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

[Plates VI. & VII.]

[Continued from vol. v. p. 409.]

Order TETRACTINELLIDA, Marshall.

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

Genus Pachymatisma, Bwk.

Pachymatisma Johnstonia, Bwk.

Alcyonium primum, Diosc. (?), Donati, Hist. Nat. de la mer Adriat. (1758).
Halichondria Johnstonia, Bwk. Trans. Micr. Soc. vol. i. p. 63, pl. vi. (1841); Hist. Brit. Sponges, Johnst. p. 198 (1842).
Pachymatisma Johnstonia, Bwk. Monogr. Brit. Spong. ii. pp. 3 & 51; O. Schmidt, Zweites Suppl. Spong. d. Adriat. Meeres, p. 12 (1866); Carter, Ann. & Mag. Nat. Hist. 1869, vol. iv. p. 11.
Caminus osculosus, Grube, Mitth. ü. St. Malo u. Roskoff, p. 132, pl. ii. fig. 3 (1873).

Bowerbank's faithful description of this sponge renders unnecessary any thing more than a supplement on some points of its histology.

1. *The Cortex.*—(i) The outermost layer of the cortex is an exceedingly thin, colourless, and transparent membrane, which rests on a layer of bacillar spicules, homologous with the layer of minute stellates in other Geodine sponges.

(ii) The bacillar layer is single, *i. e.* only one bacillus thick, the bacilli lying parallel to its surface, orientated in every direction, in close contact with each other. Since there is nothing intervening between the superficial membrane and the bacillar layer, it is clear that the former must be the ectoderm, if the generalization hold good that all the skeletal parts of the sponge originate in the mesoderm. That it now exhibits no ectodermic structure is in full accordance with Schulze's observations, who states that he has never yet seen the characteristic platten-cell outlines in spirit-specimens, but only in fresh specimens under silver or gold treatment.

(iii) The succeeding dermal layer is described by Bowerbank * as "a stratum of membranous structure and sarcode destitute of gemmules (globates)." It is of very variable thickness, in some places 0·0038 to 0·0075 inch across, in others absent, the underlying globates then coming in contact with the bacillar layer; it closely resembles the vesicular or vacuolated connective tissue of *Geodia Barretti* (see *anteà*, vol. v. p. 251); in some parts it consists simply of separate colourless, transparent, more or less oval, or polygonal cells with remarkably thin walls and devoid of contents, except for a very small quantity of colourless sarcode, in which may usually be detected a nucleus with its nucleolus (Pl. VI. figs. 5 and 13); in other places, however, the tissue exhibits in addition an intermediate substance, which joins the adjacent cells together, and appears to result from the metamorphosis and fusion of their walls; the intermediate substance is usually colourless and structureless; but sometimes it assumes a dusky grey tint, owing to the presence of abundant minute granules; it also appears in some cases to become finely fibrillated (Pl. VI. fig. 5).

(iv) The globate layer, 0·03 inch thick, has the same structure as in other Geodine sponges. The ligaments which join adjacent globates together consist of fine structureless parallel fibrillæ, amongst which at intervals occur parallel-lying granular threads, sometimes containing a nucleus and nucleolus (Pl. VI. fig. 11). They are probably derived, like the connective-tissue fibres, from elongated fusiform cells with hyaline walls and granular axial threads, in which the hyaline walls have become completely fibrillated, while the axial thread remains unchanged.

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* Phil. Trans. 1862.

(v) The subcortical layer is similar to that of *Geodia Barretti.*

2. *The Mark.*—This is chiefly composed of a granular connective tissue like that of other Geodine sponges, but partly also of vesicular connective tissue; in places groups of granular protoplasmic cells, containing a number of highly refractive globules resembling oil-drops, are met with. The ciliated chambers measure about 0·001 inch in diameter.

3. *The Canal-system.*—(i) *Incurrent canals.* Commencing with an examination of the surface of the sponge, we find that *pores* are not universally distributed over it, some parts being quite destitute of them; and in these places transverse sections of the crust prove the corresponding absence of chones. In the poriferous surface we can frequently distinguish a number of roundish or polygonal opaque white areas, separated by slightly more translucent interspaces; in these areas are set the pores, a group of six to ten pores in each, though sometimes only one or two are visible, or, it may be, even none. If the tissue bearing the pores be removed from the sponge and examined in glycerine under the microscope (Pl. VI. fig. 4), it will be found to consist of a layer of dermal vacuolated tissue, covered by the epidermal and bacillar layers; between adjacent groups of pores, and serving to define them from each other, a row of globate spicules replacing the dermal tissue is seen in addition. The dermal tissue forms a thick framework between the pores, but thins out towards their margins, leaving these to be constituted by the epidermal and bacillar layers alone. It is quite clear that these pores, although doubtless capable of opening and closing by iris-like movements of the clear marginal membrane, are not vague and transitory, as has been asserted, but, on the contrary, persistent and well defined. In my specimens they are usually elliptical in form. With regard to their size, concerning which much confusion exists in published writings, I find that the diameter averages about 0·075 inch; sometimes it becomes as much as 0·12 inch, or as little as 0·002 inch. The majority are clearly visible to the naked eye. On examining the surface from which the poriferous layer has been removed, it will be found that a chonal cavity lies beneath each cluster of pores; the opaque white areas in which they are set are thus in fact chonal roofs, the opacity and whiteness being due to the absence of the globate layer beneath them.

The chones, of which we have next to speak, are closely similar to those of *Geodia Barretti*; they were first described by Bowerbank *, and afterwards more fully by Carter †. My own observations, made on thin slices mounted some in glycerine and some in balsam, all showing the structure in the clearest possible manner, are different from those of Carter in several particulars, and accord with those made by me on *Geodia Barretti*. A transverse section of the rind, giving a longitudinal section of the chones, is represented in fig. 3, Pl. VI. The chonal roof consists of the epidermis and bacillar layer above, bearing the pores; beneath follows the vacuolated tissue, with interspersed fibrous elements concentrically surrounding the pore-canals, which descend one from each pore. The pores in the centre of the roof lead directly into the chone, those at its sides into lateral canals, which may be regarded as an extension laterally of the main chonal cavity above the globate layer and beneath or through the dermis. They are best exposed in tangential sections of the chones. There is no trace of small independent canals traversing the crust outside the chones. The ectochone has the form of a truncated cone, the base being directed outwards; it is provided below with a well-developed sphinctral muscle, the origin of which is about on a level with the inner face of the globate layer; the endochone has almost or entirely disappeared, and the subcortical crypt is of very variable size and irregular form.

The epidermis and its associated bacillar layer are continued from the pores inwards, lining the poral canals and the whole cavity of the chone; they extend through the aperture of the sphincter (the bacilli becoming very rare here), and cover the walls of the subcortical crypt. Beneath the bacillar layer in the walls of the ectochone is a layer of dermal vacuolated tissue, about 0·002 inch thick; it lies immediately on the globate layer.

The chonal sphincter varies in thickness according to its degree of contraction; when fully closed, its lower side has a mamillary form and projects into the cavity of the subcortical crypt; this swollen protuberance may have given rise to the notion of a spiral tube descending from the sphincter, which does not really exist. It is covered by small roundish cells, which are most clearly seen at its central margin, and which are, without doubt, ectodermal. It consists chiefly of dark granular muscle-fibres, which stain deeply with carmine; they have a concentric and radiate arrangement, but are mostly concentric.

(ii) *The Excurrent Canals.* The same differences as dis-

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* Brit. Spong. vol. i. p. 101.

† Ann. & Mag. Nat. Hist. 1869, vol. iv. p. 13.

tinguish the excurrent and incurrent canals in *Isops* are to be met with here.

The ultimate excurrent canaliculi flowing from the flagellated chambers join together into larger canals; and these, after one or more confluences, empty themselves into one or other of the main excurrent trunks, which, maintaining a tolerably uniform diameter for a considerable part of their course, at length open freely into a large, more or less spherical chamber (Pl. VI. fig. 1, C, fig. 2, *b*); this chamber communicates, through an aperture guarded by a thick muscular sphincter, with a smooth-walled cylindrical tube (fig. 1, T, fig. 2, *a*), the external opening of which is somewhat reduced by an extension inwards of its surrounding margin. The walls of this tube, as well as its outer rim, consist of vacuolated tissue, covered by the epidermis, dermis, and bacillar layer; the vacuolated tissue extends down to the subcortical layer, which here consists of gelatinous connective tissue of the usual composition (fig. 1, *c*), bacilli, and long, delicate, thread-like fibres, a little swollen, granular, and nucleated in the middle, and directed lengthwise towards the sphincter; the free face of the subcortical layer, which here forms the wall of the spherical chamber, is covered by a dense layer of dark grey granular fibres (fig. 1, *f*).

The vacuolated tissue of the outer tube exhibits as it approaches the sphincter an increasingly large admixture of fibres, which appear partly to arise between its cells, partly to be introduced from the globate layer.

The sphincter is formed by the union of the subcortical tissue with that of the wall of the outer tube. When these two meet they assume a common direction, so as to extend across the axis of the tube; the tissue of the outer tube forms the upper part of the sphincter, and is traceable as a distinct component almost close up to its centre; it gives us the distinct small epidermal cells covering the upper surface, the bacilli beneath, and lower still the vacuolated cells intermixed with granular fibres. The subcortical layer forms the lower two thirds of the sphincter; it furnishes the layer of epithelial cells covering the lower face of the muscle; its outer dark granular fibrous layer sweeps into the lower part of the sphincter, increasing in thickness as it goes; while its gelatinous connective tissue constitutes the middle layer of the sphincter, extending into it as an intrusive wedge-like mass. Near the centre of the sphincter all these various constituents, except the epidermal and epithelial layers, are represented by dark-grey granular muscle-fibres alone, which, taking a concentric, radiating, and vertical direction, form a central bobbin-shaped mass, easily distinguished from the other constituents by its dusky tint and the deep stain it takes with carmine. One must not omit to mention that amongst the muscle-fibres abundant bacilli occur thickly dispersed. These little spicules indeed pervade the whole of the sphincter, as much in one part as another: but it contains no stellates; these first appear in the underlying spherical chamber, the walls of which are lined by stellates and bacilli together.

The Skeleton.—The *bacilli* are clearly homologous with the minute dermal stellates of *Geodia*, their distribution in the sponge being precisely similar; in both sponges these dermal microliths pass through the cortex and enter the mark, into which, however, they extend only a little way, soon disappearing as we trace them towards the centre of the sponge, their place being taken by the larger stellates proper to the mark.

This homology is a point of some interest, since, taking into account the close family relations of *Geodia* and *Pachymatisma*, it clearly indicates for the bacilli and stellates a common origin; and the question arises as to which of the two is the more primitive form. Examining first their ontogeny, we find it possible to trace the bacillus from the adult form, cylindrical with rounded ends and roughened surface (like a comfit), to a smooth fusiform spicule with a central globular enlargement and pointed ends (fig. 10 *b*), which we may regard as a biradiate stellate.

From this we pass to a form in which the central enlargement has disappeared, and then finally to a fine hair-like rod (fig. 10 *a*), remarkably similar to one of the trichites of which the trichite-sheaves of *Stelletta Normani* are composed.

Turning next to the minute stellate of *G. Barretti*, we are able to trace it backwards, its thick rays becoming of hair-like fineness, and the whole progressively smaller, until it can be no longer followed under a Zeiss-H immersion lens; and yet it remains a multiradiate stellate to the end. Thus, from ontogeny we seem here to get no help at all. The two forms differ greatly in respect of variability, the minute stellates showing but little constancy in the number of their rays, some possessing twice as many as others; while the bacilli, on the other hand, are remarkably stable, seldom varying at all; now and then they sprout off a third ray (fig. 10, *d*, *e*), but so rarely that one has to look long for an instance. Since when once the stability of a form is disturbed it often continues to present variations, we might hence regard the bacilli as the original undisturbed forms, and the stellates as the variable descendants of a bacillus-sport.

The *stellates* of the mark possess a comparatively small number of rays, a character in curious consistency with the substitution of biradiate bacilli for multiradiate dermal stellates in this genus; six or eight rays is a common number; as many as twelve may occur; but reduction to four, three, or even two, is frequent. With only two rays in the same straight line, the spicule presents a central globular enlargement and looks like a magnified copy of a young bacillus.

A study of the various forms of these stellates is a study of nearly all the characteristic forms of spicules which distinguish the various groups of sponges: hexactinellid, tetractinellid, triradiate are all here, and a great number of other forms besides. We seem in these spicules to have the results of unhindered variation, freed from the conditions imposed by a selective environment.

The *long-shafted spicules* in the specimen under examination exhibit a great variety of monstrous growths: in many a number of siliceous globules cover as excrescences one end of the spicule (fig. 9); in others one end becomes bifid, trifid, or even quadrifid (fig. 6), the last deviation being met with in the usually simple proximal end of the shaft of a tetractinellid form; some, again, possess simple ends, but a double body (fig. 7); and, finally, in one instance the end of a spicule has sprouted out rays which are arranged in a combination of prong and anchor endings in one (fig. 8). Since anchors do not occur normally in *Pachymatisma*, this variation is of particular interest. Bowerbank has already remarked, in his description of the species, on the great variety of these spicules, and particularly says that their radii are frequently bifurcated or contorted to a great extent. This, and the irregular disposition of the trifid spicules, is worthy of notice in connexion with the possibility of a transition from the trifid to the quadriradiate Tetractinellids and the Lithistids.

Many of the spicules appear to be subject to some disease, by which the central canal has been enlarged till it occupies one third of the entire diameter, the axial thread remaining as a straight sharply defined rod of the usual size; sometimes it projects quite freely at the end of the spicule.

By manipulating the cover-glass over a teased fragment of the sponge the axial thread could be "wriggled" out nearly entire from the spicule. It is faintly bluish, transparent, structureless, very flexible, like a piece of sewing-thread, and takes a decided stain with magenta.

Some of the spicules are united where they touch in crossing each other by some tough brown-coloured matter, which stains with magenta and looks like spongin.

The *globates* agree in their general character and mode of development with those of other Geodina; and I have now only to allude to the statement that in their young form they closely resemble stellate spicules. This I cannot substantiate; closely as I have searched for transitional forms between globates and stellates, I have never yet been able to find any, any more than between stellates and bacilli. In thin slices mounted in balsam I have been able to trace the globates down to a young form, measuring something under $\frac{1}{1200}$ inch in diameter; but even in this earliest stage it consists of a vast number of minute trichites united into a central globule at their inner ends. Its outline is spherical, owing to the trichites ending at the same distance from the centre; and it is enclosed in a granular cell with a large young nucleus on one side, which takes a deep tint with carmine. It thus differs from a young stellate in just the same way as the stellate from a bacillus, *i. e.* by a great difference in the number of its rays. As the globate increases in size, each trichite becomes longer, thicker, and roughened over its free end, so as to resemble closely an adult bacillus. The globate, indeed, might now be well compared to a collection of bacilli, radiately grouped and fused together at their inner ends.

Classification.—The generic distinction of *Pachymatisma* is well founded, and is further supported by the character of its oscular openings.

In *Geodia Barretti*, which we regard as an illustrative species of the genus *Geodia*, we likewise have an oscular tube; but it differs in a most important manner from that of *Pachymatisma*; for while the latter is separated by a sphincter at its base from a common chamber below, in which the excurrent canals open freely by unconstricted apertures, the former, on the other hand, is without the common chamber and the common sphincter, and the excurrent tubes are severally and separately sphinctrated as they open directly into the oscular tube itself. In *Geodia* the oscular tube appears to result from the union of a number of excurrent chones, like those of *Isops*; in *Pachymatisma* it is produced by the over-development of a single one. In *Cydonium* there are no oscular tubes, and both excurrent and incurrent chones (if the distinction can here be maintained) are covered with a cribriform or poriferous roof, the very reverse of what holds in *Isops*, where neither excurrent nor incurrent chones are so provided. Translating the foregoing distinctions into a different nomenclature, it would seem that in *Isops* we have a compound stock consisting of a number of separate individuals, somewhat resembling an *Astræa*-stock amongst corals; in *Geodia* groups of these individuals have become united into individuals of a higher order; in *Pachymatisma* single individuals have become more complicated by a branching or budding off of main excurrent canals, which are here to be regarded each as an individual of a lower order; in *Cydonium* we appear to have a case of lipostomism, the functions of an osculum being vicariously carried on by the poriferous chones.

Indicating the individual expressed by a single excurrent chone by the symbol 1, and that expressed by a single main excurrent canal by I, we may briefly formulate the relations of the four genera in the following diagram:—

Isops	1 . 1 . 1 . 1 . 1 . 1 . 1 .
Geodia	(1 1 1) (1 1 1 1)
Pachymatisma	0 . 0 . 1 . 0 . 0 . 0 . 1
	$\overbrace{\mathrm{I\,.\,I\,.\,I\,.\,I\,.\,I}}\quad\overbrace{\mathrm{I\,.\,I\,.\,I\,.\,I\,.\,I}}$
Cydonium ?	No obvious individuality beyond that of the entire stock.

Distribution. Kors Fiord, Norway, Station 23: 180 fathoms. Bowerbank cites this sponge from Torquay, south coast of Ireland, Orkneys, and Wick, Scotland. We now have it from Norway; and Grube describes it, as pointed out to me by Mr. Norman, under the name of *Caminus osculosus* from St. Malo. It thus extends from Norway and the Orkneys on the north, to St. Malo on the south, and as far west as the Guliot caves on the south coast of Ireland; bathymetrically, it ranges from low-tide level to 180 fathoms.

Group *TETILLINA* (*TETHYINA*), Carter. (Pl. VII.)

Genus TETILLA, O. S.

Tetilla cranium, Müll.

1789. *Alcyonium cranium*, Müll. Zool. Dan. t. 85. f. 1.
1815. *Tethya cranium*, Lmk. Mém. d. Mus. i. p. 71.
1816. *Alcyonium cranium*, Lmx. Hist. d. Polypes, p. 347.
1818. *Spongia pilosa*, Mont. Mem. Wern. Soc. vol. ii. p. 119, pl. xiii. figs. 1–3.
1828. *Tethya cranium*, Flem. Brit. Animals, p. 519.
1834. *Tethya cranium*, Blainv. Mém. d'Act. p. 544.
1842. *Tethea cranium*, Johnst. Brit. Spong. p. 83, pl. i. figs. 1-8.
1864. *Tethea cranium*, Bwk. Monog. Brit. Sp. i. p. 182, pl. xxxi. fig. 362.
1866. *Tethea cranium*, Bwk. Monog. Brit. Sp. ii. p. 83.
1866. *Tethya cranium*, O. S. Adriat. Spong. ii. Suppl. pl. i. fig. 14.
1867. *Tethya cranium*, Gray, P. Z. S. p. 543.
1870. *Tetilla cranium*, O. S. Spong. Atl. p. 66.
1871. *Tethya cranium*, Carter, Ann. & Mag. Nat. Hist. vol. viii. p. 104.

1872. *Tethya cranium,* Carter, Ann. & Mag. Nat. Hist. vol. ix. p. 419, pl. xxii. fig. 9.

1874. *Tethya cranium,* Bwk. Monog. Br. Sp. iii. p. 315, pls. xiv. & lxxxix.

This interesting sponge, the occurrence of which in the Norwegian seas had been early noticed by Bishop Pontoppidan (Lamx. *loc. cit.*), is well represented in Mr. Norman's collection by several small but perfectly preserved specimens. A clear insight into its exquisite structure is afforded by a series of thin slices obtained by means of the freezing microtome, and mounted in balsam or glycerine. My chief regret is that its beauties have not found a more skilful pencil to portray them.

The sponge is approximately spherical in form, white, and with a hairy appearance due to the projection of the ends of the spicular fibres beyond its general surface. An oscule is clearly present, though Bowerbank and other observers have failed to find it. On this point Bowerbank is most explicit; his specimens were some two hundred in number, and, after careful searching, he could discover no trace of an oscule, pores, or intermarginal cavities, all of which in Mr. Norman's specimens can be easily demonstrated. Carter, it should be added, has called attention to the presence of a group of oscules in a specimen which came under his observation (Ann. & Mag. Nat. Hist. ser. 4, 1872, vol. ix. p. 419).

The oscule is a nearly circular opening, usually small (from 0·03 to 0·07 inch diameter), obliquely terminating a tunnel-like tube (fig. 6, *o*, transv. sec.) which runs for a short distance along the surface of the sponge; the tunnel-like roof of the tube is a thin imperforate membrane formed by the extension of the dermis; the floor is the ordinary dermis of the general surface, which retains its pores, and by their over-development assumes the character of a fenestrated membrane or network with round meshes.

The skin or dermal membrane rises tent-like about the ends of the projecting spicular fibres, and extends continuously from one to another, so as to completely invest the sponge. It is best seen by cutting off the ends of the projecting spicules, and viewing under an inch lens by reflected light (figs. 15, 16). One can then observe shining through the surface of the skin a number of thread-like fibres, which radiate outwards and downwards from the circumference of each spicular fibre as a centre, branching as they go, and anastomosing with those of adjacent centres to form a polygonal network, by which the overlying dermal membrane is mapped out, as it were, into a number of polygonal areas.

It is in these areas, which may be even and plain, or subdivided by smaller fibrous threads into a number of round or oval spaces, that the pores are situated: they are very small, from 0·001 to 0·002 inch in diameter; and the poriferous membrane is so tender and delicate that it would probably be torn away by an observer unsuspicious of its presence, and in this way may have escaped the notice of Bowerbank; when removed, the projecting spicular fibres appear below, each rising out of a fleshy papilla, the lower half of what we shall term a spicular column of the cortex. A good representation of the surface of the sponge, as thus denuded of its dermal membrane, is given by Johnston (*loc. cit.* pl. i. fig. 3). The spaces between the papillæ (Pl. VII. fig. 6), roofed over by the dermal membrane in the uninjured sponge, correspond to the intermarginal or subdermal cavities of other sponges.

Bisecting the sponge through its oscule, we distinguish on the cut face an external whitish rind and a pale greyish mark sharply defined from it; the skin and subdermal cavities are readily observable, forming the outer half of the rind; its inner half is a continuous whitish layer. In the mark, numerous canals are seen cut across; and one large one approaching close to the oscule, along a spiral course conformable to that of the spicular fibres, is clearly one of the main excurrent canals.

We now proceed to give a more detailed account of the structure of the sponge, as revealed in thin slices examined under the microscope.

The Ectoderm.—The study of this layer is full of perplexing difficulties, owing partly, no doubt, to the fact that one is limited to particular methods in investigating it, but partly also to the want of constancy in those characters which it clearly displays. It is in the subdermal cavities that its structure is most satisfactorily seen. There, on the sides of the spicular columns (Pl. VII. fig. 13) one may sometimes discover it as a superficial layer of irregularly polygonal plate-like cells, $\frac{1}{1500}$ to $\frac{1}{2500}$ inch in diameter, with small circular nuclei of a faint bluish tint, $\frac{1}{7500}$ to $\frac{1}{10000}$ inch in diameter, which sometimes project outwards beyond the plane of the membrane. This structure, by the loss of the polygonal outlines of its cells, readily passes into a thin membrane with scattered nuclei, of just the same size and appearance as those in the well-defined cells. If this were the only change, no difficulty concerning the ectoderm of the subdermal cavities need be felt; but in some places the minute C- and S-shaped spicules of the mesoderm are plainly imbedded in the nucleated membrane, each spicule surrounding a nucleus, which does not differ in any apparent respect from those of the plate-like polygonal cells. There can be no question that these minute spicules and their nuclei are associated parts of the same cell; but how comes this cell into the ectoderm if all spicular structures are a product of the mesoderm? Can a mesoderm-cell have wandered into the ectoderm? and if one kind of mesoderm-cell why not others? and then what becomes of the sharp distinction between these two layers? The simplest explanation would, of course, be that of mistaken observation; but, after repeated examination of my preparations, I can see no reason for admitting this. But this is not all; for in many places a thin annular wall appears about the small round nuclei (Pl. VII. fig. 9), whence results a flat oval cell about $\frac{1}{2000}$ inch in diameter, devoid of contents except for a little clear colourless protoplasm, which may form a little slightly granular heap about the nucleus and extend from it to the outer wall; the appearance of the lining membrane is now that of a thin structureless film imbedding flat oval cells, at intervals varying from that of their own diameter up to close contact. No other structure can be seen more superficial than this, either when viewed face on or in transverse section, and consequently, one can scarcely help regarding it as the ectoderm; it is at least conceivable, though not probable, that it results from a change in the form of the plate-like cells, consequent on immersion in spirits; if these, on shrinking, assume an oval form and become connected by an exudation from the mesoderm which subsequently hardens, an appearance similar to that described might be produced.

The skin (Pl. VII. fig. 7), as the outer covering membrane may be briefly called, exhibits another change of structure. This consists in the appearance of an immeasurably thin structureless membrane, which is in many places thrown into numerous minute wrinkles having no apparent arrangement, except when traced to the margins of the pores, to which they are radiate. It rises tent-like about the projecting spicules individually. Associated with it, but lying on its under surface, as can be clearly perceived by examining it in optical section where it rises into tent-like projections or is most wrinkled, are the circular pale bluish nuclei of the subdermal epithelium, often so regularly disposed at nearly equal distances from each other, that one feels almost bound to regard the nuclei and membrane together as an ectoderm from which the polygonal outlines of cells have disappeared—until one finds round some of these nuclei, and lying on the underside of the membrane, the same kind of oval annular wall before described. Hamate spicules are also found lying beneath the outer membrane. The interpretation of these observations is most difficult. If the outermost membrane be the ectoderm, why do not at least nuclei appear in it? since they are plainly seen in the subdermal ectoderm, and these have the same appearance as the nuclei which here occur below the outer membrane. If it is not ectoderm, but a structureless cuticula, where is the ectoderm? for it appears very improbable that a heterogeneous layer of oval cells, spicule-cells, and bare nuclei can represent this layer; by no means impossible, however, since, in spite of the beautiful demonstrations we have had from the masterly hand of F. E. Schulze, I do not yet feel quite convinced of the uniformity of this structure over all parts of the sponge, or that it presents the same constancy as in the other Metazoa. But it is reckless to speculate in the absence of any of the evidence possible, and the silver treatment may eventually, as I almost expect, bring out of the apparently structureless cuticula the polygonal outlines of epithelial cells; but, till that welcome sight appears, one must be content to take the facts as one finds them; and so provisionally the outermost layer is for me a cuticula, and the mixed cellular layer beneath a heterogeneous ectoderm. The cuticula and ectoderm together cover the exterior of the sponge, except in some cases near the small oval pore-areas (Pl. VII. fig. 15), which are situated in the meshes of the polygonal dermal network; in these it often happens that the cuticula is absent, or has thinned away beyond one's power of observation; for, although present on the surrounding skin, it is not possible to see what becomes of it as it is traced into the pore-area. The membrane in which the pores in these instances are set appears, when looked down upon from above, to consist of a structureless film which does not stain with carmine, and in which are imbedded granules, naked nuclei, similar nuclei surrounded by hamate spicules which often project out of the membrane, and flat oval-walled cells with similar nuclei; thus it has the same appearance as the ectoderm of the subdermal cavities. In addition, fine delicate filaments may be seen, which frequently run parallel in groups, crossing one another in the space between two pores, and then diverging so as to touch tangentially the edge of the pores. In the dermal network which forms the floor of the oscular tube and the roof of the subdermal cavity below, we can perceive a similar structure (Pl. VII. fig. 8); but transverse sections show here a superficial ectodermal layer with a thin mesodermic layer between, where the network is thickest; in the very thin layer which lies between two pores the ectodermal layers come nearly into contact, though a few fine fibrils still seem to separate them; they clearly show, however, imbedded in their midst, and not lying below them, the characteristic round nuclei with hamate spicules surrounding them. These thin and narrow trabeculæ seldom contain oval cells; they are not wide enough; but these, along with granular cells, occur in the larger nodal areas where three or more trabeculæ meet (Pl. VII. figs. 9 & 10).

The edges of the pores are sometimes bordered by minute granular fusiform cells with a minute spherical nucleolus in an oval nucleus.

Between the upper and lower ectodermal layers of the skin is a layer of mesoderm of somewhat variable character, but mainly consisting of a clear colourless jelly-like matrix, in which are imbedded various cellular elements (Pl. VII. fig. 2). The most widely diffused, perhaps, are little circular or oval rings $\frac{1}{3000}$ inch in diameter, highly refractive, and of a pale bluish tinge, enclosing round nuclei $\frac{1}{10000}$ inch in diameter, of similar optical characters; these, scattered irregularly through the clear ground-mass, give it a curious appearance like spotted muslin. Immediately beneath the annular cells of the ectoderm succeed a number of separate, irregularly rounded, granular greyish-coloured cells with round nuclei; they might very well be an early form of the annular cells. Sometimes they form a layer two or three cells deep, sometimes thin out altogether. The remaining cellular constituents are fusiform granular cells, variously distributed; lying parallel side by side, they form the fibrous strands, which run just below the epidermis to map out the pore-areas from each other; sometimes they form a thin layer beneath the surface, in which they wander in all directions, and occasionally extend singly at right angles to the surface from the upper to the lower ectodermic layer. Approaching the spicular columns the dermal mesodermic layer thickens out, so that the upper and lower ectodermic layers become gradually more and more separated from each other—the upper rising tent-like about the outer ends of the spicular columns, the lower descending in a similar but inverted tent-like curve down the continuations of the columns beneath the skin, and so rounding off the upper corners of the intermarginal cavities. In correspondence with this thickening-out of the dermal mesoderm, its fusiform fibres diverge fan-like as they enter the spicular column, the more superficial ones running parallel to their respective surfaces. The fusiform fibres in the vicinity of the spicules run parallel to them, though near the external ends of the spicular columns they appear to run at right angles to them, and appear to unite with them by their frayed and expanded ends.

At its base the spicular column expands by a thickening of the mesoderm as it extends along with the ectoderm over the upper face of the fibrous layer of the cortex, to form the floor of the subdermal cavities. Below this superficial stratum the fibrous layer consists of similar fusiform fibres to those of other parts of the mesoderm, but surrounded by a more condensed layer of matrix; they are about $\frac{1}{160}$ inch long, $\frac{1}{10000}$ inch wide, highly refractive, faintly bluish, granular, with an oval vesicular nucleus and round refractive nucleolus; the surrounding mesoderm, the walls of these cells, is clear, colourless, and sometimes slightly fibrillated. The inner face of the fibrous layer is coated with an adherent granular mark.

The fibrous layer is traversed by the smaller fusiform acerate spicules represented by Bowerbank (Brit. Spong. vol. i. fig. 362), which run through the fibres like stakes through wattlework. In Bowerbank's figure these spicules all lie parallel to each other, at right angles to the general direction of the fibrous layer; but in none of my slices is such an arrangement to be seen; the majority of the spicules run obliquely through the fibrous layer, sloping convergently towards the spicular columns at their base, and midway between crossing each other obliquely in different directions, some running at right angles to the fibres. The fibres of the fibrous layer lie concentric with the surface of the sponge, running in winding curves orientated in all directions, like the similar fibres in the cortex of *Stelletta Normani* (Ann. & Mag. Nat. Hist. 1880, vol. v. pl. vi. fig. 3). The deeper half of the fibrous layer has a duskier, darker tint than the more superficial, and takes a deeper stain with carmine. As to its function, it is probably a fibrous connective tissue, as I previously asserted of the corresponding layer of *Geodia Barretti* (Ann. & Mag. Nat. Hist. vol. v. p. 253).

The fibrous layer becomes still more modified in the same direction immediately about the incurrent canals, a little below the middle of their course through it; here the fusiform axial threads are more closely approximated, the intervening tissue is of a darker grey, and the stain with carmine strikingly marked; the arrangement of the fibres is for the most part very regularly concentric; but a few are radiately disposed. With this change in appearance there is a change of function, and the fibres form a true muscular sphincter, which is to be observed in the prepared slices in all stages of contraction. It is clear from the preponderance of the concentric fibres that the chief work done is in the contraction and closure of the sphincter; its return, on the relaxation of the concentric fibres, to a completely open state is completed by the opposing radiate fibres. This sphincter (Pl. VII. fig. 6) is precisely homologous with the chonal sphincters of Geodina and Stellettina. The fibrous layer with its spicules is homologous with the fibrous globate layer of the Geodina.

The Mark.—The mesoderm of the mark chiefly consists of a clear transparent matrix densely charged with more refractive, transparent, minute round granules ($\frac{1}{40000}$ to $\frac{1}{50000}$ inch in diameter), so thickly strewn that they appear almost in contact, and so evenly that no place seems to contain more than another: here and there at intervals small nuclei appear; and the mark surrounding them takes a deeper stain with carmine than elsewhere. If such a tissue as syncytium exists anywhere, then surely it is here. Fusiform fibres occur in the vicinity of the spicule-fibres, running parallel to the spicules, and also about the large water-canals, building around their course an indefinite fibrous layer. Most markworthy are certain large granular amœbiform cells with characteristically large oval nuclei and round nucleoli, like amœbiform ova, which are found embracing the spicules (Pl. VI. fig. 17) as though they were wandering cells creeping along them.

The endodermic cells of the flagellated chambers contribute a large share to the substance of the mark; they now appear as spherical vesicles $\frac{1}{3000}$ inch in diameter, containing a spherical nucleus $\frac{1}{10000}$ inch in diameter, which colours intensely with carmine. Carter has represented one of these chambers in his description of *Tetilla* (Ann. & Mag. Nat. Hist. 1872, vol. ix. pl. xxii. fig. 7), but has mistaken it for an ovum.

The Ova.—Sparsely scattered without apparent order through the mark are a number of very variously-shaped *Amœba*-like cells, distinguished by their disproportionately large nucleus and nucleolus. They occur of all sizes, from $\frac{1}{1200}$ inch diameter to $\frac{1}{180}$ inch, and are without doubt the ova in various stages of development. As soon as they attain a size of about $\frac{1}{700}$ inch across they occupy a distinct cavity in the mark, which serves as a brood-chamber. Pseudopodial extensions, which may become branched, proceed from them, and, passing out of the brood-chamber, wander for a considerable distance on the surrounding substance of the mark. No trace of fibrillation could be detected in these processes. The large oval nucleus, sometimes $\frac{1}{630}$ inch in diameter, with its nucleolus $\frac{1}{2500}$ inch in diameter, looking like a globular oil-drop, lies nearer one end of the ovum than the other, imbedded in granular protoplasm, which immediately about the nucleus takes a far deeper stain with carmine than elsewhere. At the end of the cell, away from the nucleus, yolk-granules (for such I take to be the heap of large refractive granules represented at *g*, fig. 5) make their appearance, and increase in quantity with age till the whole cell is crowded with them, except in the immediate vicinity of the nucleus. Some of the yolk-granules appear to present a vesicular form. On the whole, one cannot help being impressed with the similarity of this ovum to that of *Hydra*.

The Spermatozoa.—In the three specimens I have examined no trace of these structures was discoverable; and since the ova occur in every stage of development, the presumption is in favour of the sexes being distinct in *Tetilla*. Large clusters of granules occupy a large part of some specimens; but these are segmentation-spheres of a developing parasite.

The Canal-system.—The characters and arrangement of the pores have already been described. They lead directly into the subdermal cavities, which extend continuously from one spicular column to another, and communicate between the columns with each other. In the floor of each subdermal cavity are the inner ends of several ectochones, separated by the usual sphincter from the corresponding endochones; it is thus clear that each subdermal cavity is equivalent to the outer halves of several ectochones which have become confluent, or, *vice versâ*, that those ectochones of a Geodine which lie in an area bounded by surrounding spicular fibres are equivalent to a single subdermal cavity of *Tetilla*. In *Stelletta Normani* this is neatly indicated by the subcortical crypts, which have just the same distribution below the fibrous cortex that the subdermal cavities of *Tetilla* have above it; they therefore clearly map out the areas which would be occupied by similar subdermal cavities were they present; and it is interesting therefore to find that they receive from the cortex not one but several endochones between each pair of spicular fibres, as shown in transverse section. The incurrent canals, after entering the mark, soon branch, and continue to branch repeatedly; but they give off at once and all along their course minute short canaliculi, which directly enter the flagellated chambers. These are $\frac{1}{1000}$ inch in diameter, nearly spherical, and very numerously developed. The chambers less abruptly communicate with the incurrent system by excurrent canaliculi, which are usually longer than the incurrent, the excurrent canals join together into a main trunk, which traverses the cortex in a manner not yet observed, and then continues over its surface beneath a tunnel-like extension of the skin in the manner previously described, finally terminating in the osculum.

The Skeleton.—The main spicules, which are collected into fibres, are developed in granular spicule-cells, as will be more fully described in treating of the embryo. The cortical acerates and the fibrous layer are clearly homologous with the globate and fibrous layer of Geodina; and the inference is also deducible that the cortical acerates are likewise homologous with the geodine globates; surprising as this inference is at first sight, it is partly supported by the fact that both are developed in remarkably similar nucleated cells. Again, as the trichite sheaf is homologous with the globate, so it is also homologous with the *Tetilla* acerate; and here we are brought to see the essential difference between the sheaf and the acerate, the former being a fibrillated rod and the latter a concentrically-layered one.

The hamate spicules are found embracing a small round nucleus with a little granular sarcode; but no cell-wall is ever seen (Pl. VII. figs. 4 and 10); so that one is led to conjecture that the spicule may be the cell-wall, especially as it closely resembles in size and appearance the annular cell-wall, to which we have made frequent reference in describing the dermis. The nucleus of the hamate spicules is entirely different in size and character from that of the large spicule-cells and of the geodine globate; it is much smaller, no larger than the nucleolus of the latter, and shows no distinct nucleolus. It is of importance to notice that the hamates are not developed several in one cell, as Carter has asserted of the common tricurvate spicules, as Schmidt has shown for the trichites of *Esperia*, and I, subsequently, for the trichites of *Stelletta Normani*; each hamate has sole possession of its own nucleus; in other words, each hamate cell produces but one hamate spicule. Carter mentions that he has also found two examples of a bihamate occurring singly in its mother cell (A. & M. N. H. 1874, vol. xiv. p. 104, pl. x. fig. 11).

The Embryo.—The segmentation of the ovum has not been observed in any of its stages; but sections of three embryos are shown in very thin slices; they each lie in a brood-chamber lined by a distinct membrane (endothelial) and a thin layer of fibrous tissue. Two, nearly spherical and 0·033 inch in diameter, are still solid throughout; the third (Pl. VII. fig. 1), oval, measuring 0·043 inch along its major and 0·033 inch along its minor axis, is also solid, except for the presence of the subdermal cavities, which are well developed over one half the circumference, and the flagellated chambers, which are abundantly present in the mark and sometimes seem to be in connexion with the subdermal cavity by a minute incurrent canaliculus. There are otherwise no discernible canals in the mark. The mark is clearly distinguished from the cortical layer of gelatinous connective tissue which represents the non-fibrous layer of the adult cortex. The fibrous layer is at present represented merely by a thin layer of fusiform fibres in a granular gelatinous matrix, developed from the exterior of the mark and appertaining more to it than to the cortical gelatinous tissue; it is entirely unprovided with special spicules. The thick spiculated fibrous layer of the adult cortex is thus comparatively late in developing. No pores are yet visible in the skin, which consists of an external wrinkled membrane, with round nuclei in a layer beneath it (cuticula and ectoderm ?), and a mesodermic layer of gelatinous connective tissue, containing pale oval granular cells dispersed through it. The subdermal cavities are lined by a thin membrane with round nuclei imbedded in it with tolerable regularity: this epithelium may be in continuation with the ectoderm somewhere; but my specimen does not show it. The centre of the mark consists of colourless gelatinous tissue containing irregularly stellate and fusiform cells; but its outer half is granular, as in the adult sponge, and crowded with flagellated chambers; if these are in connexion with a cleavage-cavity, it is curious that there is nothing in my specimen to indicate it. Many *Amœba*-like cells are present in the mark; and in one of them a young acerate spicule is seen almost wholly immersed, as though the latter had developed within it (Pl. VII. fig. 12); and, considering that the cell is almost precisely similar in shape and in the size and character of its nucleus and nucleolus to that in which the *Geodia* globate develops, this suggestion seems not improbable. With regard to the character of its nucleus it also resembles closely the ova of the sponge, but differs in other respects, its outer sarcode being more transparent, less densely finely granular, and staining much more faintly with carmine. Much more close is its resemblance to the *Amœba*-like cells previously mentioned as associated with some of the large spicules of the adult sponge: and on reexamining these I find that the association is much more common than I had before supposed; it appears in all not fully-developed spicules of which I could get a good view, and not only in *Tetilla*, but in *Geodia Barretti* and *Isops Phlegræi* as well; moreover, in a great number of cases I could trace from the heap of sarcode which surrounds the nucleus a thin granular film extending towards each end of the spicule, up to which, indeed, it completely reaches (Pl. VII. fig. 18). In these cases the spicule-sheath is no other than a single enveloping large cell; and since the spicule increases in thickness by successive onlayerings to its surface, and nothing intervenes between it and the surrounding cell, we are obliged, so it would appear, to regard the latter as the medium through which the spicule increases in size; but the very young spicules appear in a similar cell, which only differs in being smaller and having a correspondingly smaller nucleus and nucleolus, *i. e.* in being younger. Hence it follows that the ensheathing cell is the true parent and nurse of the large spicules with which it is associated; it probably only disappears on the completion of their growth.

The spicules most conspicuously present are the projecting forks, which, with the grapnels with recurved rays and the long fusiform acerates, lie in parallel bundles, radiating not directly at right angles to the surface, but a little obliquely, their inner ends being tangential to an imaginary sphere concentric with the centre of the sponge. The tendency to a spiral arrangement, which Schmidt has well explained as naturally following from the form of the spicules, is thus early declared. Although the points of the forks frequently project through the skin, yet their centre of origin from the shaft always remains beneath or inside it. Most of the fully-developed grapnels (and most of them are fully developed, all three rays being present, although O. Schmidt asserts they do not become complete till the young sponge has left the parent) are completely covered by the skin; but those still incomplete, with only one or two teeth, as figured by Schmidt and Carter, more often protrude for some distance outside it, so that they appear to be in a retarded stage of development in adaptation to some special requirements of the larval state—it may be, for escape from the maternal tissues.

There are no short fusiform acerates, such as occur in the fibrous cortex of the adult; but hamates in their various forms are well represented.

Distribution. Kors Fiord, Norway, Station 13, 200–300 fathoms; Station 16, Station 23, 180 fathoms.

The species is also found about the Shetland Islands in deep water; Iceland, Florida: 152–183 fathoms.

The other described species of the genus are:—

1. *T. antarctica*, Carter, A. & M. N. H. 1872, vol. ix. p. 412, pl. xx. *Loc.* Antarctic Ocean, lat. 74½° to 77½° S., long. 175° W.; depth 206–300 fms. Distinguished by absence of hamates.

2. *T. arabica*, Carter, A. & M. N. H. 1869, vol. iv. p. 3, p. i. figs. 1 to 13, pl. ii. figs. 19 and 20. *Loc.* S.E. Arabia.

3. *T. atropurpuroidea*, Carter, A. & M. N. H. 1870, vol. vi. p. 176, pl. xiii. figs. 1–10. *Loc.* Unknown. Distinguished by its large hamates, which are spined, three terminal spines at each end giving them a resemblance to a tridentate anchorate.

4. *T. casula*, Carter, A. & M. N. H. 1871, vol. viii. p. 99, pl. iv. figs. 1–9. *Loc.* Port Elizabeth, Natal, Cape of Good Hope. Distinguished by absence of grapnel-like anchors and general form.

5. *T. dactyloidea*, Carter, A. & M. N. H. 1869, vol. iii. p. 15; 1872, vol. ix. p. 82, pl. x. figs. 1–5. *Loc.* S.E. coast of Arabia.

6. *T. euplocamus*, O. S. Spong. Algier. 1868, p. 40, pl. v. fig. 10. Desterro, Brazil.

7. *T. insidiosa*, O. S. Atl. Spong. Faun. 1870, p. 66, pl. vi. fig. 11. *Loc.* Florida, 17 fms.

8. *T. lens*, O. S. Atl. Spong. Faun. 1870, p. 66, pl. vi. fig. 10. *Loc.* Florida, 135–152 fms.

9. *T. polyura*, O. S. Atl. Spong. Faun. 1870, p. 66, pl. vi. fig. 8. Iceland, 85 fms.

10. *T. radiata*, Selenka, Zeit. f. wiss. Zool. 1880, xxxiii. p. 467, pl. xxvii. *Loc.* Bay of Rio Janeiro, 3 fms.

11. *T. simillima*, Bwk. Proc. Zool. Soc. 1873, p. 15, pl. iii. figs. 6–13. *Loc.* South Seas.

12. *T. tethyoides*, O. S. Atl. Spong. Faun. 1870, p. 66, pl. vi. fig. 9. *Loc.* Florida, 100–123 fms.; Iceland.

13. *T. zetlandica*, Carter, A. & M. N. H. 1872, vol. ix. p. 417, pl. xxii. figs. 1–6, 11–17. *Loc.* Shetland Isles. Distinguished from *T. cranium* by the absence of hamates.

Schmidt's genus *Craniella* is defined as a corticate *Tetilla*, a rind according to Schmidt being absent in the latter genus; but since we have shown its decided presence in *T. cranium*, it becomes highly doubtful whether it is really absent in the remaining species; I have therefore reunited *Craniella* with *Tetilla* under the common name of *Tetilla*.

The absence of hamates from some species of *Tetilla* is probably a case of degeneration similar to that of the loss of trifid spicules in the geodine sponge *Caminus*, or of anchorates from Schmidt's species *Dirrhopalum clopetarium*, with regard to which Mr. S. O. Ridley *, in his exhaustive paper on his genus *Dirrhopalum*, confirms Schmidt's statement as to their absence, though not in the case of *D. gymnazon*, where

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* "On the Genus *Plocamia*, Schmidt," by Stuart O. Ridley, Journ. Linn. Soc. vol. xv. p. 476.

he shows that they exist. Vosmaer[*], falling into the old snare of classifying from a single character, exclaimed against my placing *D. plenum* along with Schmidt's forms, on the ground that it possesses anchorates, which the latter were not supposed to possess by Schmidt. I have no doubt that, on second thoughts, this able investigator will admit that the assemblage of characters is after all of greater importance than a single one.

Classification.—*Tetilla* is a genuine though somewhat divergent member of the corticate Choristidæ, with close affinities to the Desmacidina; it links together the suborders Tetractinellida and Monaxinellida. The evidence for this statement is found first in its embryological development, next in the characters of the Esperiad *Rhaphidotheca Marshall-Halli*, Kent. In the embryo we find some of its tetractinellid spicules in course of development; they commence with a swelling at the distal end of large uniaxial spicules, from which afterwards teeth are budded off one by one. This is true both for the grapnel- and fork-shaped spicules. Thus the uniaxial clearly precedes the tetractinellid form in development, a fact of signal importance in the discussion as to which originated first, Monaxinellida or Tetractinellida, and in complete correspondence with observations made on the order of development of the spicules in the Calcispongiæ.

In the next place, in *Rhaphidotheca Marshall-Halli* we find the distal ends of some of the large spicules which project from the skeletal fibres beyond the skin distinctly thickened into globular or oval or cylindrical bulbs, in which the axial thread ends in a slight spherical expansion. To suppose that these spicules are parasitic in nature or foreign bodies appropriated by the sponge is an altogether untenable idea, as I shall show when dealing more in detail with this species; they agree in all respects with the other chief spicules of the sponge, except in this one important particular, that they have a dilated or thickened distal end, and thus maintain persistently, though in an exaggerated form, a stage through which the trifid spicules of *Tetilla* very rapidly pass. The rounded swelling of the distal ends of projecting spicules is not confined to *Rhaphidotheca*; I have it in a less marked form in a suberite to which I give the name of *Radiella schœnus* (σχοῖνος, a bullrush).

In the next place, amongst the various forms of small spicules with which *Rhaphidotheca* is richly provided, we find trichite sheaves and C- and S-shaped hamates. The pre-

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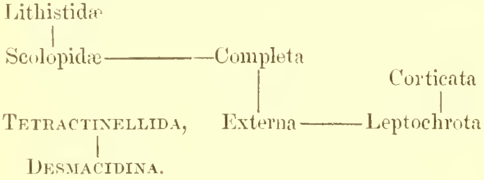
[*] 'The Sponges of the Leyden Museum,' by G. C. J. Vosmaer. Family Desmacidinæ, p. 154.

sence of the latter, so characteristic throughout the Desmacidina, would of itself have afforded us a hint as to the alliances of *Tetilla*; but, taken in conjunction with the evidence furnished by the ends of the spicules, it gives us a very strong case indeed. The swollen terminations of the spicules of *R. schœnus* suggest the possibility of a polyphyletic origin for the Tetractinellida. The trichite sheaves of *Rhaphidotheca* deserve a word of mention; for though they are found in several groups of sponges, yet they are most commonly present in Desmacidina and *Stelletta*; and a genetic connexion between these two groups being probable on other grounds, we may regard the sheaves as derived from a common ancestor, and thus gain some hope of tracing out their origin in the other group of sponges in which they occur.

If the *Tetilla* embryo, taken in conjunction with *Rhaphidotheca*, furnishes evidence of a passage from the Monaxinellida to the Tetractinellida, so no less does it show by the late development of its rind a passage from the non-corticate to the corticate sponges, and proves, what we should have predicted on *à priori* grounds, that the latter were preceded by the former. Schmidt's group of Corticata (Rindenschwämme), though heterogeneous as at first constituted, appears to me a good one if restricted to Tetractinellid sponges possessing rinds; and I consequently adopt it so amended in the table which follows below. This appears to be a good place for offering a few observations on the classification of the Tetractinellida. In my paper on the Trimmingham flints I proposed to divide the Tetractinellida into those with loose or separate spicules (Choristidæ) and those with spicules mutually interlocked to form a network (Lithistidæ). Zittel, placing greater stress on the branching character of the latter spicules, had previously declared for a wider separation between the Choristidæ (Tetractinellida) and Lithistids than this would imply; but Oscar Schmidt (rightly, as it seems to me) declares this four-rayed character of the spicules to be fundamental, although he maintains the ordinal distinction of Tetractinellida (my Choristidæ) and the Lithistidæ. The presence in the Lithistidæ of trifid forks and anchors precisely similar to those of the Choristidæ is for me a strong point in favour of their common derivation; and the primary difference lies in the different character of the chief four-rayed elements. In the Choristidæ the chief tetractinellid spicules are confined to the surface (the tetractinellid character is only skin deep); and they are clearly differentiated into shaft and rays, which have a very definite direction with regard to the surface of the sponge, the shaft being usually radial and the rays developed at its distal end. In the Lithistidæ the distinction into shaft and rays is not strictly maintained, but all four rays have the same value, and start at once from a common centre; moreover they are the chief skeletal spicules, while in many of the Choristidæ the mass of the chief spicules are uniaxial.

Thus, as the Tetractinellid character is the most fundamental, I propose to include all sponges which exhibit it as Tetractinellida; and as the next differentiation would appear to result from the development of quadiradiate body-spicules in Tetractinellids which previously possessed only trifid superficial spicules, I divide the Tetractinellida into Tetractinellida Externa and Completa. The Externa will then fall into Corticata and Non-corticata (Leptochrota, thin-skinned), the Completa into Scolopidæ (sharp-pointed), such as *Dercitus*, and Lithistidæ. The term Choristid may still be conveniently used to designate Tetractinellids in which the spicules are not conjoined into a lithistid network.

The following Table shows the relations between the different Tetractinellida as I conceive them to exist:—



or

EXPLANATION OF THE PLATES.

PLATE VI.

Pachymatisma Johnstoni.

Fig. 1. Section through the oscular tube (T), separated by the sphincter from the underlying oscular chamber (C): *b*, bacillar layer; *v*, vacuolated connective tissue; *c*, gelatinous connective tissue; *f*, fibrous layer. × 11.

Fig. 2. Section through the sponge, showing the oscular tube (*a*) and the oscular chamber (*b*), with main excurrent canals (*c*) opening into it. Nat. size.

Fig. 3. Section through the commencement of an incurrent tube, showing the poral canals, ectochone, and sphincter. × 15.

Fig. 4. View from above of the poriferous roof: *a*, chone; *p*, pore; *g*, globate spicule. × 23.

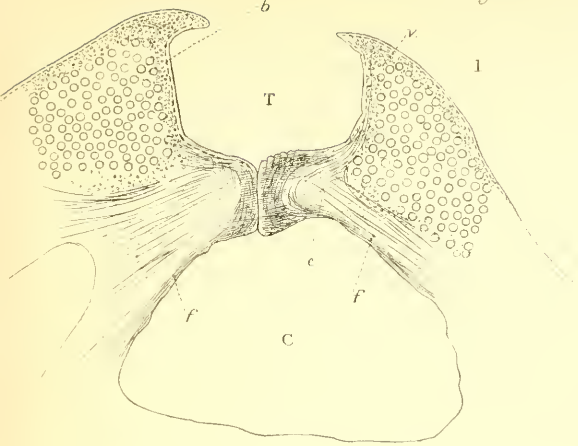
Fig. 5. Vacuolated or vesicular connective tissue, with the gelatinous matrix becoming fibrillated. × 315.
Fig. 6. Quadrifid proximal end of a trifid fork.
Fig. 7. A twinned spicule.
Fig. 8. Distal end of a spicule with fork and grapnel-ray.
Fig. 9. Tubercular outgrowths on distal ends of spicules.
Fig. 10. Bacilli: *a–c*, in successive stages of development; *a*, earliest stage; *b*, second stage; *c*, adult spicule; *d* and *e*, varieties with an additional ray.
Fig. 11. Connecting fibres between two globates, showing imbedded granular threads with nuclei. × 640.
Fig. 12. Cells with granules of reserve food. × 315.
Fig. 13. Vacuolated or vesicular tissue at the edge of an ectochone: *g*, globate spicules. × 157.

PLATE VII.

Tetilla cranium.

Fig. 1. Section through an embryo still imbedded in the maternal tissues (× 26).
Fig. 2. Section of the upper corner of a subdermal cavity (× 157).
Fig. 3. Section through the entire sponge (nat. size).
Fig. 4. Hamate spicules enclosing nuclei (× 640).
Fig. 5. Ovum with extended pseudopodium-like processes: *y*, yolk-granules. × 157.
Fig. 6. Section through a part of the sponge, showing the structure of the cortex, subdermal cavities, and the oscular tube (*o*) cut across (× 15).
Fig. 7. Poriferous membrane of fig. 15 (× 157). The crossing lines, indicating fibrils, have been too heavily drawn by the engraver.
Fig. 8. Network forming the floor of the oscular tube (× 157).
Fig. 9. A node of the preceding network (× 500).
Fig. 10. A trabecula of the same (× 640).
Fig. 11. Axial thread of one of the fibres of the fibrous connective tissue (× 640).
Fig. 12. Young spicule in its cell from a *Tetilla* embryo (× 640).
Fig. 13. Ectoderm from the interior of a subdermal cavity (× 640).
Fig. 14. Endodermic cells from the walls of a flagellated chamber (× 640).
Fig. 15. External view of the skin, showing pores in poriferous areas (× 52).
Fig. 16. External view of the skin, with its fibrous network showing through; the meshes of the network are not subdivided as in preceding figure, but pores are still present. × 23.
Fig. 17. Spicule-cell surrounding a large chief spicule, drawn on same scale as fig. 12, to show the increase in size of the nucleus and nucleolus (× 640).
Fig. 18. Large spicule completely enclosed in spicule-cell (× 166).

[To be continued.]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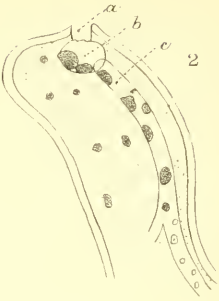
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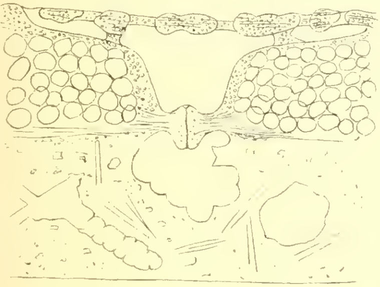
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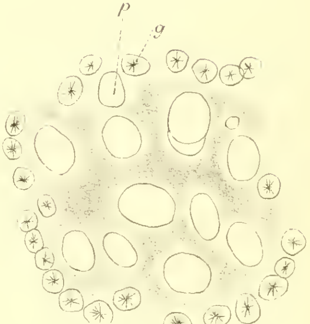
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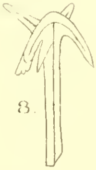
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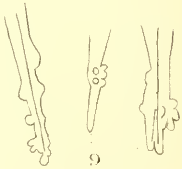
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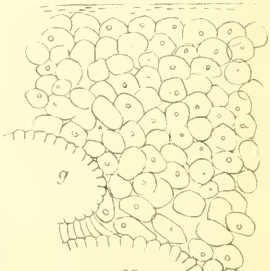
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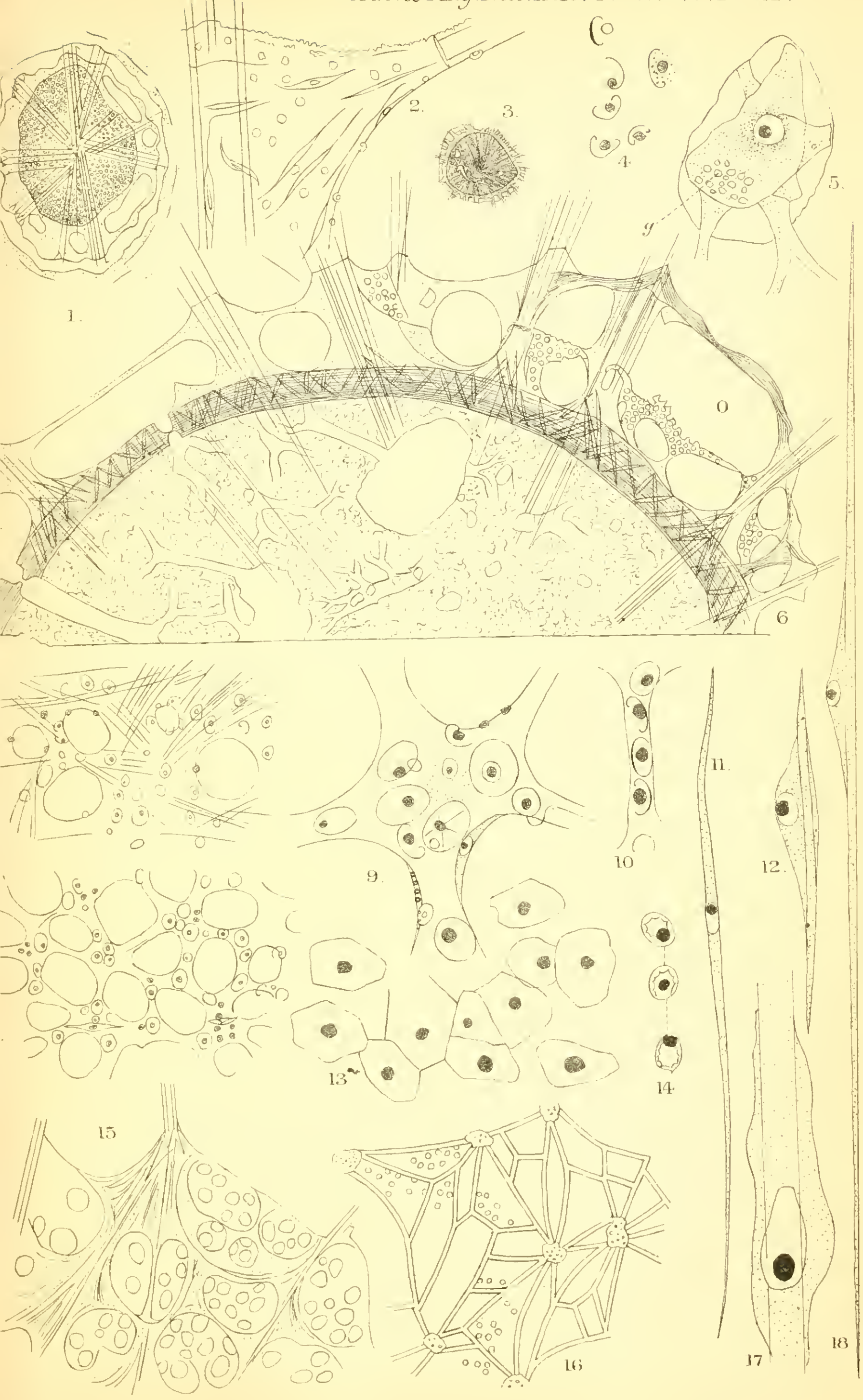
Ann. & Mag. Nat. Hist. S. 5. Vol. 9. Pl. VII.



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

[Plate XVII.]

[Continued from p. 165.]

Tetilla cranium (continued).

Before proceeding to the description of the next sponge it will be necessary to add, by way of appendix, a few words on the generic designation of this species. I had indeed hoped that its title *Tetilla* was inalienably joined to it; but unfortunately that is not the case, since it is not the type of the genus. This place is occupied by *T. euplocamus*, O. S., on which, in in 1868, the genus was founded. This species, indeed, enjoys a name which cannot be changed, but not *T. cranium*; let any difference of generic importance be discovered between it and the type, and *T. cranium* must find a new generic name. The existence of such a difference has already been proclaimed by O. Schmidt, who regards the possession of anchoring filaments by *T. euplocamus*, *polyura*, *radiata*, and *submersa* as a generic character, uniting them together, to the exclusion of *T. cranium*. As a matter of course, *T. cranium* should receive a new generic name; but, as a matter of fact, the new name has been found for the type and its congeners, while the old one is retained by the residual *T. cranium*.

Whatever special advantages this plan may possess are counterbalanced by its contravention of a recognized custom, and its consequent tendency to throw our nomenclature, which is based on recognized custom, into confusion. The oftener general rules are broken the less binding do they become; and the natural result is anarchy. The taunt of being a "purist" in these matters is a reproach to glory in; for till we have the absolute despot, desired by a writer in 'Nature,' to regulate our terminology we shall do well to make the best use we can of an existing substitute; and that is loyal and implicit obedience to those few simple rules which have approved themselves to the general sense of biologists, and of which an excellent summary is given in the 'Stricklandian Code,' published under the approval of the British Association. The practical application of this moral excursus is obviously that *Tetilla euplocamus* should retain its generic name, and if a new one is necessary it should be found for *T. cranium*. But I greatly doubt the necessity; for the presence or absence of anchoring fascicles appears to me to be of scarcely specific, much less of generic, importance; indeed I have now before me a sponge which in no detail of gross or minute anatomy differs from *Thenea Wallichii* (*Wyville-Thomsonia*), except that it is entirely devoid of the usual appendages. So far as this character goes, therefore, I see no good grounds for separating *Fangophilina* from *Tetilla*, and would therefore reunite them. In that case *Tetilla* (Sollas) would comprise *Tetilla*, Sdt., *Craniella*, Sdt., and *Fangophilina*, Sdt.; but it is quite possible that the distinction between *Tetilla* and *Craniella*, asserted by Schmidt, in the absence of a rind in the former genus, does really exist, and that *T. cranium* has been wrongly included in *Tetilla*, its true place being with *Craniella*. But if *T. cranium* be taken from Schmidt's *Tetilla* there remain only in that genus *T. polyura*, *euplocamus*, and *radiata*, all of which are provided with anchoring tails. By amending the definition of the genus so as to make it include as a character the possession of "tails," all necessity for a new name will disappear, since the residual species of *Tetilla*, left after the removal of *T. cranium*, are just those which Schmidt includes in *Fangophilina*. Thus, if *Craniella* prove distinct from *Tetilla*, we have, on Schmidt's own showing,

Craniella + *T. cranium* = *Craniella*.
Tetilla – *T. cranium* = *Tetilla* = *Fangophilina*.

It only remains to include *Fangophilina submersa* in our list of *Tetilla*, and to add a species of Bowerbank which I had previously overlooked. Continuing from page 161, we have

14. *Tetilla submersa*, O. S. Spong. Meerb. Mexico, 1880, p. 73, pl. x. fig. 3. Carib. Sea.

15. *T. unca*, Bwk. P. Z. S. 1872, p. 118, pl. v. figs. 7–10. Hammerfest, 150 fms.

Tetractinellidæ, Marshall.

Externæ, Sollas.

LEPTOCHROTA, Sollas.

THENEA, Gray.

Thenea Wallichii, Perceval Wright.

SYNONYMS.

1870. *Whyville-Thomsonia Wallichii*, Perceval Wright.
,, *Stelletta agariciformis*, O. Schmidt.
,, *Dorvillia agariciformis*, Kent.

1871. *Thenea Wallichii*, P. Wright.
1872. *Tethya agariciformis*, Kent.
1873. *Tisiphonia agariciformis* (Kent), Wyville Thomson.

LITERATURE.

(i.) 1858. *Tethea muricata*, Bwk. MS. Phil. Trans. pl. xxv. f. 18.
(ii.) 1862. *Tethea muricata*, Bwk. MS. Phil. Trans. pp. 782, 793, 826, pl. xxxi. figs. 14, 15.
(iii.) 1867. *Thenea muricata*, Bwk., Gray, Proc. Zool. Soc. p. 541.
(iv.) 1869. *Tisiphonia*, n. g., W. Thomson, MS. Phil. Trans. 159, p. 712.
(v.) 1870. *Wyville-Thomsonia Wallichii*, Perceval Wright, Q. J. Micro. Sci. vol. x. p. 7, pl. ii. (January).
(vi.) 1870. *Stelletta agariciformis*, O. Schmidt, Atl. Sp. F. p. . pl. vi. f. 12 (May).
(vii.) 1870. *Dorvillia agariciformis*, Kent, Month. Micros. Journ. p. 293, pl. lxvi. (December).
(viii.) 1871. *Dorvillia agariciformis*, Kent, Ann. & Mag. Nat. Hist. vol. vii. p. 37.
(ix.) ? *Thenea Wallichii*, P. Wright, Zool. Rec. 1870.
(x.) 1872. *Tethya muricata*, Bwk. Proc. Zool. Soc. p. 115, pl. v. figs. 1–6.
(xi.) 1872. *Tethya agariciformis*, Kent, Ann. & Mag. Nat. Hist. vol. x. p. 209.
(xii.) 1873. *Tisiphonia agariciformis*, Kent, W. Thomson, The Depths of the Sea, pp. 74, 167, fig. 7.
(xiii.) 1878. *Tethea muricata*, Bwk., Carter, Ann. & Mag. Nat. Hist. vol. ii. p. 174.
(xiv.) 1880. *Tisiphonia*, W. Thomson, Carter, Ann. & Mag. Nat. Hist.
(xv.) 1880. *Tisiphonia agariciformis*, O. Schmidt, Spong. d. M. v. Mexico.

The nomenclature of this interesting sponge is marked by misfortune more than falls to the common lot. Since it was first described twelve years ago, it has received no less than six different generic and three specific names, has been identified with species generically different from it, and placed in families of strange kin, only to be expelled as an intruder. Its history is bound up with that of another but closely allied species, *Tethea muricata*, with which, as it obtained earlier notice than *Thenea Wallichii*, we shall commence our account. Bowerbank (i.) mentions *T. muricata* as a MS. name in 1858, when describing and figuring its characteristic spinispirules or "elongated stellates," as he termed these flesh-spicules; in 1862 (ii.) he again refers to it, this time adding a figure of its dermal membrane, crowded with spinispirules and reduced to a net-like appearance by the abundant presence of pore-openings; he likewise mentions the presence of bifurcate-ternate spicules with remarkably long and acute rays, which help to form the skeleton-fasciculi, and lie with their heads expanded beneath the skin. The amount of information which Bowerbank thus incidentally accords us of this MS. species is considerable; and it would be a nice point to determine how far, after his published figures and description, it could be regarded as a merely MS. name; into that question I have fortunately no need to enter. That *T. muricata* differs in a marked manner from other described species of *Tethya* is, however, already quite clear; and Gray (iii.), who had a real knowledge of the sponge, so clearly perceived this as to make it the type of a new genus, which he named *Thenea*, and thus defined:—

> Fam. 3. TETHYADÆ.
>
> THENEA. Sponge massive.
> Spicules:—1. Simple, not protruded beyond the surface.
> 2. Large, furcate, ternate, with expanded long acute rays.
> 3. Elongate, stellate, projecting beyond the surface.
>
> *Thenea muricata*, Bwk. *ib.* i. pp. 25, 108, figs. 35, 304, 305. Norway, Vigten Isl.

In this definition I recognize as correct the statement that the sponge possesses acerate and bifurcate-ternate spicules and elongate stellates—a collocation of forms so different from that which obtains in any other sponge known in Gray's time as to make the generic distinction founded on it a matter beyond dispute. Moreover, lest it should be objected that the genus rests on a MS. species, I would submit first that Gray, by thus bringing together Bowerbank's scattered references and figures, and by adding thereto, as further information, the presence of acerate spicules, did virtually raise *Thenea muricata* from the rank of a MS. to that of a described species; and next, if this be not admitted as a matter beyond question, that there is no reason why, upon occasion, a genus should not be defined before a species. If the particular information which would enable us to define a species be not forthcoming, while the general characters which are available for generic distinction lie ready to hand, there can be no reason, beyond a superstitious adherence to custom (not recognized convention), which shall prevent us making good use of them. *Thenea*, therefore, is a well-grounded generic title applicable to all such sponges as possess a spicular complement like that defined in this connexion by Gray.

Gray's definition is not unmixed truth; thus, we know now, in direct contradiction to Gray's statements, that the sponge is not massive, that some of the acerate spicules do project beyond the surface, and that the spinispirules do not[*]. Serious as these errors undoubtedly are, they are in no way fatal;

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[*] Or do so only in dried specimens as a consequence of shrinking.

they render it necessary to amend the definition, but furnish no excuse for expunging the name of the genus. If every badly-defined genus were liable to a change of name, systematic zoologists might as well abandon the task of nomenclature altogether.

In 1869, Sir Wyville Thomson (iv.), in his fine memoir on *Holtenia Carpenteri*, founded a new suborder, "Leptophlœa," with *Tisiphonia*, MS., cited as an example. What *Tisiphonia* might exactly be, there was nothing given to show; the name stands as a word of so many letters, and nothing more. We shall find, however, subsequently that an unfounded attempt was made later to turn it into something more; but to this we shall refer in due course: we proceed now to the direct subject of this communication, *Thenea Wallichii* itself.

In 1870, Professor Perceval Wright (v.) gave a full and faithful account of a beautiful little sponge which had been obtained by Dr. Wallich from a depth of 1913 fathoms. This sponge he named, with happy appropriateness, *Wyville-Thomsonia Wallichii*, thus associating the names of the two preeminent deep-sea investigators with the first-obtained species of deep-sea sponge. It possesses the acerates, bifurcate-ternate spicules and spinispirules of *Thenea*, together with large grapnels and some curious few-rayed (one to eight) stellates, not mentioned in Gray's definition. One would thus naturally be led to include it with *Thenea*, were it not for the two forms last mentioned; and we have now to consider whether these afford sufficient reason for generic distinction. If we refer to the value placed on the presence or absence of grapnels in *Geodia* and *Stelletta*, we shall find that they never serve for more than specific distinction; moreover, if it be allowable to go beyond Gray's definition and consult the actual specimen of *Thenea muricata*, we shall find that grapnels are not wanting in it. Then there only remain the pauciradiate stellates; and these alone will not by any one be considered sufficient to distinguish as different genera species which resemble each other in every other important character. Thus, unless some considerable undiscovered difference exists between *Wyville-Thomsonia Wallichii* and *Thenea muricata*, we must be content to regard the former as a fellow species with the latter, and so to name it, as Professor Wright (ix.) himself now asserts it should be named, *Thenea Wallichii*.

Three months after Professor Wright's paper appeared, Oscar Schmidt partly described a similar sponge obtained from a depth of 178 fathoms off Florida; he figured some of its spicules, the grapnels and spinispirules, and named it *Stelletta agariciformis*. A *Stelletta* it certainly is not, as it lacks the cortex which is essential to that genus; on the other hand, it agrees fundamentally with *Thenea*, and may be called, at this stage of our argument, *Thenea agariciformis*.

Again in 1870, December of that year, Mr. Saville Kent (vii.) described quite independently a sponge in all respects identical with that mentioned and labelled by O. Schmidt. Kent's description is good and fully illustrated, perhaps a little too fully, as he includes certain extraneous sexradiate spicules as proper to the sponge, an error which he was the first to correct (viii.). Kent named his sponge *Dorvillia agariciformis*, choosing, by a quite accidental coincidence, the same character for specific designation as Schmidt had done previously. According to the fortune which seems to wait on nomenclature, we might therefore expect the species would turn out to be different; but, notwithstanding, they are certainly the same.

In the note (viii.) which followed his first paper, Kent states that *Thenea Wallichii* is an embryonic form of *T. agariciformis*, a view accepted by Wright and by spongologists generally. Since, however, Wright's figures of the large few-rayed stellates differ somewhat from those given by Kent, it appeared to me that a loophole was left open for error; and I was led therefore to compare the type specimen of *T. Wallichii* * with Kent's figures and with mountings of the usual agaric form. The result is to show, in a most satisfactory manner, that no sort of real difference exists between the two species: *T. agariciformis* is larger and has a well-marked agaric form with a specialized poriferous area, while *T. Wallichii* is of a globular form and without an evidently specialized poriferous area; these trifling differences are unquestionably due to a difference in age. Though young, Professor Wright's specimen is not embryonic—at least no more so than a child of six is, compared with an adult man. It is considerably advanced in growth; for my smallest specimens of young *Thenea Wallichii* measure only 0·0146 inch in diameter, and this is 0·075 inch, or more than five times as large across.

As Wright's species is certainly a good one, and as it takes precedence of Schmidt's by some three months, that of the latter must, by the most fundamental rule of nomenclature, be suppressed; we then have

Wyville-Thomsonia Wallichii, Wright.
Stelletta agariciformis, O. S.
Dorvillia agariciformis, Kent.
} = *Thenea Wallichii*, Wright.

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* For the loan of this valuable type my thanks are due and heartily tendered to Mr. C. Stewart and the Council of the Royal Microscopical Society.

We now return to *Thenea muricata*, of which at last, in 1872, Bowerbank (x.) published a full and illustrated description; and so closely in general appearance and in the size and form of its spicules was it found to resemble *Thenea Wallichii*, that Bowerbank declared his conviction that they were one and the same species. His manner of viewing the relations of the two specimens, Kent's and his own, is, however, in the light of further knowledge, somewhat amusing, since he considers Kent's specimen mutilated, the upper portion having, he says, evidently been torn away from the base, causing the part described to assume a form very much like that of an agaric; and he adds that the filiform anchoring appendages have very much the appearance of being some of the skeleton-fasciculi of the sponge drawn out of the basal portion at the time of its mutilation. Kent (xi.), in a "Note on *Tethea muricata*, Bk., and *Dorvillia agariciformis*, Kent," argues against the identification of the two species, resting his case on (1) the agaric form of *Dorvillia* (*Th.*) *Wallichii*, (2) its possession of fascicles of anchoring-spicules, and (3) of quadriradiate flesh-spicules (more correctly pauciradiate stellates). With reference to the first two distinctive characters, I may confess that I do not place great reliance on them: *T. muricata* is not unlike *T. Wallichii* in general form; and the agaric form of the latter is not constant. Some of Mr. Norman's specimens which possess anchoring fascicles and all the spicules proper to the species show no trace of the agaric form; again, the anchoring fascicles, though usual, are not constant. Other of Mr. Norman's specimens with the agaric form and the proper spicular complement of *T. Wallichii* are entirely devoid of anchoring filaments or of any sign of them. The third character cited by Kent is more important: the curious quadriradiate stellates (to be hereafter described) are abundant and characteristic in *T. Wallichii*; and since Bowerbank did not meet Kent's objection by replying that they also occurred in his specimen, we may conclude that they were not present; and hence so far we must admit the specific distinction of *Thenea muricata* and *T. Wallichii*.

In 1873 we again meet with *Tisiphonia*, a passing mention being made of *Tisiphonia agariciformis*, Kent, by Sir Wyville Thomson (xii.) in the 'Depths of the Sea.' The suborder "Leptophlœa" appears to have slipped the memory of its author, as he speaks of the species he had given in its illustration as "that pretty little hemispherical *corticate* form." An excellent illustration of the general form of the species accompanies this notice.

In 1878 Carter (xiii.) published a "Note on *Tethea muri-*

cata," in which, after an examination of specimens, he asserts the identity of *T. muricata* with *T. Wallichii.* The particular grounds on which this statement is made are not given, however, nor is any attempt made to reply to Mr. Kent's objections; so that one could hardly regard the matter as settled; I therefore wrote to Mr. S. O. Ridley, of the British Museum, asking him to favour me by examining the type specimen of *T. muricata*, with a view to determining whether it does possess quadriradiate stellates or not. I have to thank him for a valuable letter in reply, and particularly for the following statement, which I venture to quote:—"I have been carefully through with a high power the seven slides which represent the type specimen of *Tethea muricata*, and find nothing which seems to represent the quadriradiate described and drawn by you in your letter and figured by Wright, of which I have now *seen* specimens by examining our slides of '*Dorvillia agariciformis*,' probably representing the type of that species." After Kent's remarks and this explicit statement I consider that we must regard *T. muricata* and *T. Wallichii* as distinct species. In this connexion it is worth noticing that the quadriradiate stellates are the last spicules to appear in the development of *T. Wallichii*; so that very young examples of this species are not distinguishable from *T. muricata.*

In the "Note," Carter further states that *Normania crassa*, Bk., *Hymeniacidon placentula*, Bk., and *Eccionema compressa*, Bk., are no other than various forms of *T. muricata.* In order to enable me to examine the truth of this surprising statement, Mr. Norman placed in my hands the type specimen of *N. crassa*, together with various other specimens, not types, and *a* type specimen of *H. placentula.* I find that all these specimens, including both supposed species, agree in every essential detail with one another, but that they are generically different from *Thenea*, though otherwise nearly allied to it. This was precisely what Mr. Norman predicted. They are without the bifurcated ternate spicules and the grapnels of *Thenea*, and, on the other hand, possess in abundance a small fusiform roughened acerate which is absent from *Thenea.* Moreover the structure of their dermis is completely different; in *Thenea* it is supported by the long rays of the bifurcated ternates, in *Normania* by horizontal fascicles of large fusiform acerates, with an occasional triradiate or quadriradiate spicule. These differences are sufficient to support the generic distinction of *Normania* and *Thenea*; but that they are closely allied is shown by the similarity in the character of their mesodermic tissue, and by the presence in both of the same form of spinispirula; both likewise are Leptochrotæ.

In 1880 Carter (xiv.) again refers to *T. muricata*, retracting some of his previous statements, as when he admits the specific value of the differences between *T. Wallichii* and *T. muricata*; and he still rightly maintains the specific identity of *N. crassa*, *H. placentula*, and *E. compressa*.

Perhaps the most striking contribution made in this communication to nomenclature is the attempt to impose *Tisiphonia* upon it, the claims of *Thenea*, to say nothing of *Wyville-Thomsonia* and *Dorvillia*, being wholly ignored. *Thenea* has precedence of this MS. name by two years; and *Wyville-Thomsonia* and *Dorvillia* were fully defined and illustrated three years before the first figure of *Tisiphonia*, unaccompanied by generic diagnosis, was published in a popular book.

Finally, Oscar Schmidt (xv.), in a work bearing 1880 as the date, also adopts the name *Tisiphonia*, and relies on its rooting fibres as the characteristic feature by which it is distinguishable from *Stelletta*. If it were possible to establish the genus on this character (and I am confident it is not), the claims of *Tisiphonia* to recognition would not be enhanced thereby, since with *Thenea* out of the way there would still remain *Wyville-Thomsonia* and, perhaps with still stronger claims, *Dorvillia* to be disposed of; and till genera are named by one man's caprice this will not prove an easy task. Again, if my contention so far should fail, then I will put in argument the fact that the name *Tisiphonia* has already been twice preoccupied, once by a butterfly (*Tisiphone*), and again by a reptile (*Tisiphone*), and is therefore unavailable.

But, finally, the generic value attributed by Schmidt to anchoring filaments has no existence in the case in point. Amongst Mr. Norman's sponges there is a specimen of *T. Wallichii*, which in no single feature differs from the ordinary type except in one, that, namely, which Schmidt has come to regard as of generic importance. No naturalist would make a different species of it; and yet it has the misfortune to be without anchoring fibres. The distinction of *Thenea* from *Stelletta* is not trifling; it is sharp and obvious. The spicules of the two are, it is true, similar, except that the former is characterized by a spinispirule in place of a stellate; but this difference is just as useful in classification as that between the globate of *Geodia* and the *Stelletta* stellate. The real difference lies, however, as Sir Wyville Thomson perceived in 1869, in the absence of a crust in *Thenea*, which widely separates it from the *Stelletta* series. Other differences almost as great are also known—the clear gelatinous character of the mesoderm, so different from the grey granular mark of *Stelletta*, for one, and the vesicular character of the water-canal system for another.

General Form.—If we imagine a round or oval tureen, with a conical cover overlapping it at the edges, and the foot produced into a number of descending rootlets, we shall have a good idea of the general form of a symmetrically-grown and adult example of *Thenea Wallichii.* The part corresponding to the cover we shall call the upper half, that to the dish the lower half of the sponge; and the space between them overlapped by the edge of the cover we shall call the "equatorial recess." The upper half is usually conical, with a circular oscule at the apex; near the base it curves over into a convex overlapping edge, which covers, as the edge of a thatched roof does the eaves, the rounded annular inflection which we term the equatorial recess. The lower half, which is usually either more or less hemispherical or conical, is produced into a number of descending conical processes, from each of which issues a root as a single fibre, which afterwards frays out into a white woolly-looking tuft by the separation of its component spicules. Variations, greater or less, from the general form are very numerous: the equatorial recess, which in the most symmetrical forms extends all round the sponge, in others frequently fails to do so, being interrupted at intervals, through which the upper and under surfaces pass insensibly into each other; sometimes it is confined to one quarter of the circumference ot the sponge, or even less; and in one specimen, in every other respect precisely like its fellows, it is entirely absent. The roots vary in number: in the youngest specimens they are never more nor less than one; in the largest of Mr. Norman's specimens there are as many as twenty; on the other hand, in one remarkable specimen of average adult size there are no roots at all, nor any signs of their ever having been present. The roots are liable to be given off from abnormal regions: thus, in a specimen from North America, dredged between Anticosti and Gaspé, they arise from one side of the sponge at a place where the equatorial recess would usually be present, but which has been suppressed here and on the adjacent margin, with a compensating over-development on the side opposite; this arrangement would lead to the sponge being so anchored or rooted that the equatorial recess, which is a special poriferous area, would be the uppermost part of the sponge, while the oscule would lie halfway down the side, looking out laterally. A similar modification occurs in another specimen from the same locality, but with a slight difference, which leads to the oscule being situated on one side of the sponge, and the limited equatorial recess on the opposite side, while the roots descend from what appears to be the base, but which corresponds really to the side of other specimens. These last two specimens may be instances of a local variety, which, however, I shall not dignify by a name, as Schmidt has his *T. fenestrata*. The size of the sponge averages about 1·5 inch in diameter by 1·2 inch in height; the rooting-fibres extend downwards for 0·8 inch usually before fraying out. Mr. Norman's largest specimen measures 3 inches by 2·5 inches in width and breadth, by 1·5 inch in height.

External Surface.—The outer surface of the sponge is felted and thatched by obliquely-projecting, long, slender, acerate, and grapnel-shaped spicules. Round the middle of the upper half, midway between the oscule and the lower edge (tegminal edge we may call it, since it covers or roofs over the equatorial recess), the spicules, lying prostrate almost parallel with the surface, point this way and that, and by their intercrossing form a loosely-felted thicket above the skin—the home of all kinds of animals, Foraminifera (some form of which covers the surface with long strings of sand-grains), Ascidians, worms, and Crustacea. Above this zone the spicules, still projecting obliquely from the skin, point directly towards the apex, so that within a radius of half an inch from it they form a close, regular, but inverted thatch, the free ends of the spicules projecting upwards, and those immediately around the oscule fencing it in with a forest of bristling points. Below the middle zone the spicules proceeding obliquely from the skin point directly downwards towards the tegminal edge, beyond which they project in a fringe of long fine lashes; the thatch is here in the right direction; and the fringe reminds one of the uncut straw hanging over the eaves of a cottage. The lower half of the sponge is covered by obliquely-projecting spicules, showing no regularity in direction, except opposite the tegminal edge; here they point upwards and intercross with the spicules descending from the fringe, forming with them a defensive sieve of great efficiency.

Great variation exists in the distribution and disposition of the spicules as just described; sometimes projecting acerates seem confined to the margin of the oscule and the tegminal edge, or even to the oscular margin alone. Probably in some of these cases the spicules have been lost since the specimen was obtained; in others, on the contrary, they seem never to have been present. Owing to one or other of these causes, *i. e.* abrasion or non-development, or to both, projecting spicules are usually absent over a large part of the skin, the outer surface of which is then clearly exposed to view; it has a greyish tint in spirit-specimens, is often nearly pure white in dried ones. Examining it with a lens, we perceive the thin skin to lie immediately upon the extended rays of bifurcated ternate spicules, which, regularly overlapping, map out the skin into a number of triangular spaces, most of which are singly perforated by a circular pore 0·004 to 0·01 of an inch in diameter. This arrangement is to be seen on both upper and under halves of the sponge; but in the equatorial recess it is replaced by another. There the skin is separated to a greater extent from the mass of the sponge by the underlying vesicles of the canal-system; it is not supported by the rays of furcate spicules, but fine threads, crossing it transversely, strengthen, support it, and divide it into a number of more or less oval areas, each of which is perforated by a great number of closely-set pores, which reduces it to a fine network (see Kent, xii. pl. lxvi. figs. 3, 4). Of spicules this cribriform floor of the equatorial recess contains chiefly minute spinispirules, and only occasionally quadriradiate stellates.

On cutting the sponge across, one sees a greyish mass enveloped in a thin skin, but without a cortex, traversed by fascicles of spicules and a great number of vesicles; the vesicles lie in rows, longitudinally and radiately disposed.

The Canal-system.—The pores have been already described as distributed generally over the whole surface of the skin, including its conical extensions over the roots of the anchoring fibres. They occupy the triangular spaces in the skin mapped out by the overlapping rays of the furcate spicules below it; usually there is one pore to each space, rarely two. In the equatorial recess the skin is divided into oval areas by fibrous strings, and in these areas is so abundantly perforated by pores as to be converted into a sieve-like net, in just the same manner as described by Schulze in so many Cerospongiæ, and by myself in *Tetilla*, as likewise occurs in many *Esperiæ*, and probably also in a vast number of other sponges. The curious way in which this cribriform poriferous membrane occurs in a recess, while the rest of the sponge is perforated by single pores, reminds one forcibly of similar arrangements in some of the *Esperiæ*. The pores, whether of the recess or the general surface, lead directly into spherical or ellipsoidal chambers or vesicles beneath the skin, the first of a series of vesicular dilatations which constitute the incurrent canal-system (Pl. XVII. fig. 6). For in this sponge the canals are not canals in the ordinary sense of the word, *i. e.* not continuously open more or less tubular channels, but a succession of vesicles, which seldom open into each other except by narrow sphinctrated orifices. Thus, in a linear series of vesicles representing a canal in other sponges, every vesicle possesses at least two sphinctrated orifices, one putting it in communication with the vesicle behind, and the other with that in front—every vesicle, that is to say, except those beneath the pores; for the pores are not provided with sphincters. The openings into the flagellated chambers are also without sphincters. While two is thus usually the least number of sphincters apparent in a vesicle, a greater number is not uncommon, since, when a lateral series proceeds from a main line, equivalent to the branching of a canal, the first vesicle of the secondary series communicates with that from which it proceeds by a sphinctrate aperture; and thus, as one vesicle of a larger series may bud off, as it were, more than one subsidiary series, it may exhibit four or more sphincters in its walls—two about the communications with vesicles of its own order, and two or more about the communications with vesicles of a lower order. The subsidiary series of vesicles bud off others, and these again others, till the ultimate vesicles are reached which communicate with the flagellated chambers. In this way the size of the vesicles diminishes from 0·015 inch in diameter, which is the average of those in the main series, down to and 0·005 to 0·001, which is that of the ultimate smallest vesicles.

The flagellated chambers (Pl. XVII. fig. 15) are spherical or ellipsoidal sacs communicating by a large circular pore, 0·0032 to 0·006 inch in diameter, with the ultimate incurrent vesicles, and by a wide mouth, from 0·0064 to 0·0096 inch across, with the ultimate excurrent canaliculi. In size they average 0·001 inch in diameter, and thus agree with the similar chambers of the Geodina generally, and of *Tetilla* and such *Esperiæ* as I have examined. This uniformity in size is in striking contrast with the differences which distinguish the chambers of the Chondrosiæ and the Cerospongiæ examined by Schulze, and leads one to suggest that it may result from close genetic relationship.

The excurrent canaliculi lead directly into the nearest vesicle of the excurrent system, about which the flagellated chambers are clustered in a concentric layer (Pl. XVII. fig. 6, *f*). Excepting the canalicular form of its ultimate branches, the excurrent exhibits the same vesicular character as the incurrent system.

The oscule is a more or less circular opening, averaging 0·1 inch in diameter, usually situated in the midst of a gently rising conical eminence; its circular margin is thickened into a lip or annulus of a bluish translucent cartilaginous appearance; and immediately outside this is a surrounding fringe of long acerate spicules. The oscule leads into a wide excurrent canal or oscular tube, transversely constricted by extensions inwards of its walls, but not so completely as to acquire a vesicular character; the mouths of several tributary series of vesicles immediately open into it; and after proceeding for a very short distance downwards, it completely disappears as a tube, and is continued by several vesicular series, into which it subdivides.

Notwithstanding its wonderful transformation, the canal-system is evidently homologous with that of the more normally constituted sponges; the sphincters which invariably occur at the junction of any two vesicles are almost certainly an excessive over-development of the concentric rugæ which characterize the canals of the Geodina and other sponges, and which are more distinctly developed in the smaller branches of the incurrent canals of *Isops Phlegræi* (see *anteà*, vol. v. fig. 1, p. 403). The first incurrent vesicle immediately beneath the skin is situated in tissue characterized by the absence of flagellated chambers, and is clearly homologous with the ectochone of the Corticatæ. The second vesicle, so far as its outer half, is similarly situated; but its inner half is brought into close communication with flagellated chambers; it thus represents an endochone and a subcortical crypt, while the sphincter by which it opens into the first vesicle exactly corresponds to that which we have termed the chonal sphincter.

It is easier to extract homologies from the modifications of the canal-system than to find a use for them. Had the sponge been a coast-dweller, subject to exposure between tides, one might have regarded the vesicles and sphincters as a provision for retaining a supply of water and thus guarding against desiccation. But, so far from this, it is a characteristic deep-sea form, exposed, as one would think, to but few changes of condition.

The vesicular enlargement of the canals certainly gives them a larger capacity and superficial area, with a corresponding diminution of the quantity of tissue in the sponge: the volume of tissue is here at a minimum, of the canal-system at a maximum; thus the advantage is on the side of increased food-supply, while the quantity of tissue to be fed is diminished. Furthermore, not only does the vesicular arrangement permit of a larger quantity of water being present in the sponge at any given moment, but it facilitates a rapid passage of water through it; and, taking this fact along with the abundance of large pores all over the sponge, it would appear as though the most characteristic features of the canal-system were in special adaptation to a free and rapid water-streaming. We might then expect to find the body of the sponge exceedingly well nourished and abounding in protoplasmic structures; and yet, when we come to study its histology, we shall find that it is distinguished, in marked contrast with the Corticatæ, by the small proportion of its protoplasmic contents, the great mass of the sponge consisting of a gelatinous matrix which, whatever its composition may be, is certainly something very different from protoplasm. The rapidity of the water-streaming is therefore probably connected with the poverty in food-particles of the surrounding water, a great deal of water having to pass through the sponge in order to afford it sufficient nourishment.

The sphincters probably act as regulators to the water-streaming, checking it when the water is more than usually burdened with suspended particles, allowing it freer passage when food is scarcer. They might also govern its distribution, closing the passage in some directions, opening it in others, though, in the presumed absence of a combining apparatus such as a nervous system would furnish, this seems unlikely.

In connexion with the "wide-openness" of the canal-system, the small size of the oscule is worthy of note. It seems to point to a rapid escape of the outflowing water, and its consequent ejection to a considerable distance from the inhalant surface. The relative size of the poral and oscular areas in different sponges has never yet been made the subject of investigation, although it differs greatly in different species, and must stand in close connexion with the physiology of the water-streaming system. As a beginning, I have attempted to determine, in the case of this sponge, (i.) the ratio of the poral to the superficial area, and (ii.) the ratio of its total poral area to its total oscular area. In order to make the first determination, a specimen was taken from spirits and allowed to drain till the edges of the open pores just became visible; a part of the surface with its pores was then accurately sketched with the aid of an oblique reflector and under a magnification of thirty diameters. We shall not need to trouble about the absolute size of the pores, as we are only about to determine a ratio. A given area of the drawing was next taken, and the area of the pores in it calculated. I give the results obtained in two instances. In the first—

(i.) The area of the sponge-surface taken from the sketch was 6 square inches.

(ii.) It contained sixteen pores, of which two had a diameter of 0·3 inch, two of 0·25, two of 0·22, eight of 0·2, and two of 0·1.

The total area of these is 0·58216 square inch; and

$$6 : 0{\cdot}58216 = 1 : 0{\cdot}097,$$

i. e. 1 square inch of the sponge-surface contains 0·097 square inch of pore-area.

In the second—

(i.) The area of the sponge-surface taken (in the sketch) was 1·5 square inch.

(ii.) It contained twelve pores, two of 0·2, two of 0·15, and eight of 0·1 inch in diameter.

The total area of these is 0·14283 square inch; and

$$1{\cdot}5 : 0{\cdot}14283 = 1 : 0{\cdot}095,$$

a close correspondence for two quite independent determinations, and remarkable considering the difference in the average size of the pores measured in the two cases; it would appear that the smaller pores made up in number for what they lacked in magnitude. Taking the average we obtain 0·096 : 1 as the ratio of the poral to the general area; and the number 0·096 may be called the pore-index of the sponge.

We have next to ascertain the relative size of the total poral to the total oscular area. The specimen on which the preceding observations were made measures 4·084 inches in circumference and 0·8 inch in height; it may be regarded as formed by two equal segments of a sphere 0·9 inch in diameter, each 0·4 inch high, and thus has a superficial area of 2·26 square inches. Multiplying 2·26 by 0·096, the poral index, we have 0·172 square inch as the total poral area; so, if all the pores were to coalesce, they would form a single aperture under one fifth of a square inch in area. This, however, is an underestimate, since no account has been taken of the larger number of pores in the equatorial recess.

The oscule is 0·1 inch in diameter, or 0·007854 square inch in area; and the oscular (O) is consequently to the poral (P) area as

$$0{\cdot}007854 : 0{\cdot}172 = 1 : 22.$$

$$\therefore \frac{P}{O} = 22.$$

This number may be conveniently styled the poral-oscular index. Its determination is here probably a little too low; but it suffices to show that, with an almost imperceptible influx of water into the pores of the sponge, there may be a very lively discharge from the oscule. A determination of the value of $\frac{P}{O}$ was made in a second specimen, unfortunately a dried one, so that the results are not trustworthy. The calculation is as follows:—Total area 6·16 square inches, total poral area consequently 0·59136 square inch; area of single oscule 0·0416 square inch; $\frac{P}{O} = \frac{0{\cdot}59136}{0{\cdot}0416} = 14{\cdot}2$. The smallness of this number is probably due to the large size of the oscule, consequent on its enlargement by drying.

To ascertain, further, whether any definite relation exists between the general and oscular areas, and consequently between the poral and oscular areas, the largest of Mr. Norman's specimens was examined. In form it approximates to a hemisphere with a radius of 1·4; so that its total area may be taken as 18·475 square inches. It bears six oscules, giving one to every 3·08 square inches of total area.

In the first examined specimen (see *anteà*) we had 2·26 square inches to one small oscule, in the second 6·16 square inches to one large oscule; taking an average from these we have 4·21 square inches to each oscule. Though this is sufficiently greater than the value found from the third specimen to prove that the relation between the general and oscular area is by no means precise, it yet indicates some kind of broad connexion which it may be worth while to further investigate.

The Skeleton.—The large spicules of the skeleton are stout fusiform, and slender filiform, acerates, simple and bifurcated forks, and variously-shaped grapnels. The small spicules are spinispirulæ of two kinds:—(i.) The stout fusiform sharp-pointed acerates are the staple body-spicules; they measure frequently 0·2 inch in length by 0·034 in breadth, and appear sometimes to attain to as much as 0·5 inch in length. (ii.) The long slender acerates, which project beyond the general surface of the sponge, are seldom seen entire, so that it remains doubtful in many cases whether they are truly acerates or only the shafts of grapnel-spicules; they may reach 0·7 to 0·8 inch in length. (iii.) The commonest forks (Kent (vii.), figs. 6, 7) are bifurcated ternates with exceedingly long rays, the primary rays usually measuring about 0·01 inch, and the secondary 0·047 inch in length; the shaft varies greatly, but is often 0·19 to 0·2 inch long; at a short distance below the head it often undergoes a rapid diminution in thickness, becoming almost filiform towards its proximal end, something like a tap-root. (iv.) The forks (*vide* Bwk. (x.), fig. 3) with undivided simple rays are frequent; they are also of very various sizes, 0·27 inch is a not unusual length for the shaft, and 0·034 inch for the rays.

It is not unusual for both kinds of forks to have the rays rounded off at the ends, so that, instead of being long, slender, and pointed, they become short, thick, and stumpy. The proximal end of the shaft is sometimes rounded off in the same way.

(v.) The grapnels (Pl. XVII. fig. 4) are distinguished by their long, sharp, usually straight rays, but there is great variation among them in this and other respects; in one form (fig. 4) the head of the shaft is scarcely at all thickened, and the long rays start with a wide outward sweep from it (at an angle of 55° to 60°) and then somewhat abruptly turn backwards and run more nearly parallel with it, frequently at an angle of 18° to 20°; in another form the shaft thickens towards the head, which is thick and long, and the rays form only short, stout, widely-diverging prongs (Pl. XVII. fig. 14); but there is every intermediate form between these two, and many minor variations surrounding them; in the expansion or not of the shaft below the head, in the size and form of the head, in the length of the rays and the angle they form with the shaft, there is great variety; by far the commonest form, however, is that shown at fig. 4, or some close approach to it. Those grapnels which lie entirely within the body are often 0·1 inch long in the shaft, with rays 0·0082 inch long; those which extend beyond it have not yet been observed entire, but have been measured up to 0·34 inch in length, and probably in the entire state they are sometimes not much shorter than 1 inch.

The development of the grapnels will be described in treating of the young forms of the sponge.

(vi.) A not uncommon variety of large spicule remains to be noticed (Pl. XVII. fig. 3); it resembles the shaft of a ternate spicule, but instead of dividing it thickens club-like at the distal end; in some cases (fig. 17) a protuberance representing a rudimentary ray occurs on one side. These spicules call to mind the club-shaped forms of *Rhaphidotheca Marshall-Halli*, and are either young forms of ternates, or ternates in a state of arrested development, or abnormal forms of the fusiform acerate spicule.

(vii.) The smallest of the minute spicules are the spinispirulæ (Pl. XVII. fig. 24); these consist of a straight or curved shaft, from which spines arise along a spiral course and project radially; the spines are usually sharp-pointed and smooth, but frequently also very finely roughened all over, often with quite abruptly truncated ends. The shaft sometimes becomes very short; and then the spinispirula is scarcely distinguishable from a minute stellate.

(viii.) The larger minute spicule appears to be a spinispirula reduced to a very simple form (*v.* Kent, vii. figs. 16, 17, 18).

It most commonly consists of a very short straight shaft with two long spines radiating from each end, the plane containing the spines at one end being frequently turned at right angles to that containing those at the other, a disposition which suggests a spiral arrangement, not otherwise discoverable in the shaft. Almost as frequently, however, all four spines lie in one and the same plane (*v.* Kent, vii. fig. 18). The number of rays varies greatly: sometimes only two appear, giving us a bent acerate form; often only three, the triradiate so formed closely resembling the characteristic spicule of the Calcispongiæ; four is the commonest number; but additional rays are not uncommonly present, up to and possibly exceeding eight; in instances where the number of rays exceeds five the spiral tendency is more markedly displayed. The shaft sometimes shortens and disappears; and then the four-rayed form resembles the quadriradiate of *Dercitus* (*v.* Kent, vii. fig. 16). The fourth ray often appears as a sprout from one of the rays of a triradiate. The spines are usually sharply pointed, but often become rounded at the ends (fig. 13); they are smooth and only very rarely roughened. In size these spicules vary enormously: the rays of the larger forms are frequently 0·0034 inch long, but they may reach 0·005 or more; in the smaller forms they are often no more than 0·00091 inch long. By multiplying the length of the rays by 2 we get a close approximation to the length of the whole spicule.

The minute spicules are scattered without apparent arrangement through the sponge; the large spicules, on the contrary, lie in fascicles or short fibres, which radiate from the centre to the surface, the rays of the forks spreading out beneath the skin, and the heads of the grapnels lying close beneath them, in the angle between the rays and their shafts. The forks appear never to extend outside the surface of the sponge; but the acerates and the grapnels project a considerable distance beyond it. The proximal ends of these projecting spicules appear about each fibre a little below the skin (Pl. XVII. fig. 6); and the spicules, diverging from each other, pass out in a conical pencil, having its apex pointing inwards. Towards the base one finds in addition numerous spicules converging from the middle of the sponge towards conical papillæ, from which they emerge as single fibres; here the base of the cone is inwards; the fibres afterwards open out to form the terminal tufts of diverging spicules, the greater part of which appear to be grapnels.

The Ectoderm.—The epidermis (Pl. XVII. fig. 32) is a thin membrane everywhere investing the sponge, and bearing immediately on its under surface very definite minute round nucleolated nuclei 0·000125 inch in diameter, each of which is situated in the midst of a cluster of fine granules; it is clearly a layer of pavement-cells from which the cell-outlines have disappeared. Very fine fibrils are usually apparent wandering over its lower surface; they are probably the tenuous ends of branching processes extended from the corpuscles of the underlying connective tissue. The ectoderm is continued inwards as an epithelial lining (Pl. XVII. fig. 47) to the incurrent canals or vesicular system, from no part of which is it absent. In describing the ectoderm of *Tetilla* we stated that the characteristic minute spicules of the sponge (hamates) appear to contribute to its composition; similar components appear also in the ectoderm of *Thenea*. The spinispirules which in this sponge represent the hamates of *Tetilla* are associated, wherever they occur, with a small round nucleus, which lies close to their shaft between two of its spines; when the shaft is curved the nucleus lies in its concavity (Pl. XVII. fig. 24). The nucleus of the spinispirules is undistinguishable in character from that of the ectodermic cells; and in many cases one can see in the epithelium lining a vesicle a nucleus otherwise precisely similar to its fellows, but here embraced by the concave shaft of a spinispirule, and so closely as to show that it belongs to the spicule, which on its part lies so near to the epithelium that its minute spines project through it (Pl. XVII. fig. 47). The nucleus is clearly a part of the epithelium; but likewise it belongs to the spicule; and thus it would appear that the spicule is a genuine component of the epithelium. But spinispirules in association with epithelial and epidermic nuclei are far from uncommon, indeed remarkably frequent; so that we are led to conceive of these membranes as to a considerable extent composed of spicule-bearing cells. Further, as in *Tetilla*, we are brought to the alternative of regarding the ectoderm as a skeletogenous tissue, or of admitting that mesodermic cells may find their way into it and contribute to its formation.

Endoderm.—This lines the excurrent system of vesicles as an epithelium which does not differ from the ectoderm except when it forms the walls of the flagellated chambers. The flagellated cells, in their present state, are rounded or oval bodies 0 000125 inch in diameter, with a well-marked round nucleus containing a nucleolus. They are seated on the walls of the chamber, about 0·00011 inch remote from each other on the average, and number about forty to a chamber. Sometimes one is to be observed markedly larger than the others, 0·00028 inch in diameter; and sometimes a little heap of four small ones is to be seen, as if resulting from the fission of one of the unusually large forms (Pl. XVII. fig. 21).

Mesoderm.—This consists of a gelatinous connective tissue, of which the matrix is a quite colourless transparent jelly, highly unalterable by acids and alkalies, and remarkably poor in granules, those present being exceedingly minute; its corpuscles (Pl. XVII. figs. 25, 29, 30) consist of a variable quantity of granular propoplasm, often vacuolated, and provided with an oval or round nucleus 0·00013 to 0·00017 inch in diameter, within which is a minute nucleolus. The outer protoplasm extends into long branching processes, which terminate in threads, scarcely traceable near their ends for fineness. Sometimes the threads diminish regularly up to their ends; sometimes after diminishing they thicken out up to a point of bifurcation (fig. 30); frequently the angle of the bifurcation is filled up by an accumulation of protoplasm; sometimes, finally, a short process from the corpuscle thickens into a lump of sarcode at the end, from which several short hair-like processes radiate outwards (Pl. XVII. fig. 30). Sometimes the fine ends of the threads appear to terminate freely; more often they unite with those from neighbouring corpuscles. A large proportion of them are elongated in one direction and joined end to end to form long granular nucleated threads (Pl. XVII. fig. 25); the lateral branches proceeding from the protoplasm about the nuclei of the corpuscles unite with similar threads or enter other corpuscles. Sometimes the matrix about the fibre becomes in places finely fibrillated parallel with it (fig. 25, *f*). The ends of the fibres or of the branches from them appear to be ultimately brought into close connexion with the ectodermic and endodermic layers; for on the inner faces of these layers fine filamentous processes are often seen wandering, and the branching filaments of connective-tissue corpuscles can frequently be traced right up to them; in several cases also, I believe, I have seen a connexion between the individual cells of a flagellated chamber and the branching processes of a corpuscle (fig. 15). It is, indeed, difficult while studying this reticulum of connective-tissue corpuscles to resist the idea that we are here dealing with something that plays the part of a nervous system. And just as the nervous tracts usually follow and are protected by the skeletal structures, so here a large number of the corpuscular fibres are seen running parallel close by the side of the chief spicules of the body. On the other hand, the modifications which some of the corpuscles undergo seem inconsistent with special nervous properties.

In an irregularly defined layer a little below the skin, at about the level of the first and second vesicles of the incurrent canal system, the connective-tissue corpuscles have undergone a remarkable internal change (Pl. XVII. fig. 18). Within the granular protoplasm a smooth shining globule makes its appearance; it is colourless, transparent, homogeneous, and highly refringent. In some corpuscles only one such body is present; in others several, lying in close contact with flattened apposed faces. The number in different groups does not follow any regular series, such as 1, 2, 4, 8, &c., but any number may occur from 1 to 8, and perhaps more: nor are the granules of a group all of the same size; there may be one large and several smaller ones of various degrees of minuteness. Sometimes they lie in immediate contact with the protoplasm, more often separated from it, lying in a vacuolated space. We are able fortunately to determine the stage in which they earliest appear, by finding them in evidently very young corpuscles, distinguished by the large quantity of their finely granular protoplasm, which takes a specially deep stain with reagents. From this starting-point we can readily trace their history as they are followed deeper into the interior of the sponge. In corpuscles a stage older than the preceding we find the protoplasm becoming less granular, staining much less deeply with carmine, and diminishing likewise in quantity, so that it forms a mere spherical or oval shell around the granules, but still retaining its outward radiating processes (Pl. XVII. fig. 19); these, however, in the next stage also disappear, and the corpuscle becomes simply a mere oval or spherical sac, filled with the products of its metamorphosis or secretion, amidst which the nucleus lies concealed (Pl. XVII. figs. 26, 45, 46). The shining granules next begin to diminish in number and size, and at length finally disappear, leaving as an effete residuum the investing sacs, which, lined by a small quantity of protoplasm produced sometimes into branched processes and showing the now reexposed nucleus, contribute largely to the histological elements of the gelatinous tissue (Pl. XVII. figs. 31, 44).

The manner in which the fat-like granules make their appearance and their subsequent history seem to point to their being food-reserves of some kind; but of what kind in particular, one cannot safely even conjecture. They stain deeply with carmine, turn brown, and not blue, with iodine (i.), do not dissolve in ether or chloroform (ii.), nor in boiling water (iii.), nor in strong sulphuric acid (iv.); strong acids, indeed, like nitric and sulphuric, seem to have no action upon them in the cold, even after prolonged treatment; iodine does not stain them blue after treatment with sulphuric acid (v.): a 5-per-cent. solution of potash hydrate dissolves them; but the resulting solution does not reduce copper from Fehling's solution (vi.). By (i.) they are proved not to be any common form of starch, by (ii.) not fat, by (iii.) not inulin, by (iv.) not tunicin, by (v.) not cellulose, and by (vi.) not sugar. What they are, not one test indicates; and one is led to think they may be some kind of albuminoid.

Another constituent of the mesoderm is furnished by the muscle-fibres, which occur chiefly as forming the sphincters about the openings of the vesicles (Pl. XVII. fig. 47). They are fusiform bodies prolonged at each end into long slender filaments, 0·0002 inch across where broadest, and 0·014 inch in length, composed of granular protoplasm, which stains deeply with carmine, and is thus rendered very distinct amidst the unstained colourless jelly of the matrix, and containing in the middle a round, or more usually oval, nucleus 0·000148 inch broad, with fluid contents and a minute round nucleolus. Occasionally the body of the fibre exhibits very distinct longitudinal striation. The muscle-fibres lie side by side concentrically arranged, to form the sphincters; the ends of some of those towards the outside of the sphincters escape from them tangentially, and wander into the surrounding matrix, where they appear to become connected with the fine terminations of the connective-tissue corpuscles—a union still further suggestive for the latter bodies of a nervous function.

Fibres similar, but differing in slight details from those of the sphincter, run radiately from its outer margin into the surrounding tissue; these are connective-tissue corpuscles.

Large amœbiform cells with pseudopodium-like processes, gigantic oval nuclei, and included spherical nucleoli are to be seen here and there in the mesoderm (Pl. XVII. fig. 48). They never occur in definite lacunæ, like the similar cells of *Tetilla*. It is probable that they become converted into sperm-balls, like those to be presently mentioned.

Spicule-cells have been already mentioned in connexion with the spinispirules; these little spicules are frequently found with an accumulation of protoplasm about their shafts, which extends as a granular fibre over their spines, and contains a small round nucleus with a nucleolus. The large quadriradiate spinispirules occasionally, but not often, present cases of indubitably associated nuclei. The large body-spicules frequently bear on one side of the shaft a large cell, something like the amœbiform cells noticed above, the granular protoplasm of which extends into a thin film, traceable for greater or less distances along the spicule, just as described in similar cases in *Tetilla* (Ann. & Mag. Nat. Hist. ser. 5, vol. ix. pl. vii. fig. 18).

Sperm-balls (Pl. XVII. fig. 28) are the last constituents of the mesoderm to which we need allude; they are rounded or oval clusters measuring about 0·0071 inch along the minor, and 0·01 inch along the major axis, consisting of a vast number of closely packed spherical bodies of various sizes, from 0·00025 to 0·000057 inch in diameter. These stain deeply with carmine; they present no trace of flagella, and are probably spermatozoa in an unripe state. Immediately surrounding each sperm-ball the gelatinous matrix is very finely fibrillated, and outside this thin fibrillar layer abounds in young abundantly and frequently coarsely granular protoplasmic cells (Pl. XVII. fig. 1), which appear to be connective-tissue corpuscles, with short branches and in a very active state of growth. The large amœbiform cells are also sometimes found close to the sperm-ball. Besides these, abundant fusiform connective-tissue corpuscles radiate from the surrounding tissue towards the sperm-cluster, and penetrate the fibrillar layer which immediately surrounds it. This layer, when seen from the inside by the removal of the sperm-granules, presents the appearance of very fine curved striæ, which wander about in all directions, but exhibit a more or less concentric direction about the ends of the fusiform corpuscles which they surround (Pl. XVII. fig. 16).

Finding such a specialization of the mesoderm about each sperm-ball, one almost expects to find them also characterizing some special region of the body; but this is not the case; they occur as near the top as the bottom of the sponge; and all one can say is that they do not approach nearer the surface than the third vesicle of the incurrent system.

Development.—On the early stages of development I can contribute no information; but Mr. Norman's specimens have furnished me with six very young forms, which differ in several particulars from the adult sponge. All six agree in having a prolately ellipsoidal body provided with a single anchoring fibre; and in none is there any trace of an equatorial recess. This is also absent in Prof. Wright's specimen; but in a little example 0·5 inch broad by 0·4 inch high, with five rootlets, it is perfectly developed, as also are all the other characters of the adult sponge. The length of the body in the smallest specimen (Pl. XVII. fig. 7) is 0·02 inch, in the largest 0·06 inch. The anchoring-fibre is continued through the centre of the body as an axis; and a tuft of spicules projecting from the oscular end seems to be its upward termination. In the larger specimens the tufts of spicules radiating from the oscular region outwards are more numerous than in the smaller; and in the largest a branch from the axis downwards seems to be a second rootlet. The spinispirules do not differ from those of the adult; but the quadriradiate spirules are absent from the two youngest forms.

The slender spicules of the anchoring-fibres, over which the ectoderm extends, are mostly rounded at the distal end (Pl. XVII. fig. 39), like many of the spicules of *R. schœnus*, or the forms which so frequently occur as varieties amongst the pin-shaped acuates. These represent the first stage of the grapnel-spicules, which thus differ from the similar spicules in *Tetilla* by the absence of an initiatory inflation. In the next stage (Pl. XVII. figs. 33–38) these spicules exhibit near the distal end a number of little tubercular excrescences, similar to those which occur as abnormal thickenings on many of the spicules both of the Monaxonidæ and the Tetractinellidæ. In many cases these tubercles take the form of small teeth, often recurved, and varying in number from one to six. They are seldom situated at the extreme end of the spicule, usually a little distance from it. In the larger specimens we find a considerable advance in growth and development; the spicules show a marked increase in size; and though some of these larger forms still present a merely rounded end, others possess in addition from one to three short conical teeth budded off at some little distance before the end (Pl. XVII. figs. 40 to 42). There is still not the slightest trace of any terminal inflation, such as occurs in *Tetilla*-grapnels. The rays arise merely as spines, precisely similar at this stage to the more numerous spines which cover the distal end of the quadriradiate spicules of *Tricentrium muricatum*. We may indeed, on the basis of these observations, regard the rays of these grapnels as highly developed spines, which, at their inception indefinite in number, become subsequently limited to three. The club-shaped spicules, previously mentioned as the probable parents of the forks, have also been observed in these young forms; but no spines have yet been found proceeding from them. The bifurcated forks, however, are in these early stages very small, their rays being 0·006 inch long, while those of the adult are 0·05 inch, or eight times as long.

Classification.—Thenea is evidently a true tetractinellid sponge; but it differs from those hitherto described in this Report by the complete absence of a cortex, and thus is a typical example of our Leptochrota; this character has been noticed long ago by Sir Wyville Thomson, who, in his paper on *Holtenia*, recognized its classificatory value, and founded his suborder Leptophlœa upon it. This suborder is nearly the same as my

Leptochrota—the similarity in names, however, being only what we call accidental, arising really from our both having the same idea to express in a single word. Thomson's sub-order, however, was intended to include monaxonid as well as tetractinellid sponges, and thus, ignoring a distinction which all spongologists are now agreed to regard as fundamental, cannot be maintained. This is not the case with Leptochrota, which is a division of the Tetractinellidæ, not of the heterogeneous group Radiantia; Leptochrota, therefore, escapes anticipation, though by a very narrow chance.

As secondary characters distinguishing *Thenea* we may cite the vesicular character of the canal-system, the superabundance of clear gelatinous matrix in the mesoderm, and the substitution of spinispirules for stellates. As agreements of doubtful value with other sponges, we have the similarity in size of its flagellated chambers with those of the Corticata and such *Esperiæ* as I have examined, and the resemblance of its club-shaped spicules to those of the Esperiad *R. Marshall-Halli*. This latter resemblance I regard as possibly due to homoplasy; but in any case it is eminently suggestive of the manner in which the tetractinellid spicules have been evolved.

Distribution.—Kors Fiord, Norway. Station 13, 200 to 300 fathoms. The following occurrences are also recorded:—Atlantic, 58° 23′ N., 48° 50′ W.; 1913 fms. (*Wright*). *Loc.?* 500 fms. (*Kent*); Florida, 178 fms. (*O. S.*); between Anticosti and Gaspé, 220 fms. (*Whiteaves*). Grey ooze generally (*W. Th.*).

Broadly speaking, therefore, it is known on both sides of the Atlantic, from Norway to Florida, and ranging from 100 to 2000 fathoms in depth. Probably its area will be found to be much more extended than this: there is, indeed, a suggestion of its occurring in the Pacific; for Mr. Norman has placed in my hands a specimen which seems specifically identical with *T. Wallichii*, and which came, according to the assertion of the dealer who sold it, from Cebu.

EXPLANATION OF PLATE XVII.

Thenea Wallichii, P. Wright.

Fig. 1. One of the coarsely granular cells in the connective tissue surrounding a sperm-ball (×500).

Fig. 2. Median longitudinal section through the sponge: *o*, the oscule; *t*, tegminal edge; *e*, equatorial recess (nat. size).

Fig. 3. A variety of acerate spicule, with swollen distal end (probably a precursor of the tetractinellid form) (× 30).

Fig. 4. A grapnel-spicule from the body of the sponge (× 45).

Fig. 5. A fusiform fibre from the outer margin of a sphincter (× 435).

Fig. 6. Section from the skin, a short distance inwards. *a*, first incurrent vesicle (=ectochone); *b*, second incurrent vesicle (=endochone and subcortical crypt); *s*, a sphincter; *e*, excurrent vesicle; *d*, *d*, layer characterized by food-reserve cells; *e*, inner ends of a tuft of spicules projecting from the skin; *f*, flagellated chambers. × 22·5.

Figs. 7–12. Outlines of six young forms of *Thenea* (× about 3).

Fig. 13. Pauciradiate stellate or spinispirule, with the spines rounded at the ends (× 315).

Fig. 14. Head of a form of grapnel-spicule common in the anchoring tails (× 166).

Fig. 15. Flagellated chamber, with a large cell seated, like a flagellated cell, on the wall, but connected by a short process with a fusiform connective-tissue corpuscle: *p*, incurrent pore (× 250).

Fig. 16. The inner face of the wall of a cavity, containing a sperm-ball, showing its fibrillated structure and the ends of the connective-tissue corpuscles which penetrate it (× 250).

Fig. 17. Club-shaped distal end of abnormal acerate, showing a rudimentary spine at one side (× 166).

Fig. 18. A young granular cell, containing a large shining grain of undetermined nature—food-reserve cell (× 500). The series of changes which this kind of cell appears to undergo is represented by figs. 19, 26, 43, 45, 46, 44, 31, in the order here given.

Fig. 19. Food-reserve cell (× 500).

Fig. 20. A young granular spherical cell common in the gelatinous connective tissue, and sometimes apparently forming one of the cells of a flagellated chamber (× 500).

Fig. 21. Part of a flagellated chamber seen in optical section, with a group of three young cells within a common cell-wall (× 500).

Fig. 22. Some of the spherical granular bodies which compose a sperm-ball (× 500).

Fig. 23. A flagellated chamber with a connective-tissue corpuscle ending in fine processes over its wall (× 500).

Fig. 24. Spinispirule with its nucleus (× 500).

Fig. 25. A thread of united connective-tissue corpuscles; at *f*, the gelatinous matrix immediately surrounding a corpuscle shows a fine longitudinal fibrillation (× 333).

Fig. 26. Food-reserve cell containing four granules (× 500).

Fig. 27. Fibrillæ in layer surrounding a sperm-ball, having the appearance of tails radiating from the sperm-granules, indicated by the small circles (× 500).

Fig. 28. A sperm-ball with its surrounding layer of modified gelatinous connective tissue (× 20).

Fig. 29. A branching connective-tissue corpuscle, having one of its fibres continuous with a fusiform cell resembling a muscle-fibre: *v*, vacuole (× 500).

Fig. 30. A connective-tissue corpuscle (× 500).

Fig. 31. A cell from the gelatinous connective tissue, consisting of a thin wall enclosing a large vacuole-like space and a round nucleus (probably an exhausted food-reserve cell) (× 500).

Fig. 32. A small portion of the epidermis seen *en face* (× 500).

Figs. 33–38. Young forms of grapnel-spicules from the roots of the young specimens indicated by figs. 7 and 8 (× 315).

Figs. 39–42. Also young forms of grapnels, from the specimens of figs. 10–12 (× 315).

Fig. 43. Small spherical cell with protoplasmic contents, vacuole, and food-grain (× 500).

Fig. 44. Connective-tissue corpuscle with large vacuole (probably an exhausted food-reserve cell) (× 500).

Figs. 45, 46. Cells with large vacuoles and food-grains (× 500).

Fig. 47. A vesicle of the canal-system, showing the nuclei of its epithelial cells and associated spinispirules: *b b*, edge of the vesicle; *s*, sphincter; *c*, surrounding connective tissue. × 250.

Fig. 48. Large amœbiform cell of the connective tissue (× 333).

L.—*Description of a new Species of* Crastia, *a Lepidopterous Genus belonging to the Family* Euplœinæ. By F. MOORE.

Crastia Distantii.

Upperside dark cupreous brown, glossed with olive-green: fore wing with a series of eight or nine white submarginal spots, and a marginal row of small spots, similarly disposed and of the same shape as those in the Malayan *Euplœa Bremeri*, Feld., but somewhat larger; two small spots also on the disk below the upper and middle median veins in some specimens; a short slender sericeous streak between the lower median and submedian in the male: hind wing with two rows of prominent white spots.

Underside greenish olive-brown: fore wing with marginal markings as above; two small spots also on the costa, another spot at the end of the cell, and three on the disk: hind wing with prominent marginal spots; a spot at the end of the cell, and five spots beyond. Expanse 2$\frac{6}{8}$ to 3$\frac{1}{8}$ inches.

Hab. Sumatra. In coll. F. Moore.

LI.—*Researches on the Nervous System of the Larvæ of Dipterous Insects.* By Prof. ED. BRANDT.

HAVING received from M. Behling a number of Dipterous larvæ belonging to families which had not been previously examined as to their nervous system, I took the opportunity to dissect them, and with the following results.

I have examined the following:—

LEPTIDÆ: *Leptis*, sp.
BIBIONIDÆ: *Bibio Marci*, L.
—— *Pomonæ*, Fabr.
—— *ferruginatus*, L.
—— *varipes*, Meig.
—— *hortulanus*, L.
—— *laniger*, Meig.