Studies on the Comparative Anatomy of Sponges.

VI. On the Anatomy and Relationships of Lelapia australis, a Living Representative of the Fossil Pharetrones.

By

Arthur Dendy, D.Sc.

With Plate 13.

I. Introductory Remarks.

In my memoir on the 'Structure and Classification of the Calcarea Heterocœla,' recently published in this Journal (1), I had occasion to refer to that very remarkable calcareous sponge Lelapia australis. Unfortunately this species is extremely rare, only two specimens being as yet known. Both of these were dredged by Mr. J. Bracebridge Wilson, M.A., off the Victorian coast, and both were sent to Mr. Carter, by whom their external characters and spiculation were described (without illustration) in the 'Annals and Magazine of Natural History' (2). At the time when I wrote I had never had the opportunity of personally investigating this sponge, but since then Mr. Carter, with his usual generosity, has most kindly sent me a portion of the better of the two specimens, preserved in spirit.[1] He has also sent me an unpublished sketch of the entire sponge, and has permitted me to make use of it in the present memoir (fig. 1). For this and many other kind-

[1] The specimen itself is in the British Museum.

nesses of a similar nature I desire to express my most sincere thanks to Mr. Carter. The material was fortunately in sufficiently good condition to enable me to make out the structure of the canal system, and to establish the correctness of my supposition that it belonged to the Leuconoid type. By far the most interesting feature of the species, however, proved to be the very remarkable reticulated fibrous character of the skeleton, which appears to have hitherto escaped observation. This character is unknown in any other living calcareous sponge, while it forms the most prominent feature in the great fossil group "Pharetrones" of Zittel (3), hitherto regarded as entirely extinct. Lelapia australis may therefore be looked upon as the only known living representative of this important group,[1] and a minute study of its anatomy thus acquires an exceptional interest.

I have much pleasure in again expressing my most sincere thanks to Professor G. B. Howes for kindly undertaking the correction of the proof sheets in my absence from England.

II. Anatomy of Lelapia australis.

A. External Form.

The larger of the two specimens (fig. 1) measured $3\frac{1}{4}$ inches in length by 1 inch in greatest diameter, and is thus described by Mr. Carter (2, p. 148) :—" Cylindrical, clavate, the largest part upwards, somewhat curved or bent upon itself, rugose longitudinally. Consistence firm. Colour dark grey. Surface even, smooth, interrupted by the projection of crooked ridges extending from the free to the fixed end, subspirally and longitudinally, in broken lengths, sometimes reduced to mere scattered tubercular points, most pronounced on the concave side towards the mouth, least so on the opposite side: largest and most continuous ridge $\frac{1}{3}$ inch long, $\frac{1}{48}$ inch broad, and $\frac{3}{48}$ inch high. Pores plentifully scattered over the surface, not

[1] Whether the group, as it stands, is a natural one, appears to me doubtful.

remarkably large. Vent single, terminal, represented by a narrow elliptical opening about $\frac{1}{8}$ inch in its longest diameter, so constricted in the centre as to be closely approximated by an infolding of the lip on each side; provided with a peristome, whose spicules here are broken off short; leading into a cloaca corresponding in shape with the specimen, that is, wide above, narrowed to a point below (after which the stem becomes solid)."

The specimen thus described is obviously a single Leuconoid individual. The smaller specimen, however, as described by Mr. Carter, showed some indication of a tendency to branch, and possibly the species may sometimes form branching colonies.

B. The Skeleton. 1. The Spicules.

The following account of the spicules is taken from preparations boiled out with caustic potash, as it is extremely difficult to obtain a satisfactory view of entire spicules in their natural position. I have not had the opportunity of examining the spicules of the peristome, but we learn from Mr. Carter's writings that there is no important modification amongst these which is not also met with elsewhere. All three principal types of calcareous spicules are met with, but the quadriradiates are rare, and the apical ray is very feebly developed.

Oxeote Spicules.—Three varieties may be clearly distinguished:

(1) Large, stout, fusiform; usually slightly curved and slightly irregular in diameter; tapering gradually to a sharp point at each end (fig. 2, *a*). Size variable, when fully grown about 1·9 by 0·11 mm.

(2) Long, straight, and very slender, gradually and sharply pointed at both ends, and sometimes slightly hastate or bayonet-shaped (fig. 2, *b*). Size variable, say about 0·9 by 0·008 mm., but often less.

(3) The so-called "mortar-spicule." Minute; straight or slightly crooked; gradually and sharply pointed at both ends,

lanciform or hastate at one (fig. 2, *c*). Size variable, say about 0·08 by 0·004 mm.

Triradiate Spicules.—Here again three principal varieties may be clearly recognised :

(1) Normal sagittal triradiates ; with wide oral angle; with long straight shaft (or basal ray) and much shorter lateral (or oral) rays which may be straight or slightly curved away from one another (fig. 2, *e*). All rays rather slender, and gradually and sharply pointed ; orals measuring about 0·25 by 0·016 mm. ; basal about 0·46 by 0·016 mm. (The subgastral sagittal triradiates usually have somewhat longer and stouter rays.)

(2) Laterally extended sagittal triradiates ; with oral rays so widely divergent as to be almost in the same straight line, and basal ray very much shorter, reduced almost to insignificance (fig. 2, *f*). Oral rays almost straight or curving slightly away from one another, gradually and sharply pointed, measuring about 0·25 by 0·012 mm. ; basal ray short, straight, conical, about 0·05 by 0·0082 mm, but of course variable.

(3) The "tuning-fork" spicules ; with all three rays long, straight, and slender, gradually and sharply pointed ; the basal ray longest and stoutest, and the two oral rays running straight forwards, parallel to and almost touching one another, so that the entire spicule is much elongated in the oro-basal direction (fig. 2, *d*). The two oral rays are commonly slightly unequal in length. Total length of an average example, 0·74 mm. ; basal ray, 0·42 by 0·01 mm. ; longest oral, 0·32 by 0·007 mm.

Quadriradiate Spicules.—These are exactly like the laterally extended sagittal triradiates, with the addition of a very short, straight, sharply pointed apical ray (fig. 2, *g*).

In addition to the principal forms of spicules thus described, various intermediate as well as more or less abnormal forms occur, but these are neither numerous nor important.

2. The Arrangement of the Skeleton (figs. 3—5).

As in all the more highly organised Calcarea Heterocœla, we can divide the entire skeleton into three principal parts, viz. that of the dermal cortex, that of the gastral cortex, and that of the chamber-containing layer of the sponge-wall between the two. To these may be added the skeleton of the peristome, but this is hardly of sufficient importance to deserve special consideration. The principal part of the skeleton is, of course, that of the chamber layer, which occupies nearly the entire thickness of the sponge-wall, and it is here that we meet with the most surprising peculiarities in structure.

Skeleton of the Dermal Cortex.—The dermal cortex is very thin, and its proper skeleton consists of a thin, confused layer of rather small, slender-rayed, normal sagittal triradiates, lying parallel with the dermal surface, together with an immense number of the minute oxeote "mortar-spicules." Mr. Carter notes the occurrence of small quadriradiates on the dermal surface, but these I have not detected in the small piece which I have examined. They certainly do not play any important part in the formation of the skeleton, and, unlike the large subdermal quadriradiates of the Amphoriscidæ, cannot be regarded as of any systematic importance. The huge oxeote spicules take no part in the formation of the dermal cortex proper, although many of them lie just beneath it. Here and there the dermal cortex is pierced by very stout and densely packed bundles of the long slender oxeotes (intermingled with "tuning-fork" spicules. These bundles (fig. 3, *d. t.*) constitute the expanded (but densely packed) ends of some of the spicular fibres of the chamber layer, which just pierce the dermal cortex and give rise to the characteristic ridges on the outer surface of the sponge. The outermost ends of the spicules are commonly broken off short.

Skeleton of the Gastral Cortex.—The gastral cortex is very much more strongly developed than the dermal, having a thickness of about 0·2 mm. It is composed almost entirely of very densely packed, laterally extended sagittal triradiates, with very long oral rays and very short basals. These spicules are arranged with their longest axes parallel to the gastral surface, but otherwise in the greatest confusion, with the short basal rays pointing in all directions instead of constantly towards the base of the sponge. This is the only situation in which I have detected quadriradiate spicules, and even here they are few in number, and the apical rays, which project towards the gastral cavity, are very feebly developed. The widely extended oral rays of the subgastral sagittal triradiates may also be regarded as taking part in the formation of the gastral cortex, but these spicules are best considered in connection with the next portion of the skeleton.

Skeleton of the Chamber-bearing Layer.—The part of the sponge lying between the gastral and dermal cortex and containing the flagellated chambers is, in the piece examined by me, a little over 4 mm. in thickness, the total thickness of the sponge-wall being about one sixth of an inch. Its skeleton is very strongly developed, and (excluding the triradiates which line the large exhalant canals, and which resemble more or less those of the gastral cortex) it consists of the following parts:

(a) The subgastral sagittal triradiates. Very well developed and abundant; occupying the normal position, with widely extended oral rays lying beneath the gastral cortex, and long straight basal rays penetrating the chamber layer more or less vertically or obliquely (fig. 4).

(b) The spicular fibres (figs. 3—5, *fi.*). These consist of long bundles of the characteristic slender, elongated, "tuning-fork" spicules. The component spicules are closely packed together side by side, parallel with one another (fig. 4). So closely are they packed together that in a stout fibre it is very difficult to make out the outlines of the individual spicules. There does not seem to be any special connecting substance analogous to the spongin of siliceous sponges, but the spicules appear to be held together simply by the gelatinous ground-substance of the mesoderm. The arrangement of the fibres is very similar to that of the spicular fibres in many siliceous sponges. They do not simply run through the wall of the sponge from gastral to dermal surface, but they run in every direction, and, by frequently coming in contact and crossing one another at all sorts of angles, give rise to a loose, irregular network (fig. 3). The thickness of the fibres is very variable, according to the number of spicules entering into their composition at any given point. They are seldom more than about 0·07 mm. in diameter, except towards the dermal surface, where their thickness may be greatly augmented by the addition of numerous slender oxeote spicules as already mentioned. Towards the gastral surface the fibres often appear, as it were, to spring from the long basal rays of the subgastral sagittal triradiates (figs. 4, 5), a relation which is of considerable importance in considering the derivation of this peculiar type of skeleton from the primitive articulate type. Except just close to the two surfaces of the sponge-wall the fibres appear to consist solely of the remarkable tuning-fork-shaped triradiates. All the spicules of any one fibre, so far as I have been able to make out, have their basal rays pointing in the same direction. Usually the fibres have a distinct, though more or less oblique trend from gastral to dermal surface, and it is extremely interesting to note that the basal rays of the component spicules in such cases almost always point towards the outside of the sponge, a fact which has already been noted by Mr. Carter.

(c) The huge Oxeote Spicules. These occur in immense numbers, disposed in the utmost confusion between the spicular fibres (fig. 3). The thickness of each one is greater than that of an average fibre, and, indeed, the fibrous portion of the skeleton can only play a part of secondary importance in strengthening the sponge-wall as compared with these giant spicules.

Skeleton of the Peristome.—This appears, from Mr. Carter's description, to present no very characteristic or important features. It consists of long, straight, slender oxeote spicules arranged perpendicularly (parallel to the long axis of the sponge). The lower ends of these spicules are crossed at right angles and supported by the outspread lateral rays of the gastral triradiates.

c. The Canal System.

The canal system of Lelapia australis conforms in all respects to the typical Leuconoid arrangement, the entire sponge being, as already pointed out, a single Leuconoid individual. The flagellated chambers are spherical or ovoid, only about 0·06 mm. in diameter and frequently less. They are thickly scattered in the transparent, gelatinous, mesodermal ground-substance which separates the branches of the inhalant and exhalant canals. Their exhalant openings are, as usual, circular and well-defined, each with a delicate chamber-diaphragm. The prosopyles, which are not very easy to make out in small Leuconoid chambers, I have not succeeded in detecting.

The inhalant canal system is irregular and more or less lacunar. Owing to the feeble development of the dermal cortex, there is no separately recognisable cortical canal system. The inhalant pores are small and scattered over the dermal surface. They open into short canals which unite to form larger trunks before penetrating the deeper parts of the sponge-wall, but there appears to be nothing definite about the arrangement. The smaller exhalant canals collect into large trunks, which run to open on the gastral surface, piercing the gastral cortex more or less at right angles. The wider parts of these trunks are lined by a layer of laterally extended sagittal triradiates, similar to those of the gastral cortex, and amongst them may be seen sagittal triradiates like the subgastrals, with long basal rays projecting into the surrounding tissue at right angles to the course of the canal. These facts argue in favour of the supposition that the larger exhalant canals in Lelapia may be formed by pitting in or folding of the gastral surface. The openings of the exhalant canals (fig. 6, *ex. ap.*) into the wide gastral cavity are abundantly scattered over the inner surface of the gastral cortex, and are provided with membranous diaphragms, as Mr. Carter has already pointed out. From the gastral cavity, of course, the water finds its way out of the sponge through the wide, terminal osculum (fig. 1, *osc.*).

The histology of the sponge, so far as the condition of the specimen will permit of investigation, offers no features of special interest, and appears to agree with that of other Heterocœla. Beyond the transparent gelatinous ground-substance of the mesoderm, the contracted collared cells, and the nuclei of the pavement epithelium lining the canals, I have not been able to make out any details.

III. Relationships of Lelapia.

A. Relationships to other recent Heterocœla.

The canal system of Lelapia australis, as already pointed out, offers no features of peculiar interest and, as regards its probable derivation from the more primitive Syconoid type, stands on exactly the same footing as the canal system of any other Leuconoid Heterocœle. As the probable mode of derivation of the Leuconoid from the Syconoid type has already been discussed in my memoir on the structure and classification of the Heterocœla (1), it is unnecessary to enter further into the question in this place.

The skeleton, however, is very peculiar, and, at first sight, may seem to place great difficulties in the way of believing in the Syconoid ancestry of Lelapia. These difficulties, however, disappear upon closer examination.

The peculiar form of the "tuning-fork" spicule is not, in itself, of much significance, and, as already pointed out by other writers, it is paralleled more or less closely in Haeckel's Leucandra (Leucortis) pulvinar and L. (Leucetta) pandora (4), both of which are recent species; while it is also met with in the fossil Sestrostomella rugosa and S. clavata described by Dr. Hinde (5). In none of these, however, does it appear to attain to anything like the degree of development met with in Lelapia australis. The tendency of the triradiate to vary is well known, and we meet with a modification perhaps even more remarkable in my Grantiopsis cylindrica (1).

As I have previously pointed out, the arrangement of the skeleton in the Calcarea Heterocœla is of more importance for purposes of classification than the mere form of the component spicules, and the difficulty lies in explaining how the very peculiarly arranged skeleton of Lelapia can have been derived from a Syconoid ancestor with its characteristic articulate tubar skeleton.

We may, however, at once confine our attention to the skeleton of the chamber-bearing layer, for that of the dermal and gastral cortex differs in no essential points from the corresponding parts in other corticate Heterocœla. Taking first the subgastral sagittal triradiates, we find in these a strong argument in favour of our view, for they exactly correspond to the similar spicules of the typical articulate skeleton. These spicules, indeed, seem to be wonderfully persistent, being also met with, as I have already pointed out, in the genus Leucandra, after all other traces of the articulate tubar skeleton have disappeared.

The huge oxeote spicules are probably, like the very similar spicules of some species of Leucandra (e. g. L. cataphracta, Haeckel), to be regarded as incursions from the dermal cortex, the dermal surface being the characteristic position for oxeote spicules.

We have left the spicular fibres, whose presence distinguishes Lelapia australis from all other known recent sponges. These I believe to be derived from the articulate tubar skeleton of a Syconoid ancestor. The arguments in favour of this view are as follows:—(1) The position of these spicules with regard to one another is the same as in the typical articulate tubar skeleton, i. e. with their basal rays parallel, overlapping, and all pointing in the same direction. (2) The position of the spicules with regard to the gastral and dermal surfaces is, when the position of the fibre as a whole allows of it, almost invariably the same as in the articulate tubar skeleton, i. e. with the basal rays pointing to the dermal surface. (3) The relations of the subgastral sagittal triradiates to the fibres is, in many cases at any rate, identical with that of the corresponding spicules to the articulate tubar skeleton of a Syconoid.

Thus, while in Leucandra the spicules of the primitive articulate skeleton become scattered and disjointed, in Lelapia they retain their mutual relationships, and indeed become much more intimately associated with one another to form spicular fibres,—this formation of fibres being greatly facilitated by their very peculiar shape. The fibres as a whole, however, become irregularly arranged, as do the individual spicules of Leucandra.

Thus, then, I see no reason for altering the systematic position of the genus Lelapia as given in the genealogical tree at the end of my previous memoir (**1**). In other words, I regard Lelapia as an offshoot from the great family Grantidæ, coming off from the same branch which gave rise to the genus Leucandra. At the same time this way of thinking would not prevent us, if necessary, from accepting the Pharetrones as a distinct family and including Lelapia therein.

B. Relationships to the Fossil Pharetrones.

Professor Zittel, in his classical "Studies on Fossil Sponges" (**3**), accepted Haeckel's division of the Calcarea into Ascones, Leucones, and Sycones, but added thereto a new family, Pharetrones, which he regarded as of co-ordinate systematic value with Haeckel's three groups. The following diagnosis was given of the new family:—"Wand dick, mit ungeraden Astcanälen oder ohne alle Canäle. Skeletelemente zu anastomosirenden Fasern angeordnet. Dermalschicht häufig vorhanden."

In this family Zittel placed, with one exception (Protosycon), all the then known fossil Calcarea, amounting to no less than fifty genera, and ranging from the Devonian to the Upper Chalk.

These numerous fossil genera are naturally very imperfectly known, and even their calcareous nature has been disputed. This was largely owing to the fibrous character of the skeleton, which was not then known to occur in any living calcisponge, and certainly appeared to indicate a siliceous nature for the Pharetrones.

In 1882, however, Dr. Hinde published a valuable paper (5) in which this question was fully discussed, and described more or less in detail the spiculation of five species of so-called Pharetrones from the Cretaceous and Upper Greensand formations. These observations sufficiently proved the calcareous nature of at any rate these five species, for characteristic triradiate and quadriradiate spicules were detected.

The first species described by Dr. Hinde is Verticillites d'Orbignyi. The description and figures clearly prove this to be a calcareous sponge, but I do not think that there is the slightest evidence in favour of regarding it as a Pharetronid. It is a very thin-walled sponge, and the portions of the skeleton described are evidently simply the dermal and gastral cortex respectively. The latter is very strongly developed and differs in no essential respect from that of many living Heterocœla, being composed of a dense feltwork of triradiate spicules with aborted basal rays. This layer is pierced by the circular exhalant apertures leading into the gastral cavity, which, being placed near together, give the gastral cortex a reticulate character. To apply the term fibrous to this skeleton appears to me to be a mistake; it is no more fibrous than that of many living Heterocœla, and the so-called fibres are certainly not homologous with the spicular fibres of Lelapia. Verticillites d'Orbignyi ought, then, to be removed from the Pharetrones altogether. The thinness of the sponge-wall and the regular disposition of the exhalant openings on the gastral surface suggest that it may have possessed a Syconoid canal system, while the presence of quadriradiates in the dermal cortex, with inwardly projecting apical rays, suggests a position amongst the Amphoriscidæ of my classification.

In the next two species, again, Corynella rugosa and C.

socialis, the evidence placed before us does not seem to be conclusive as to the truly fibrous character of the skeleton, apart from the so-called fibres of the cortical one.

In the two species of Sestrostomella, viz. S. rugosa and S. clavata, described by the same author, there appears, on the other hand, to be little doubt as to the existence of a truly fibrous skeleton distinct from the cortical one. The fibre itself, to quote the words of Dr. Hinde, "exhibits an altogether different character in the form and arrangement of the component spicules from that which prevails in the examples of Verticillites and Corynella, already described." The ensuing description, however, also shows that the fibre is very different from that of Lelapia. "The central portion of the fibre generally appears to be occupied by a large tri- or quadriradiate spicule, one ray of which extends along the central axis of the fibre. . . . Beyond this centrally-placed large spicule the remaining portion of the fibre appears to be composed of several different forms of triradiate spicules, whose rays are so compactly and intricately interlaced together that it is extremely difficult to ascertain their complete forms with any degree of precision." Amongst these smaller spicules occur fork-shaped triradiates somewhat similar to those of Lelapia, but they appear to be irregularly arranged. In view of the occurrence of these spicules in other recent Heterocœla, as already mentioned, their systematic value must be considered as very questionable.

Lelapia, then, does not appear to be very closely related to any of the fossil Pharetrones described by Dr. Hinde. Whether it is more closely related to any of the other numerous fossil sponges which have been included in that group, it is impossible, in the absence of detailed information as to the form and arrangement of the spicules in the latter, to decide. It has, however, a truly fibrous skelelon; and in this respect it agrees with the main character of the family Pharetrones as laid down by Zittel. We may therefore regard it as a living representative of the group, but whether the group itself, as it stands, is a natural one is another question altogether, and one which, owing to the state of preservation of the fossils, will perhaps never be decided.

Zittel (3) regarded his Pharetrones as the ancestral forms from which the living calcareous sponges (Ascones, Leucones, and Sycones of Haeckel) originated. I need hardly say that I do not agree with this view, and I have endeavoured to show in this paper how a "spiculo-fibrous" skeleton may have been derived from the more primitive Syconoid type. My arguments, however, obviously apply only to the case of Lelapia, for the minute structure of other calcareous sponges with a fibrous skeleton is not sufficiently well known to justify speculation as to their origin. Thus it is possible that the fibres of those Pharetrones which are described by Zittel as consisting of bundles of parallel oxeote spicules are really composed of elongated, fork-shaped triradiates. Even in Lelapia it is hard to distinguish these, in situ, from oxeote spicules, owing to the closeness with which they are packed together; and in a section of a fossil sponge it would be impossible to do so unless one happened to get a section passing just through the fork of the spicule and in the plane of all three rays.

All things considered, then, it seems unadvisable, in the present state of our knowledge, to introduce the family Pharetrones into our system of recent Calcarea, and Lelapia may be regarded simply as a very specialised type of the Grantidæ.

MELBOURNE, November, 1893.

REFERENCE LIST OF LITERATURE.

1. DENDY.—"Studies on the Comparative Anatomy of Sponges: V. Observations on the Structure and Classification of the Calcarea Heterocœla," 'Quart. Journ. Micr. Sci.,' vol. xxxv, N. S., p. 159.

2. CARTER.—"Descriptions of Sponges from the Neighbourhood of Port Phillip Heads," 'Annals and Magazine of Natural History,' vol. xviii, ser. 5, p. 126.

3. ZITTEL.—"Studien über fossile Spongien, Dritte Abtheilung," 'Abhandlungen der k. bayer. Akademie der W.,' II Cl., Bd. xiii, Abth. ii, 1878.

4. HAECKEL.—'Die Kalkschwämme.'

5. HINDE.—"Notes on Fossil Calcispongiæ, with Description of New Species," 'Annals and Magazine of Natural History,' vol. x, ser. 5, p. 185.

DESCRIPTION OF PLATE 13,

Illustrating Dr. Dendy's paper "On the Anatomy of Lelapia australis."

Reference Letters.

a. Large oxeote spicules. *b.* Long slender oxeote spicule. *c.* Small oxeote spicules ("Mortar-spicules"). *d.* Tuning-fork-shaped triradiates. *e.* Normal sagittal triradiates. *f.* Laterally extended sagittal triradiates. *g.* Quadriradiate. *d. c.* Dermal cortex. *d. t.* Dermal tuft of triradiates and slender oxea. *ex. ap.* Openings of exhalant canals into central gastral cavity. *ex. c.* Exhalant canal. *fi.* Spicular fibres formed of tuning-fork-shaped triradiates. *g. c.* Gastral cortex. *osc.* Osculum. *s. g. s.* Subgastral sagittal triradiates.

(The spicules are delineated in blue throughout.)

FIG. 1.—Lelapia australis. (From a sketch by Mr. H. J. Carter, F.R.S.)

FIG. 2.—Isolated spicules, from a preparation boiled out with caustic potash. Only the two ends of the large oxeote (*a*) are drawn. All are drawn to the same scale, under Zeiss C, ocular 2, camera.

FIG. 3.—Skeleton arrangement, as seen in a thick, unstained, longitudinal section. × 25.

FIG. 4.—Portion of the gastral cortex and adjacent skeleton of the chamber-bearing layer, as seen in a thick, unstained, longitudinal section. Drawn under Zeiss C, ocular 2.

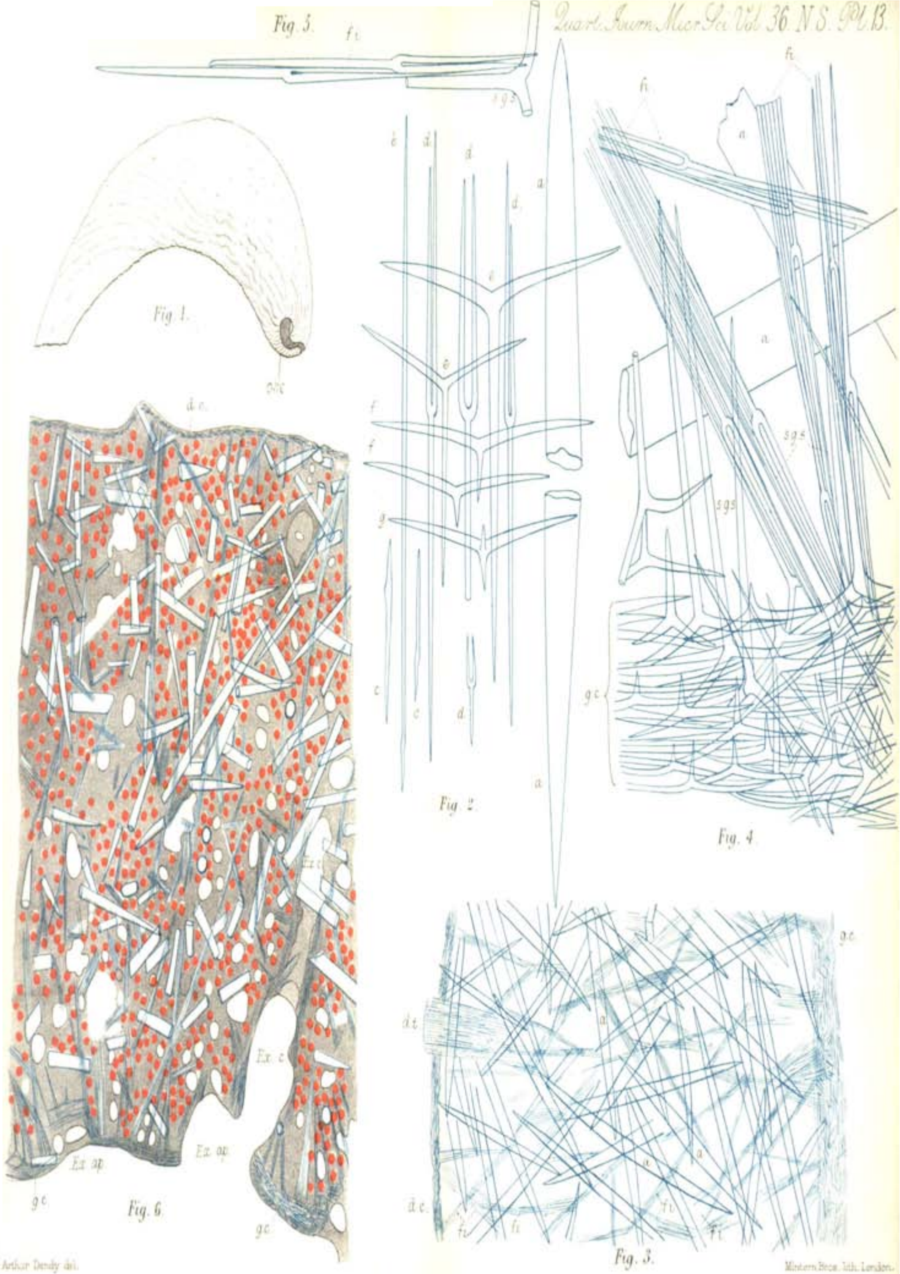
FIG. 5.—Portion of a subgastral sagittal triradiate, showing its relation to a very slender fibre formed of tuning-fork-shaped triradiates. Drawn under Zeiss C, ocular 2.

FIG. 6.—Portion of a transverse section, stained with borax carmine and cut by the paraffin method. × 25. Each flagellated chamber is represented by a red spot.

APPENDIX.

I take the present opportunity of correcting a few slight misprints which occur in the last paper of this series, "On the Structure and Classification of the Calcarea Heterocœla."

Page 163, line 2, *for* "caused" *read* "lined."
" 166, " 16, *erase* the comma after the word "to."
" 166, " 34, *for* "strobulus" *read* "strobilus."
" 167, " 17, *for* "Bauerbank" *read* "Bowerbank."
" 168, " 15, *for* "tuber" *read* "tubar."
" 168, " 24, *for* "fig. 8" *read* "fig. 5."
" 169, " 34, *for* "cram" *read* "crown."
" 171, " 11, *for* "non-" *read* "inter-."
" 176, " 2, *for* "situated" *read* "inflated."
" 179, " 3, *for* "Syllectoid" *read* "Sylleibid."
" 195, " 11, *for* "strangely" *read* "strongly."
" 206, " 28, *for* "Lycetta" *read* "Sycetta."
" 208, " 4, 5, 6, *for* "Heterocœla Calcarea" *read* "Calcarea Heterocœla."
" 216, " 3, *for* "into" *read* "on to."
" 217, " 12, *for* "permanent" *read* "pavement."
" 229, " 9, *for* "van" *read* "von."
" 232, " 16, *for* "Thabden" *read* "Rhabden."



Arthur Dendy del.

Mintern Bros. lith. London.