareous Foraminifera, however, lose the calcareous walls of their test by absorption, some kind of hyaline material taking their place; at the same time the mark surrounding the tests and filling their chambers becomes converted into gelatinous connective tissue.

Turning, again, to the foreign bodies of the exterior, one very singular case of commensalism remains to be noticed. A small Geodine sponge, only just escaped from the larval stage, has attached itself immediately over one of the incurrent chones (Pl. XVII. fig. 1, *p*), and grown in such a manner that the terminal opening of its single branched excurrent tube is exactly applied to the ostium of the incurrent chone of the *Isops*; and thus the supply of food and water brought to this particular chone can only reach it after straining through the intercepting parasite.

Should the association, which we may here regard as accidental, become permanent, great structural changes would probably be produced in the parasite: for one thing, the collared cells would be relieved of the necessity of propelling water through the organism, and could restrict themselves to gathering food for it; and no doubt this would lead to various other modifications. That in certain cases the association does become persistent is quite certain; for in a large specimen of *Ectyon sparsus* contained in the Bristol Museum we find a large number of the oscules lined each by a small parasitic *Geodia* belonging to an undescribed species; but as this specimen is unfortunately not preserved in spirits, we cannot determine the kind of histological change which may have been induced in it.

EXPLANATION OF PLATE XVII.

Isops Phlegræi (n. gen. et sp.).

Fig. 1. Section across the rind, showing an excurrent chone (E) and an incurrent chone with a young Geodine sponge (*p*) grown over its mouth: *f*, subcortical fibrous layer; *c*, gelatinous connective tissue (× 15).

Fig. 2. A long-shafted spicule enveloped in the spicule-sheath, *s*, and encircled by single, fusiform, hyaline fibres, *z* (× 140).

Fig. 3. Transverse section of the rind, showing incurrent chone with its sphincter protruding into the subjacent crypt (× 15). Canada-balsam preparation.

Fig. 4. Transverse section of lower part of rind: *g*, lowest-lying globates of globate layer; *f*, fibrous layer; *c*, gelatinous connective tissue with scattered fusiform fibres and an oval granular cell; *r*, rugæ of cryptal canal (× 70).

Fig. 5. Fusiform acerate spicule (× 15).

Fig. 6. Head of slender ternate spicule with recurved rays (× 60).

Fig. 7. Trifid spicule (× 15).

Fig. 8. Head of slender porrecto-ternate spicule, with only one ray developed (× 60).

Fig. 9. Bifurcated trifid spicule (× 15).

Fig. 10. Large stellate from the mark (× 435).

Fig. 11. Section across the dermal layer: *e*, epidermis; *d*, dermis, with intercalated stellates; *g*, outermost globates of the globate layer (× 217).

Fig. 12. Sphæro-stellate of the rind (× 435).

Fig. 13. Stellate of the mark, usual size (× 435).

Fig. 14. Outline of globate (× 60).

Fig. 15. A granular cell with terminal filament; from the gelatinous connective tissue of the subcortical layer (× 435).

Fig. 16. Similar to fig. 15, but without the extended filament (× 435).

Fig. 17. A fusiform hyaline fibre, showing a central cavity (nucleus) with a small spherule (nucleolus) (× 435).
Fig. 18. The hilum of a globate, with its contained nucleus. The nucleus exhibits a distinctly double contour, fluid contents, and a spherical nucleolus (× 435).
Fig. 19. A globate cell after treatment with dilute potash (5 per cent.), showing separated cell-wall and contained nucleus (× 435).
Fig. 20. Transverse section across rind and subjacent mark, showing an incurrent chone opening by a sphincter protruding into a rugose incurrent canal (*i*), and the smallest branches of the excurrent canal (*e*) terminating close to its walls (× $7\frac{1}{2}$).
Fig. 21. A fragment of mark containing a granular mark-cell (*m*) and a globate cell (*s*) (× 435).
Fig. 22. The smallest or earliest stage of globate yet observed (× 435).
Fig. 23. A ciliated chamber (× 435).
Fig. 24. The tubercular surface of a globate, seen face on, showing the large axial canals perforating the tubercles (× 435).
Fig. 25. Longitudinal section of the terminal branch of an excurrent canal (*e*) with its canaliculi ending in ciliated chambers: *i*, the ultimate branch of an incurrent canal supplying the ciliated chambers (× 157).
Fig. 26. An iris-like diaphragm from one of the rugose incurrent tubes, seen face on (× 60).
Fig. 27. Transverse section of an incurrent tube, from which canaliculi proceed and enter the ciliated chambers (× 204).

[To be continued.

XXXVIII.—*New Genera and Species of Coleoptera from Madagascar.* By CHARLES O. WATERHOUSE.

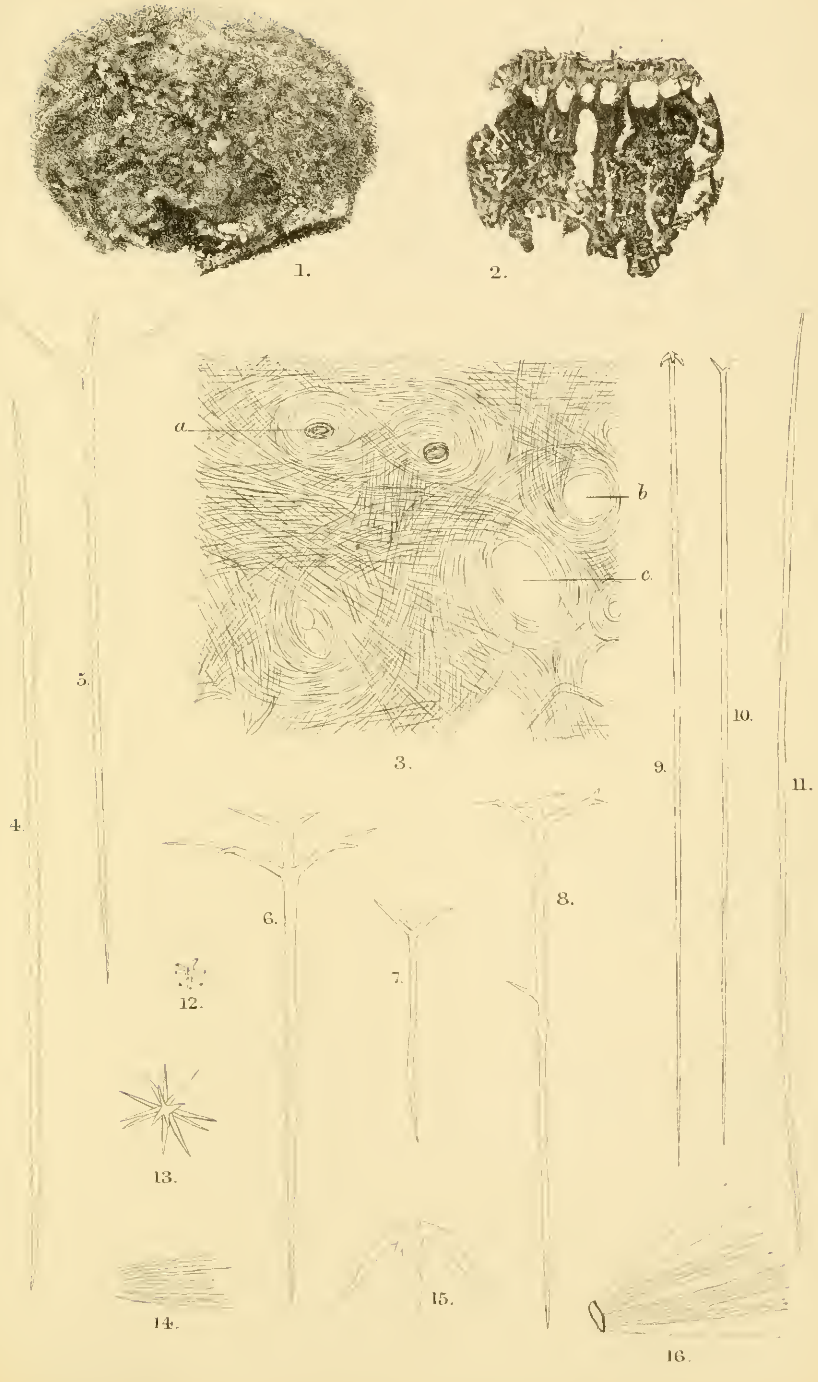
A COLLECTION of Coleoptera recently received at the British Museum from Madagascar has brought to light several new species, which I here describe, with some also which were received from former collections.

Cetoniidæ.

Parachilia compacta, n. sp.

Nigra, opaca; elytris obsolete punctatis, marginibus obscure piceis; pedibus nitidis. ♂, ♀.
Long. 13 lin.

Very close to *P. bufo*, G. & P., but differs in being considerably shorter, less narrowed posteriorly, and with the elytra apparently constantly margined with purple-pitchy colour. The legs are shorter, and the difference in the length of the tarsi is very great in the male; in *P. bufo* the posterior tarsi are longer than the tibiæ by the two apical joints, whereas in *P. compacta* the tarsus is only about half the apical joint longer



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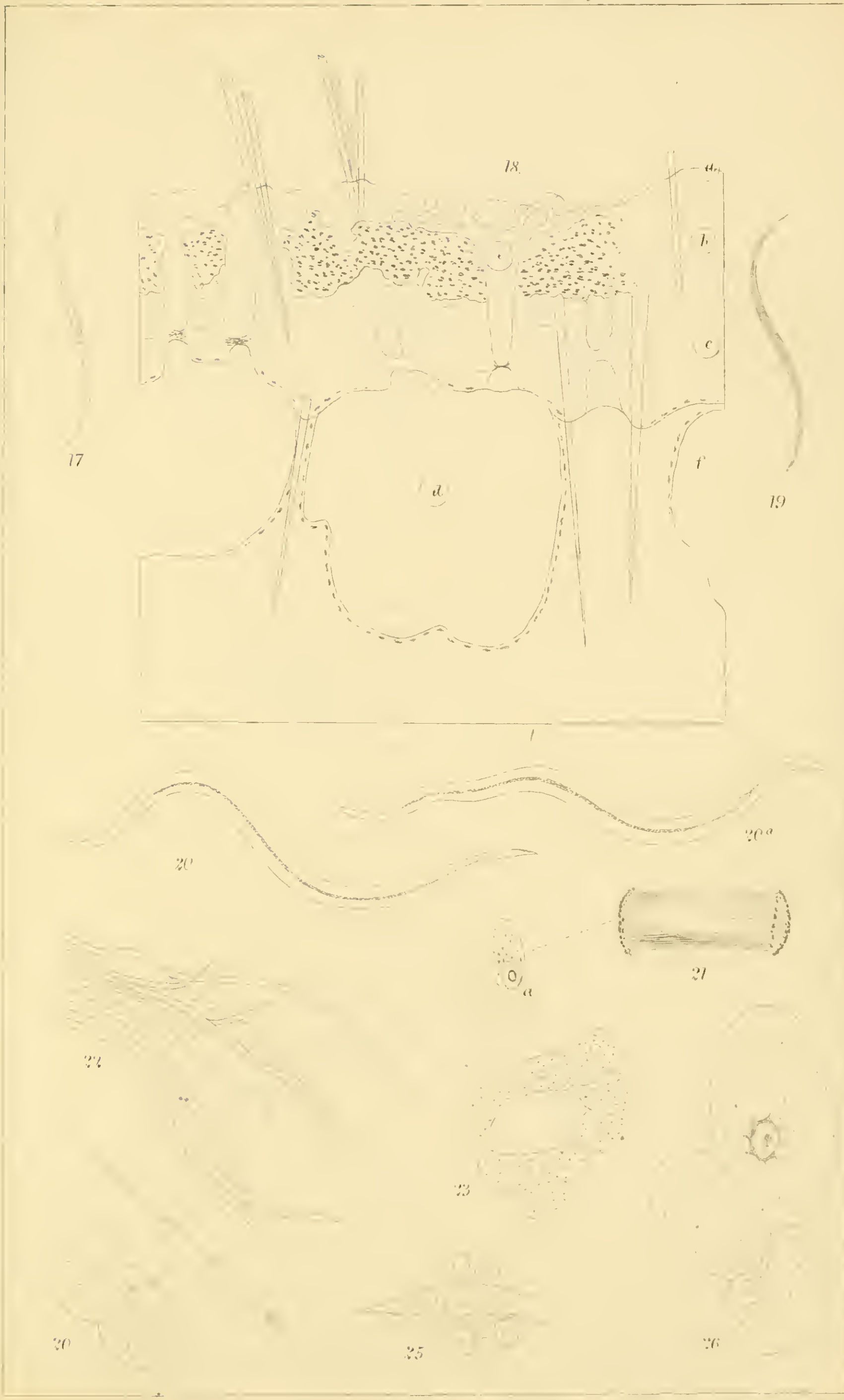
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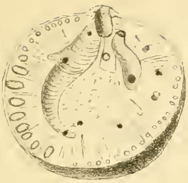

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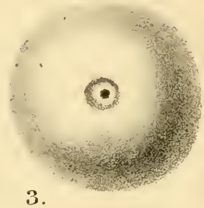

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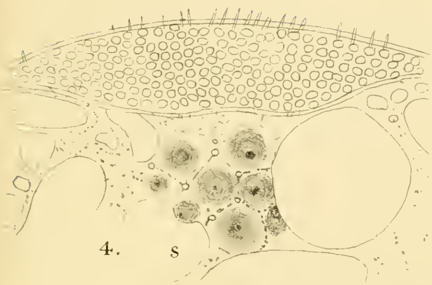

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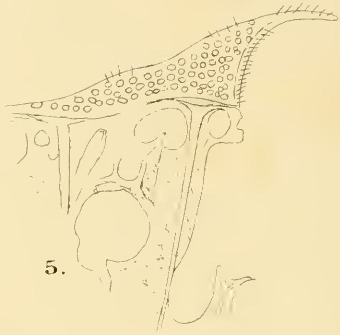

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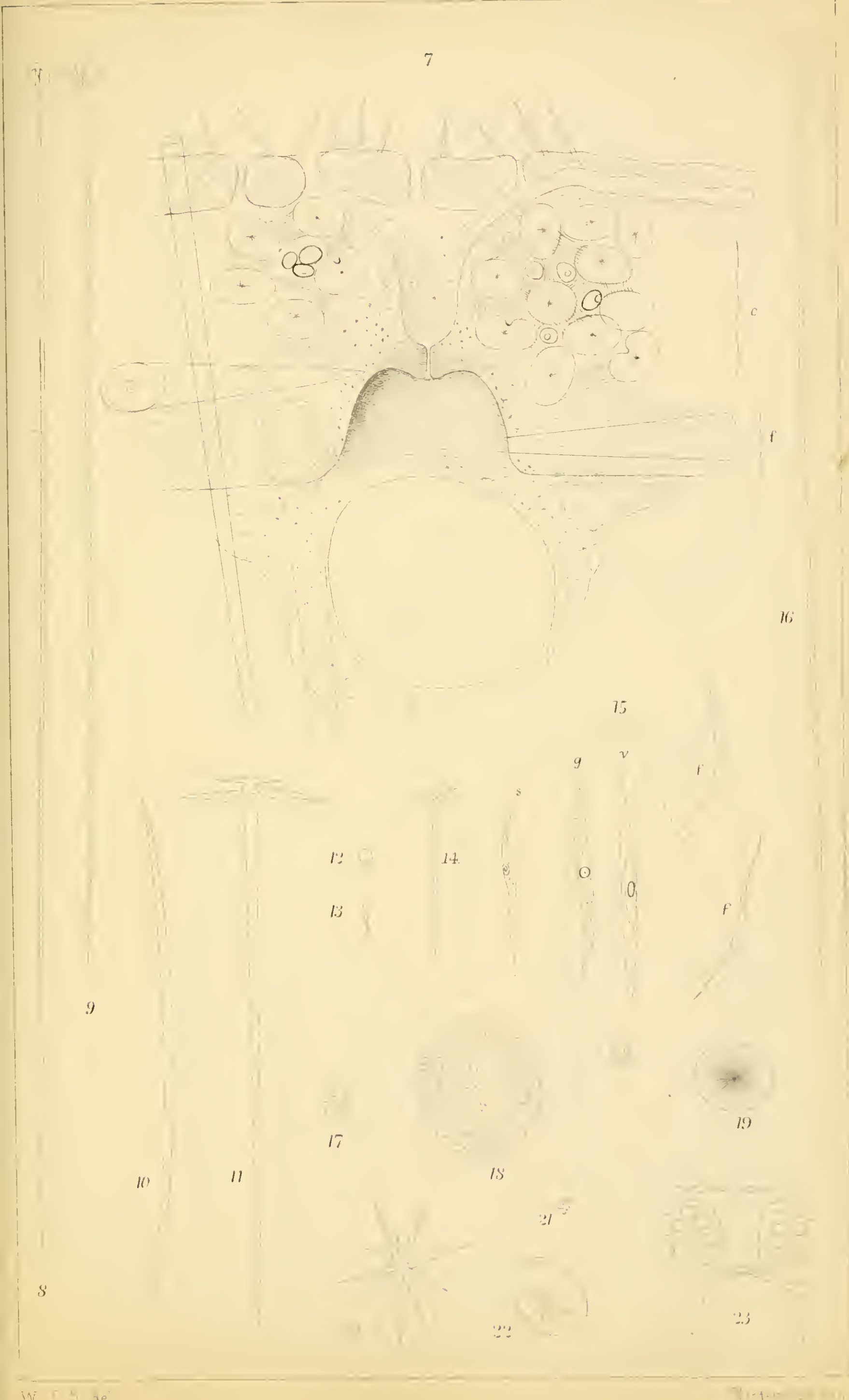

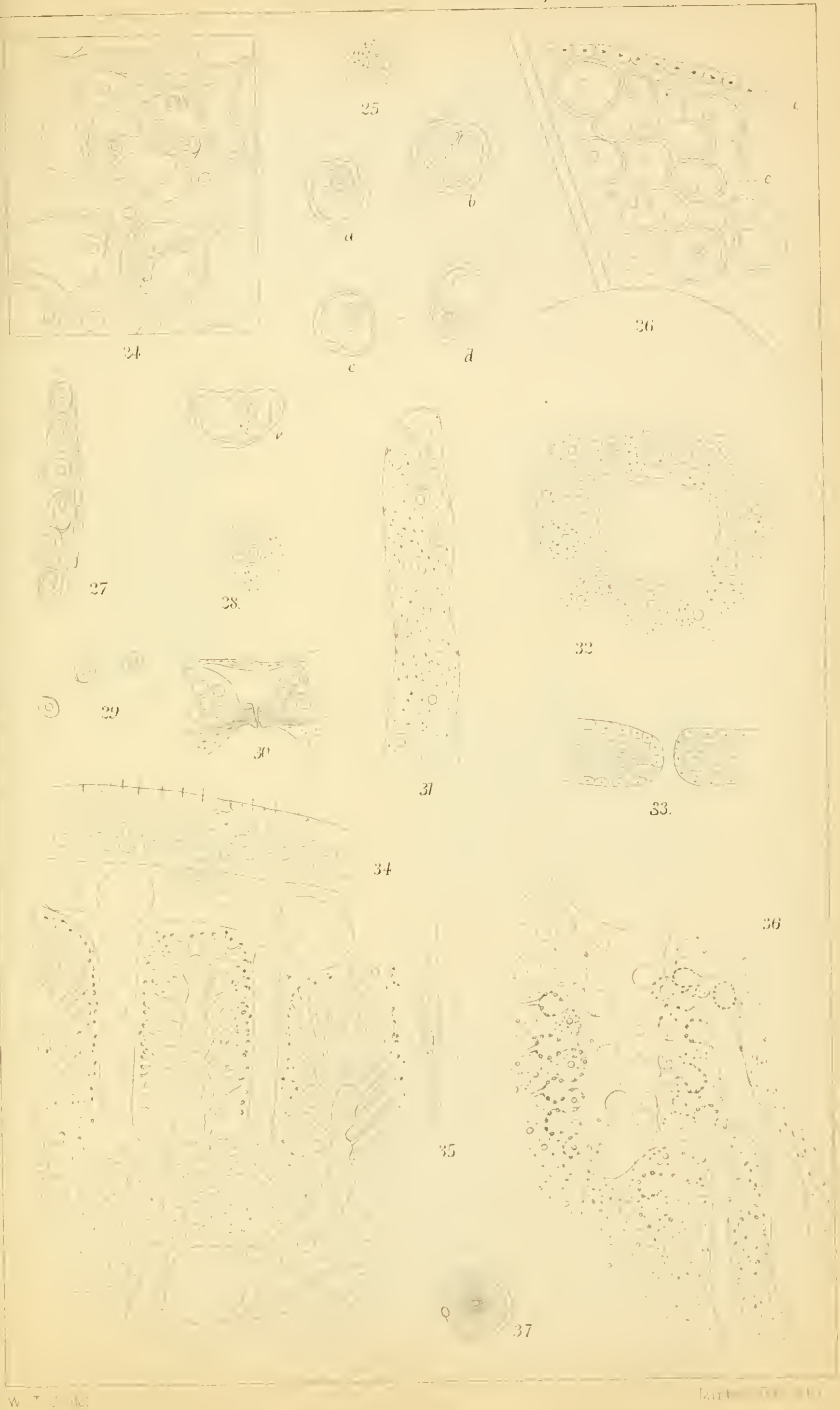
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