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AND

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[FIFTH SERIES.]

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XIII.—*Studies on Fossil Sponges.*—II. *Lithistidæ.*
By KARL ALFRED ZITTEL *.

[Plate VIII.]

A. GENERALITIES.

Since the publication of the first section of these "Studies" (see 'Annals,' ser 4, vol. xx.) the literature of fossil sponges has been enriched by a work of great importance. The first three parts of the fifth volume of F. A. Quenstedt's 'Petrefactenkunde Deutschlands' have appeared. These treat exclusively of fossil sponges. In sixteen folio plates the astonishing abundance of marine sponges in the White Jura of Swabia and Franconia is made manifest; and the figures in truth to nature and accuracy are certainly unsurpassed. Unfortunately Professor Quenstedt has disdained to pay any attention to the histological characters. Structural conditions are only referred to so far as they can be recognized with the lens; and thus the zoological value of this important work is essentially diminished. In the grouping of the different forms, geological occurrence and general habit are taken into consideration in the first place; a systematic treatment of the material in a zoological sense is, as a matter of course, not

* Translated by W. S. Dallas, F.L.S., from a separate impression communicated by the author, of his paper in the 'Abhandlungen der k. bayer. Akad. der Wiss.' II. Classe, Bd. xiii. Abth. i. pp. 67-154. The original memoir is accompanied by ten plates, from which some figures will be used, where necessary, for the illustration of this translation.

attempted; and it is left to the reader to summarize the observations made on the different species and to construct from them genera, families, &c. Quenstedt's monograph consists solely of descriptions of species; generic names are, indeed, occasionally proposed for particular groups, but are rarely consistently retained in the text, and never defined by diagnoses.

In the case of the latticed sponges the living Hexactinellidæ are occasionally referred to; but with respect to all other forms we find no indications of their position relatively to the sponges of the present day. In Quenstedt's latest publication, therefore, the fossil and living sponges are just as unconnected as in the works of Goldfuss, Michelin, D'Orbigny, Fromentel, &c. Admirably as Quenstedt brings out, by numerous figures, the external appearance and, in part, also the canal-system of the Upper Jurassic Lithistidæ, which are chiefly comprised under the generic names *Siphonia*, *Cnemidium* (*Cnemispongia*), *Tragos*, and *Planispongia*, we nevertheless gain not the least instruction as to their finer structural characters and systematic grouping. Hence the following investigations, carried out upon a different method and from different points of view, cannot be rendered superfluous by Quenstedt's monograph.

For the first certain evidence of the existence of fossil Lithistidæ we are indebted to Oscar Schmidt*. Soon afterwards (1871) H. J. Carter† recognized certain isolated siliceous bodies from the Greensand of Haldon as remains of Lithistidæ. Forked anchors and quadri- or radiate skeletal corpuscles of Lithistidæ are figured by Perceval Wright‡ from the Chalk of Ireland, and by Rutot§ from the Eocene sands of Brussels. Lastly, in a memoir on the fossil sponge-genus *Pharettospongia*, W. J. Sollas|| states that the genera *Siphonia* and *Polypothechia* belong to the Lithistidæ.

I have now occupied myself for more than two years almost exclusively with the study of fossil sponges, and have already, at the annual meeting of the German Geological Society at Jena in the autumn of 1876¶, and also at the fiftieth meeting

* 'Grundzüge einer Spongienfauna des atlant. Gebietes,' 1870, p. 24.

† Ann. & Mag. Nat. Hist. ser. 4, vol. vii. p. 112.

‡ Rep. Belf. Nat. Field Club, 1873-74, Append. pl. ii. figs. 16-18, pl. iii. figs. 2, 3, 8-10.

§ Ann. Soc. Malac. Belg. tome ix. pl. iii. figs. 9-11, 22-26, 43, 45, 46.

|| Quart. Journ. Geol. Soc. vol. xxxiii. (1877) p. 252.

¶ Zeitschr. deutsch. geol. Gesellsch. Bd. xxviii. p. 631.

of German naturalists at Munich in September 1877*, made communications upon the organization, microstructure, and geological distribution of the fossil Hexactinellidæ and Lithistidæ, and illustrated them by the exhibition of microscopic preparations and numerous drawings.

This, so far as I know, is all that has hitherto been published about the occurrence of fossil Lithistidæ. The literature of the living representatives of this group is also of but small compass. The first forms belonging to it were described by Johnson †, Gray ‡, Bowerbank §, and Bocage ||, but, notwithstanding the peculiarity of their structural characters, were not separated from the other marine sponges with a vitreous (siliceo-fibrous) skeleton. It was only in the year 1870 that the examination of several species, newly discovered in the Atlantic Ocean, led Oscar Schmidt ¶ to establish a distinct order of Lithistidæ. Oscar Schmidt characterizes as Lithistidæ (*l. c.* p. 21) "the sponges with coherent siliceous tissue, the spicules of which do not grow in accordance with the triaxial type, but form an apparently quite irregular complication. In this, generally, a centrifugal and a concentric primary direction is recognizable, which, however, does not express the influence of a dominant spicular type, but adaptation to the general conditions of currents. Although their sarcode possesses properties which approximate them, to some extent, to the Hexactinellidæ, and, with these, probably to the fossil sponges, they approach very closely to the (other) living sponges in the canal-system, which is very indistinct in the former group. In external form there is no agreement within the family; but cup- and bowl-shaped species abound."

What this character wants in sharpness and definiteness is supplied by the careful descriptions and figures of eight species, which O. Schmidt distributes between the three genera *Leiodermatium*, *Corallistes*, and *Lyidium*.

H. J. Carter has published a complete summary and critical discussion of all the Lithistidæ known up to the year 1873**. In this admirable memoir the characters of the Lithistidæ are established more clearly than by O. Schmidt, and the whole group is characterized as follows:—"Spicules developed upon

* Amtl. Ber. über d. 50. Versamml. deutsch. Naturf. und Aerzte in München, 1877, p. 161.

† Proc. Zool. Soc. Lond. 1863, p. 257.

‡ Ibid. 1859, p. 437, pls. xv., xvi.; 1867, p. 507; 1868, p. 565.

§ Ibid. 1869, pp. 66-100, pls. 3-6, and p. 323.

|| Journ. Sci. Math. Phys. et Nat. Lisb. 1869, no. iv.

¶ Grundz. Spong. atlant. Geb. 1870, p. 21.

** Ann. & Mag. Nat. Hist. ser. 4, vol. xii. (1873) pp. 349-373, 437-472.

a quadri- or radiate division of the central canal, held together by amorphous sarcode and an interlocking of their filigreed arms, forming a reticulated glassy structure, whose interspaces are more or less irregular and curvilinear. Composed of two kinds of 'skeleton-spicules,' viz. those which form a layer on the surface and are accompanied by minute or 'flesh-spicules' characterizing the species, and those forming the body, which are more or less alike in all the species and accompanied by fewer flesh-spicules. The skeleton-spicules of the surface, which, for the most part, are provided with a smooth, pointed, vertical shaft, directed inwards, and a horizontal head of different shape according to the species, will be termed 'surface-;' and the spicules of the body, which interlock with their neighbours through a filigreed development of all the arms, will be termed 'body-spicules.'"

Several deep-sea Lithistidæ, dredged up in the Atlantic Ocean by Prof. Wyville Thomson on board the 'Porcupine,' have since been submitted by Carter to an accurate analysis*.

A. Pomel, in his great work † on the fossil sponges of Oran (pls. A, B, & E), also gives figures of several living Lithistidæ. Unfortunately, however, an accurate description of the minutest structural characters is wanting to the genera *Cisselia*, *Ægophymia*, and *Pumicia* of Pomel; so that it can hardly be decided with certainty whether these agree with already known forms, or whether they are to be regarded as new genera or species.

External Form.

The external appearance of the Lithistidæ is exceedingly various, and even within the same genus is by no means constant. From the solid stony nature of the skeleton, we might have expected a greater constancy of form than in other sponges; but, notwithstanding this circumstance, we may apply to the Lithistidæ also the principle that the general form only plays a secondary part in the classification of the sponges, and can never be available for the characterization of orders or families.

The Lithistidæ most frequently imitate the forms of basins, cups, leaves, tops, and cylinders, but globular, pyriform, nodular, and amorphous bodies not unfrequently occur, whilst branched and bushy stocks are met with only in a few genera. They are generally adherent. In many the lower part of the sponge-body is developed into a longer or shorter stalk, which

* Ann. & Mag. Nat. Hist. ser. 4, vol. xviii. (1876) pp. 460-468.

† Paléontologie de l'Oran, 1873.

is furnished with root-like processes at the extremity; others are attached to their support by a broad base, or may even, under certain circumstances, live as parasitic crusts upon foreign bodies; and only a few (*Aulocopium*, *Plinthosella*, *Spongodiscus*) appear to be destitute of any point of attachment.

From the Hexactinellidæ the Lithistidæ in general differ by their much thicker walls and by the denser texture of the siliceous skeleton. Thin-walled tubes, or mæandrically contorted delicate laminæ, such as are not unfrequently observed among the Hexactinellidæ (*Euplectella*, *Eurete*, *Plocoscyphia*, *Myliusia*), never occur among the Lithistidæ. The sponge-body consists of a compact stony mass of great solidity, which, when examined macroscopically reminds one rather of the structure of certain corals and Hydromedusæ with highly developed cœnenchyma than of that of the ordinary sponges.

The presence or absence of one or of several stomachal cavities has essential influence upon the external appearance. If a single central infundibuliform or tubular body-cavity sinks into a sponge-body of cylindrical, conical, globular, or pyriform shape, there can be no doubt as to the monozoic character of the latter. The genera *Aulocopium*, *Melonella*, *Cylindrophyma*, *Cœlocorypha*, *Scytalia*, *Pachinion*, *Siphonia*, *Trachysycon*, *Phymatella*, *Theonella*, *Discodermia*, *Isoraphinia*, &c. are in this case.

With equal certainty we may regard as polyzoic stocks those forms in which isolated large oscula with corresponding canal-depressions are distributed at considerable distances upon a nodular or ramified body, as, for example, in the genera *Astrobolia* and *Astrocladia*.

A phenomenon very characteristic of certain fossil Lithistidæ is the replacement of a simple stomachal cavity by a greater or less number of *vertical tubes*, sometimes grouped in bundles, sometimes arranged in series, sometimes irregularly distributed, penetrating the skeletal mass of the sponge-body in a perpendicular or nearly perpendicular direction, and usually reaching down to the base. These tubes are generally round, unramified, like quills, and nearly of the same diameter throughout their length, whilst the true stomachal cavities are always more or less narrowed downwards. Their orifices are situated in the vertex or at the upper margin of the sponge-body, which in most cases possesses a cylindrical, branched, or elongate-pyriform shape. In this group of Lithistidæ the question of their monozoic or polyzoic nature is difficult of solution. Their canal-system presents exactly the same characters as in the monozoic forms of the first

group; and where reproduction takes place by gemmation, each branch possesses the same number of tubes as the parent body. If, therefore, we are to regard each of the above-described tubes as a separate stomachal cavity (as we are justified in doing, seeing that they undoubtedly serve as efferent canals), the sponges belonging to this category present examples of "syndesmotie" forms, in which each "person" is capable of existing only in conjunction with several others. The genera *Jerea*, *Thecosiphonia*, *Polyjerea*, *Marginospongia*, *Stichophyma*, *Jereica*, *Turonia*, *Doryderma*, *Carterella*, &c. serve as examples of this phenomenon.

The question of individuality becomes still more difficult in the cup-shaped and vase-shaped sponges. In these the wall encloses a central space which is very wide above and narrowed like a funnel below, the interpretation of which as a stomachal cavity is certainly open to doubt, although numerous similar radial canals of the same structure and direction open into it. In many cases the oscula of these radial canals attain a considerable size, and receive, on their own account, the access of special lateral canals; so that they themselves play the part of flues or stomachal cavities, and the whole sponge-body, like that of the common sponge, may be conveniently regarded as a composite stock. As, however, young stocks possess the same cup-shaped or vase-like form as the full-grown ones, as, further, the development of one of the above-described oscula into a distinct stock resembling the parent body has never been observed, and as these secondary stomachal cavities at the same time also act as radial canals of the whole colony, I leave the question of individuality undecided, characterize such "strobiloid stocks" as simple sponge-bodies, and place them in opposition to the "composite" ones, in which, by gemmation in various ways, several such strobiloid individuals of concordant habit are united into a colony. Here, therefore, as among the Hexactinellidæ, we probably have polyzoic forms which in their external appearance resemble a single individual, and, in a certain sense, are equivalent thereto. This conception finds further support in the fact that sometimes in one and the same genus the central cavity decreases in dimensions and becomes gradually converted into a wider or narrower funnel, the interpretation of which as a stomach can hardly be doubtful. In the case of the funnel-shaped and vase-shaped forms, moreover, one is always in face of the dilemma, whether the central space is to be regarded as the common efferent orifice, and the canal-system is to be conceived as a unitary and coherent system, or whether each large osculum, with the canal belonging to it,

acts as a separate stomachal cavity. In favour of the latter assumption we have the fact that sometimes, in one and the same genus, together with cup-shaped species, there occur flat forms without any central cavity, in which the canals furnished with oscula manifestly serve as stomachal cavities. From such examples it may be seen that in the Lithistidæ, as in all sponges, the limitation of the individual is very uncertain and incomplete, and therefore can only be employed with caution in classification.

To the doubtful types of cup-shaped form (in which the question of individuality may be decided in either sense, according as we regard the sponge-body as a strobiloid stock or a simple person) the following genera belong:—*Verruculina*, *Amphithelion*, *Epistomella*, *Leiodorella*, *Hyalotragos*, *Azorica*, *Macandrewia*, *Corallistes*, *Leiodermatium*, *Callopegma*, &c.

If the presence of a simple stomachal cavity appears doubtful even in the vasiform Lithistidæ, it is certainly entirely wanting in a number of laminar, nodular, or disciform Lithistidæ, in which one or both surfaces are furnished only with small orifices, or even only with fine pores, from which fine canals penetrate more or less deeply into the sponge-body. These pores perform exactly the same part as the oscula in the preceding group, and may consequently be regarded either as the stomachal cavities of distinct individuals of a polyzoic stock, or as the mouths of canals of a simple irregular-shaped sponge-body. To this category we may refer the genera *Chonella*, *Seliscothion*, *Chenendopora*, *Ragadinia*, &c.

Finally, in a last group of Lithistidæ complete astomism prevails. The whole sponge-body consists of a loose, uniform tissue of skeletal elements, in the interspaces of which the circulation of water takes place without the aid of canals or stomachal cavities. The fossil genera *Platychonia*, *Lecanella*, *Bolidium*, *Mastusia*, and *Spongodiscus* furnish examples of this kind among the Lithistidæ.

Canal-system.

The water-circulatory system in the Lithistidæ presents greater variation than in the Hexactinellidæ, and even exceeds in multifariousness that of the Calcispongiæ. From the compact and thick-walled nature of most Lithistid skeletons, the conduction of water could generally be effected only by the formation of definite passages which remained free from skeletal elements. Then, as the latter were deposited around these constant aquiferous tubes, there was produced finally a regular lapidification of the canal-system, which enables us in

the Lithistidæ to study the canal-system in macerated or fossil skeletons with as much certainty as in fresh specimens.

Six different modifications of the water-circulation may be distinguished in the Lithistidæ :—

1. A special canal-system is entirely deficient.
2. From one or both surfaces, finer or coarser, arched and frequently ramified canals penetrate, to a greater or less depth, into the wall.
3. Simple or branched, more or less curved canals run in a nearly horizontal direction from without inwards, and terminate in the stomachal cavity, whilst a second system of similar radial canals traverses the wall in a centrifugal direction and opens at the surface.
4. Simple, straight, often capillary radial canals traverse the wall in a centrifugal direction from within outwards; besides these there is sometimes a second system of curved canals running more or less parallel to the outer surface, and opening into the stomachal cavity.
5. The sponge-body is traversed by vertical tubes, to which radial canals are frequently superadded.
6. The whole wall consists more or less distinctly of perpendicular skeletal lamellæ or wedge-shaped segments, between which the water-circulation takes places in a radial direction.

The first and simplest case, that of the complete deficiency of a true canal-system, occurs only in a few genera of globular, disciform, or nodular form (*Spongodiscus*, *Lecanella*, *Platychoxia*, *Bolidium*, *Mastostia*). In these the entire water-circulation takes place solely through the larger or smaller interspaces of the skeletal substance. On the surface there are no large oscula; and in these forms there is also never a stomachal cavity: either the surface presents exactly the same structure as all the rest of the sponge-body (*Spongodiscus*), or the substance of the skeleton becomes a little condensed and leaves only fine roundish pores (*Bolidium*, *Mastostia*).

From this simplest arrangement we find all intermediate steps to the second modification, in which the surface is covered with larger or smaller orifices, from which more or less curved canals penetrate into the interior of the wall. In the external form of these Lithistidæ the cup, vase, basin, or laminar form prevails. In certain genera (*Chonella*) the orifices are scarcely $\frac{1}{2}$ –1 millim. in diameter, like pores, and corresponding to this the canals also are fine and but slightly developed. The laminiform or cup-shaped sponge-bodies also therefore possess no distinct stomachal cavities, unless the wide central space

of the cup is to be regarded in this light. Sometimes both surfaces are similarly constructed, and the canals penetrate from both sides into the skeleton, either as simple, at first somewhat curved, tubules, or dividing as they pass inwards into two or three branches. Such an abundant ramification as Hæckel has described in the *Leucones* I have never observed in the *Lithistidæ*. Penetrating canals, traversing the whole thickness of the wall, are also deficient in the whole of the second group; but there are certainly cases in which the canals only terminate immediately beneath the opposite surface (*Chenendopora*).

The two canal-systems, running in opposite directions, are not always equally developed. Very frequently one surface bears oscula, measuring 4–5 millims. or still more, and either depressed (*Hyalotragos*, *Chenendopora*) or prominent and margined (*Verruculina*, *Epistomella*, *Macandrewia*, *Azorica*), while the other is merely covered with fine pores. The one system is then reduced to a capillary net, whilst the other principally provides for the efflux (and perhaps also the influx) of water. In general, in the cup-shaped sponge-bodies, the larger oscula are situated on the inner surface (*Verruculina*, *Corallistes*, *Macandrewia*); but the contrary case may also be met with (*Leiodermatium*). If both surfaces are beset with larger oscula (*Leiodorella*, *Amphithelion*), a conclusion may be arrived at from the size of the orifices as to the development of the canal-system.

The third modification of the canal-system appears only in genera with a well-developed stomachal cavity of cylindrical, trochiform, or some similar shape. If we regard the wall of the stomach as the inner surface of a cup-shaped sponge-body, all that has been said as to the course of the canal-system of the preceding group applies also to the present one. The ostia of the radial canals opening towards the stomachal cavity are distributed either in series or quite irregularly. The canals penetrating from them into the wall are curved in a somewhat undulated manner, rarely straight; towards the outside they gradually diminish in size, at the same time sometimes forking into a few branches. Similar canals originate in the interior of the wall, and take their course in a radial direction outwards, where they open at the surface in larger or smaller ostia. The genera *Cylindrophyma*, *Phymatella*, *Calymmatina*, *Megalithista*, &c. possess a canal-system of this kind.

In a fourth group of globular, pyriform, top-shaped, or cylindrical sponge-bodies, usually with a narrow central cavity, straight (sometimes capillary) canals run in a horizontal

or oblique direction from the centre towards the periphery and open at the surface as fine pores. These canals exist in great number and are pressed close together and never ramified; they give the sponge a fibroid structure in transverse or longitudinal sections. Frequently the canal-system of the preceding group is combined with these radiating radial canals. As typical genera of this kind may be mentioned *Cœlocorypha*, *Scytalia*, and *Pachinion*.

The canal-system becomes rather more complicated in the fifth group, to which *Aulocopium*, *Siphonia*, and some allied genera belong. In these, curved canals of considerable size, which are at first parallel to the periphery, but become almost perpendicular towards the middle, open into the funnel-shaped stomachal cavity. Besides these bowed canals, simple, straight, radial canals of the same or smaller size run in an oblique direction from within outwards: their number is in inverse proportion to their diameter; so that in forms with thick radial canals (*Siphonia*, *Melonella*) comparatively few are present, whilst sometimes (*e. g.* in certain *Aulocopia*), by their capillary nature and closely approximated position, they almost give rise to the appearance of a fibrous structure. This modification of the canal-system has already been admirably figured by F. Roemer* in the genus *Aulocopium*, by Quenstedt† in *Melonella*, and by Sowerby‡ in *Siphonia*.

A very characteristic form of canals in the Lithistidæ are the vertical tubes, which have already (p. 117) been described. These frequently appear to replace the central cavity (*Jerea*, *Jereica*, *Stichophyma*, *Carterella*). They are either collected into bundles, or are more isolated and traverse the whole length of the sponge-body in the form of round tubes; in ramified stocks the principal stem and all the lateral branches are penetrated by such tubes. Their walls are usually furnished with pores, the apertures of fine radial canals. If the skeleton is of very loose texture and the vertical tubes are closely approximated, the latter may acquire a polygonal section, when they are generally separated from each other by thin walls (*Hyalotragos*, *Pyrgochoonia*). Radial canals of the most various kinds may be combined with these tubular canals.

A last type of canal-system seems to occur, so far as I know, only in a few Lithistidæ. In these the entire, usually

* Die fossile Fauna der silurischen Diluvialgeschiebe von Sadewitz, Taf. ii. fig. 1^a, 2^b, 3^b, and Taf. iii. fig. 1^b, 2^b.

† Petrefactenkunde Deutschlands, v., Taf. 126. figs. 61, 62, 63.

‡ Fitton, "Strata below the Chalk," Geol. Trans. ser. 2, vol. iv. pl. xv^a. figs. 4-7.

thick wall of the cup-shaped, basin-shaped, top-shaped, or cylindrical sponge-body consists of vertical laminæ of small thickness, or of wedge-shaped segments, separated from each other by perpendicular clefts, which are either simple or divided towards the outside. By this means the whole sponge acquires a decidedly radiate structure, and in many cases reminds one of the calice of a coral with numerous radiating septa. The vertical clefts are bridged over at certain regular distances by skeletal layers, which consequently divide each cleft into a complete system of parallel radial canals standing one above the other. The latter penetrate the wall and open at the outer surface and on the wall of the central cavity in rounded or irregular pores. Striking examples of this form of the canal-system are furnished by the genera *Cnemidias-trum*, *Corallidium*, and *Seliscotho*.

Finally it may be mentioned that very frequently, at the surface where the growth of the sponge takes place, therefore especially at the vertex, the canals in course of formation appear as radiating furrows of very various nature, and up to a certain point indicate the course of the canal-system in the whole sponge-body.

Condition of the Skeleton and State of Preservation.

The skeleton of the Lithistidæ is remarkable for its stony, solid texture. The sarcode sinks into the background relatively to the siliceous deposits, and in living forms exists only in comparatively small quantity. As, moreover, the walls (or indeed the whole sponge-body) are of considerable thickness and usually traversed only by comparatively fine canals, the Lithistidæ must be reckoned among the most persistent and resistant of sponges. It is true that the small skeletal elements do not fuse together, as in the Hexactinellidæ, to form a coherent framework; but they are so closely interlocked that even after the death of the animal they do not fall asunder, so as to be scattered by the waves like the spicules of other siliceous sponges. This stony texture of the Lithistidæ specially adapts them for preservation in the strata of the earth; in fact a great proportion of the old Petrospongiæ belong to this group. Well-preserved skeletons, freed from matrix by muriatic acid, are scarcely distinguishable in their appearance and texture from the bodies of recent forms freshly macerated or newly taken from the sea.

There are certain localities, especially in the Upper Cretaceous of North Germany (Ahltens, Lemförde, and Linden in Hanover; Vordorf and Biewende in Brunswick; Coesfeld, Legden, and Darup in Westphalia), where the fossil Lithis-

tidæ are to be obtained almost unaltered. We have merely to treat the fragments of rock with dilute muriatic acid to have before us in a short time the whole skeleton in perfect beauty. In the White Chalk of England and France, also, Lithistidæ, especially of the genus *Siphonia* (*Choanites*), sometimes occur which show the skeletal elements in excellent preservation enclosed in a crust of flint; but in these the canal-system is filled with a mealy siliceous substance, which cannot be removed by treatment with acid.

The above-mentioned skeletons behave, when examined microscopically, exactly like recent Lithistidæ. They possess the same optical properties as the latter in Canada balsam, resins, and glycerine. But this favourable state of preservation only occurs rarely.

In England the White Chalk of Flamborough Head appears to furnish the most numerous Lithistidæ; but although these specimens, after treatment with muriatic acid, show all the external characters of the sponge-body, and especially the canal-system, in wonderful beauty, they are but little adapted to microscopic examination. The individual skeletal elements, which are usually united to form fibres, are almost always soldered together by an accession of silica, more or less converted into crystalline silica, and so much altered that we can only exceptionally succeed in determining their original form. Certain specimens from the Coral Rag of Nattheim, and the Upper Jurassic strata of Muggendorf and Amberg, in the Franconian Jura, also behave in the same way.

A different process of silicification has taken place in most of the Lithistidæ from the Middle and Upper Cretaceous of France (Touraine, Normandy), as also in many from the North-German Cretaceous. In these the skeleton is certainly often well preserved; but flint has penetrated into all its interstices, so that it is useless to think of isolating its individual parts. Examination with a good power under the microscope leads most quickly to a determination in such cases; but for a more thorough investigation thin sections must be prepared. Under certain circumstances, however, fine translucent chips will suffice.

In Brunswick (near Boimtsdorf and Gliesmarode) Lithistidæ, preserved in the above manner and penetrated with flint, occur in great abundance in a derivative deposit (Diluvium). The skeleton is often of a dark colour and here and there somewhat decomposed, but in the main well preserved and capable of being shown in thin slices. Most of the Cretaceous sponges of Touraine present similar characters. In the latter, however, the process of decomposition has not unfrequently

gone further: in thin sections we observe only isolated well-preserved skeletal elements, between which lie an immense number of blackish or reddish-brown spherules (probably of hydrated peroxide of iron), which are sometimes quite irregularly dispersed, but sometimes have undoubtedly got into and completely fill the empty forms of previously existing skeletal elements which have been washed out.

In the English White Chalk and also in the neighbourhood of Rouen, amorphous flint-nodules occur in great quantities, from which, when split, beautifully preserved sponges are frequently set free. The sponge-body is enveloped by a white porous crust of decomposed flint. Between this and the sponge there is usually a thin layer of snow-white siliceous dust, in which there are numerous well-preserved sponge-spicules. The sponge-body itself either exhibits the state of preservation already described in the case of the *Lithistidæ* of Flamborough Head, or, still more frequently, its interior is completely filled with a homogeneous mass of flint, in which all sponge-structure is destroyed; in thin slices it appears as a homogeneous amorphous substance. The surface of the sponge, however, as well as all the parts covered with white siliceous powder, are generally excellently preserved, and are particularly well adapted for examination by direct light.

A less favourable state of preservation of the silicified *Lithistidæ* is that in which the original skeletal elements have been dissolved and carried off, and are now replaced by cavities in the siliceous mass, furnishing a more or less true negative picture of the skeleton which formerly existed there. Numerous specimens from Touraine, from the White Chalk of England, from the Greensand of Regensburg, and the Coral Rag of Nattheim, Gingen, Muggendorf, and Amberg show this phenomenon.

Similar "negative" skeletons, not, however, enveloped in flint but in phosphatic glauconitic calcareous sand, occur in the Upper Cretaceous of Saratow in Russia, where the cavities are also sometimes filled with brown ironstone. I have already called attention to this state of preservation (which also occurs in the *Hexactinellidæ*), in the first section of these "Studies."

Lithistidæ in which the original siliceous skeleton is replaced by rust-coloured hydrated peroxide of iron occur very frequently in the *Mucronatus*- and *Quadratus*-chalk of Schwiechelt, Peine, and Vordorf in Brunswick, sometimes near Ahlten in Hanover, in the White Chalk of France, also in the North-German, Bohemian, and Saxon Pläner, and frequently in the Franco-Swabian Jura.

Lastly, we have still to mention the calcified lithistid skele-

tons. Even in the specimens from the celebrated sponge-locality of Sutmerberg near Goslar, most of the siliceous skeletons of *Lithistidæ* show the commencement of a pseudomorphosis. If they are placed in dilute muriatic acid, a portion of the sponge-body is sometimes dissolved, and, indeed, generally the surface and the parts nearest to the surface. The rest of the skeleton consists of silica; in fact, the interior is not unfrequently thoroughly impregnated with flint.

If these siliceous parts of the skeleton be more closely examined, they generally show a dull corroded surface, and the finer adornments of the small skeletal corpuscles have for the most part disappeared. Optically they differ from living and other Cretaceous *Lithistidæ* in that they possess nearly the same refractive power as Canada balsam, and therefore must be examined in glycerine, oil, water, or some such medium. A similar behaviour is shown by the *Lithistidæ* from certain Upper-Jurassic localities in the Franco-Swabian Jura (Schauergraben, near Streitberg, Uetzing in Franconia, Sozenhausen, Pappelan, and Sontheim in Württemberg) and in the Cracow district (Wodna, Kobilany, Luszowice); only here, as a rule, the calcification has advanced much further than at the Sutmerberg, so that during treatment with acid large portions of the sponge-body are destroyed. The remaining parts behave optically in the same way as the *Hexactinellidæ* occurring in the same locality*.

In general the pseudomorphosis of the Upper-Jurassic *Lithistidæ* is not confined to particular parts of the sponge-body, but the whole skeleton is usually converted throughout into calc-spar. In such forms the interspaces between the skeletal particles and the canals are without exception filled with stone, and, indeed, usually with limestone. In the Franco-Swabian Spongitenkalk of the White Jura β , γ , and δ , most of the *Lithistidæ* are completely calcified, and it is only now and then that a few siliceous skeletal corpuscles are obtained in the residue after treatment with acid. The same state of preservation is shown by the *Lithistidæ* from the upper and lower Spongitenkalk of Switzerland (Baden and Binnensdorf beds) and of the French Jura, the valley of the Rhone, the Cevennes, and the neighbourhood of Niort. In the Pläner of Saxony and Bohemia also the calcified skeletons predominate. I have already attempted to give an explanation of this remarkable phenomenon in the first section of these "Studies" ('Annals,' October 1877, p. 266).

It is remarkable that, in the pseudomorphosis of an origi-

* See the first section, 'Annals,' Oct. 1877, pp. 262, 263.

nally siliceous skeleton into calc-spar, in general no considerable change takes place in the form of the small skeletal parts. For example, if we cut a *Cnemidiastrum* or a *Hyalotragos* from the Swabian Jura at any point and examine the cut surface with the lens or under the microscope by direct light, the somewhat dark-coloured skeletal corpuscles, consisting of calc-spar, stand out sharply from the lighter rock-mass which has penetrated the sponge, and the structure may thus be recognized without further preparation. With a little practice mere examination with the lens, or, under certain circumstances, even with the naked eye, will suffice for the immediate recognition of the different genera of Hexactinellidæ and Lithistidæ.

Carter distinguishes three kinds of characteristic siliceous structures in the skeleton of the Lithistidæ:—

1. The true "skeleton-spicules" interwoven by means of sarcode and of thin filigree-branched ends;

2. The "surface-spicules," which are generally furnished with a vertical shaft; and

3. The so-called "flesh-spicules," uniaxial siliceous corpuscles, usually of small size, which lie freely in the sarcode, generally in the greatest abundance at the surface of the sponge-body, but also occur more or less frequently in the interior.

Of these three constituents, the small "flesh-spicules"* are deficient in all fossil Lithistidæ: but even in living specimens they can only be observed when the skeletons are still furnished with their sarcode coating; when the latter has been removed by decomposition, these minute corpuscles disappear with it.

According to the recent investigations of Sollas, the flesh-spicules are rapidly destroyed by alkalies; and therefore they could not long resist the process of fossilization.

Leaving out of consideration these little flesh-spicules, many Lithistidæ are further provided with large uniaxial bacillar spicules or cylinders, which also lie in great quantities at the surface or in the canals, and sometimes form a complete spicular coat. These large bacillar spicules appear, in certain fossil Lithistidæ, to replace the anchor-shaped surface-spicules, and may therefore be more particularly considered hereafter with them.

The denomination *spicules* does not apply very well to the

* Good figures of these little flesh-spicules are to be found in Bowerbank's "Monograph of the Siliceous Sponges," P. Z. S. 1869, pl. v. figs. 7 & 8, pl. vi. figs. 8 & 10-14, and pl. xxiii. fig. 6.

essentially skeleton-forming elements of the *Lithistidæ*, which constitute the principal mass of the sponge-body. These corpuscles are very seldom truly spicular in their form; they are never simple, straight, and pointed at one or both ends; but they are always composite, more or less branched corpuscles, and usually furnished with root-like appendages, which present but little resemblance to the siliceous skeletal elements of other sponges. I therefore regard it as inadmissible to speak of "skeleton-spicules" in the *Lithistidæ*, and will adopt the name of "skeletal elements" or "skeletal corpuscles" for them.

On the whole, a great uniformity prevails among the *Lithistidæ* with regard to the form of their skeletal corpuscles; so that it is only exceptionally that they suffice by themselves for the characterization of a genus.

In the most strongly marked and probably also highest *Lithistidæ*, almost all the constituents of the skeleton, both the true skeletal corpuscles and the surface-spicules, are quadriradiate, which, however, does not prevent one of the four rays being developed differently from the other three. I denominate this group TETRACLADINA. If we place any fragment of the skeleton of a *Phymatella*, *Siphonia*, *Callopegma*, *Aulaxinia*, *Turonina*, *Jerea*, &c. under the microscope, it is seen to be composed entirely of quadriradiate corpuscles similar in form and also agreeing pretty closely in size (Pl. VIII. fig. 1). All the four arms, of equal length, meet in the centre at angles of 120° ; they are usually smooth, rarely beset with verruciform excrescences, and divided at the ends turned away from the centre into a few short branches, which again may be in turn beset with root-like processes. According as the four arms divide first of all into two or more thick branches, and these again into finer ramifications, or even into short fibres, there are produced at the ends pad-like dilatations composed of small root-like fibres. When well preserved, we may recognize in the interior of these siliceous corpuscles a quadriradiate cross of canals which represent the axes of an equilateral pyramid. The four canals meeting at the centre at 120° are often but short; they either cease before the first furcation of the arms, or divide by bifurcation and pass for a short distance into the two main branches, without, however, reaching the root-like processes. These canals are usually of capillary fineness; but sometimes they are considerably enlarged, probably by chemical action during the process of fossilization. In my memoir on *Cœloptychium** I have figured a number of such corpuscles

* Denkschr. bayr. Akad. Cl. ii. Bd. xii. Taf. vii. figs. 11-15, 20-23, 28, 32, 33.

from the internal skeleton of various Lithistid genera. Among existing Lithistidæ the genera *Kaliapsis*, *Discodermia*, *Rhacodiscula*, and *Theonella* approach the above-mentioned fossil forms.

The union of these corpuscles is effected as follows:—The dilated and ramified extremities of two or more arms of neighbouring quadriradiates come close together, whereby their root-like processes are so closely interlocked that the skeleton cannot easily break up into its individual particles.

In the genera *Spongodiscus* and *Plinthosella* the more or less regularly quadriradiate skeletal corpuscles are remarkable for their knotty structure and the slight branching of their arms. Almost the whole surface of these quadriradiates is beset with blunt, warty excrescences; one of the four arms is sometimes abbreviated, and their ends are somewhat thickened. The axial cross in the interior consists of four short, capillary canals, which may be much enlarged by subsequent influences*. The union of these warty quadriradiates is effected by the ends of neighbouring arms being brought close together, so that an apparently connected, coarsely fibrous skeleton is produced. In general, in the Lithistidæ, the whole sponge-body (leaving out of consideration the surface-spicules) consists of similar skeletal elements, so that it is a matter of indifference from what part of them a sample is taken for microscopic examination. In some Tetracladina, however (*Siphonia*, *Phymatella*, *Aulaxinia*), the base is distinguished from the upper, true sponge-body by a different microstructure. In these the normal quadriradiates, furnished with strongly furcate arms, become gradually more irregular below, and are in part converted into elongated siliceous fibres ramously forked at the ends and also furnished with lateral processes. Between the elongated fibres there are a number of shorter branched skeletal corpuscles, which on the whole may be recognized as irregular quadriradiates (Pl. VIII. fig. 2). It is a remarkable circumstance that the root-elements, which are longitudinally distorted, do not possess four axial canals, but only a single and generally short central canal.

These last-mentioned root-elements serve to unite the Tetracladina with another section of Lithistidæ, which I group together under the denomination MEGAMORINA (μέγας, particle) on account of their unusually large and elongated skeletal elements.

In these the quadriradiate structure almost entirely disap-

* Figures of such quadriradiates are given in my monograph of the genus *Ceoleptychium*, pl. vii. figs. 16–20.

pears, or can only be exceptionally detected; but even in the latter case the four arms are always unequally developed and differently branched, and they do not meet in the centre at any definite angle. In certain genera, such as *Doryderma* (Pl. VIII. fig. 3), *Lyidium*, and *Heterostinia*, they are divided into several unequal branches, which again may fork into a few short and blunt lateral branchlets; in others, such as *Megalithista* (Pl. VIII. fig. 4) and *Carterella*, short branches originate at the ends of the elongated and curved skeletal corpuscles, diminish rapidly in thickness, and usually fork only once, or at the utmost twice. Besides these, short knobby processes spring from the main stem here and there. In the genus *Isorhaphinia* the skeletal corpuscles acquire nearly the form of simple, crooked, cylindrical spicules; but their thickened ends, often cleft into two short branches, prove them to be true Lithistid elements.

All Megamorina possess a simple axial canal, which sometimes traverses nearly the whole length of the main stem (fig. 4), but without ever making its appearance at the ends; but sometimes only forms a short capillary central canal in the middle of the branched skeletal corpuscle.

The skeletal corpuscles either compose alone the entire inner skeleton of the sponge-body (*Isorhaphinia*, *Doryderma*, *Lyidium*, *Megalithista*), or they are accompanied by much smaller, strongly ramified siliceous elements (*Heterostinia*), which in their general characters agree with those of the next group. The union of the large Megamorine corpuscles is effected by the curved ramified ends applying themselves to neighbouring skeletal corpuscles, and, indeed, frequently completely embracing them.

A small group of Lithistidæ, hitherto known only in the fossil state, is characterized by its irregularly ramose skeletal corpuscles, the branches of which meet in a nodosely thickened centre (Pl. VIII. fig. 5). As the branches are only moderately ramified at the ends, a meshed network is produced, which in many cases shows a great resemblance to the latticed framework of certain Hexactinellidæ, and, indeed, may be confounded therewith upon a hasty examination. By the furcation of the 4-7 usually smooth arms, these sponges, which I have proposed to denominate ANOMOCLADINA, are proved to be true Lithistidæ. The genera *Cylindrophyma*, *Melonella*, *Lecanella*, and *Mastusia* are the representatives of this group, from which, possibly, the Tetracladina have been developed.

In the great majority of the Lithistidæ the skeleton consists neither of these Anomocladine corpuscles, nor of distinct quadri-radiates, nor of large, feebly ramified Megamorine ele-

ments, but of elegant and sometimes minute siliceous corpuscles, which are remarkable for their irregularly branched, many-pointed form (fig. 6). The slender, curved branches are either similarly developed, or one of them appears as the main stem in consequence of its greater length and strength, and from it the others are given off as secondary branches. The main stem and the branches are always set with root-like or wart-like simple or forked lateral processes. These filigreed corpuscles, from which I name this group RHIZOMORINA, not unfrequently fork into four principal arms, and then remind one of the Tetracladina; but it is very rarely that the four branches meet together at angles of 120° . In general, it may be said that no general law can be established for the Rhizomorina with respect to their ramification; they are irregularly formed, and show a definite typical form only within the same genus and species.

The presence of an axial canal is generally difficult to ascertain, as the round, toothed branches usually appear quite solid by transmitted light. But with favourable preservation and illumination I have been able to observe an axial canal in both recent and fossil Rhizomorina. In the Jurassic forms *Hyalotragos* (Pl. VIII. fig. 6), *Platychonia*, and *Cnemidiastrum* there is in the main stem a short, straight, simple axial canal closed at both ends; in the Cretaceous and recent Rhizomorina the wide, indistinctly limited axial canal, which sometimes shines through like a somewhat brownish nuclear stripe, follows the course of the main stem, and usually also sends ramifications into the larger branches, the smaller branches and the root-like processes being perfectly solid. O. Schmidt has figured such axial canals in *Corallistes microtuberculatus* (l. c. pl. iii. fig. 4) and *Corallistes typus* (l. c. pl. iii. fig. 3). Among the fossil Lithistidae the genera *Seliscothos*, *Chonella*, *Verruculina*, &c. show the axial canals distinctly.

In the arrangement and union of these little toothed skeletal elements great variety prevails. Sometimes the fine processes of neighbouring corpuscles interlock to form a loose confused tissue, which, when treated with acid, either breaks up into its constituent particles, or sometimes remains loosely connected; or they group themselves close together and form anastomosing or parallel fibre-like bands, in which the particles, which are generally deposited in definite directions, are very intimately interlocked by their branches and root-like processes.

In the isolated siliceous structures which lie partly at the surface and in part scattered in the skeleton, and which are denominated "surface-spicules" and "flesh-spicules," greater

variety prevails than among the true skeletal elements. They are either *uniaxial* or *quadriaxial* siliceous structures.

The former present no peculiarities worth notice. Bacillar spicules from 0.5 to 10 and 20 millims. in length may be observed in the most various modifications. They are usually spindle-shaped and pointed at both ends, sometimes blunt at one end and pointed at the other, or rounded off at both ends. Most frequently they are straight; but curved, S-shaped, and sometimes even undulated spicules occur. Their surface is smooth, rarely spinous. In an undescribed recent species, which I have received from Dr. W. Marshall, there are undulated spicules which are furnished at regular intervals with pointed frill-like processes, and in their habit resemble the form of spicule figured by Bowerbank in the Mon. Brit. Sp. pl. i. fig. 14.

The spicules of the quadriaxial type, to which it would be better to give Carter's name "trifid" or "ternate," are much more multifarious in form, as one axis is always differently developed from the rest and appears sometimes as a long shaft, sometimes as a short style, and sometimes only as a button-like thickening. Apparently perfect equality of the four rays never or extremely seldom occurs in the Lithistidae. At least, I have never observed the so-called *chevaux de frise* either in living or in fossil forms.

Most frequently we find anchors with long simple shafts, diminishing towards the free end. The three prongs at the opposite end are rarely simple, and are then usually short (patento-ternate, recurvo-ternate, expando-ternate, incurvo-porrecto-ternate spicules, &c. of Bowerbank, *l. c.* figs. 45-54, 128, 129); but generally they divide again into two (rarely more) prongs, forming so-called double anchors (bifurcated expando-ternate spicules, Bowerbank, *l. c.* pl. v. fig. 130, and spiculated dichotomo-patento-ternate spicules, fig. 53, &c.).

In the simple anchors the three prongs either diverge obliquely outwards at equal angles or they are bent back. This is the case also in the forked anchors; but in these the three furcate prongs more frequently lie in the same plane, starting at right angles from the shaft, or their ends may even bend a little backwards. In my monograph of the genus *Cœloptychium* I have figured (Taf. vi. figs. 3-30, and Taf. vii. figs. 1-10) many such anchor-shaped structures, presumably all derived from Lithistidae; so that any further description appears superfluous. Among these figures there are some (Taf. vii. figs. 9, 10) in which the arms of the forks are not smooth and straight, but furnished on the outside with branch-

ing excrescences. Similar furcate anchors beset with nodose warts also occur in some recent Lithistidae (such as *Coralistes nolitangere*, fig. 7, c.)

A remarkable modification of the furcate anchor with arms standing perpendicular to the shaft is to be observed in the genus *Theonella*. Here the shaft is reduced to a short, pointed style, the three arms are compressed from above, curved, and divided at the ends into two short branches (see Bowerbank, *l. c.* fig. 306, and Proc. Zool. Soc. 1869, pl. v. figs. 8, 9). In the fossil genus *Rhagadinia*, and in an undescribed recent *Rhacodiscula* kindly communicated to me by Mr. Carter, the shaft is still shorter, and the very broad compressed arms divide into two, three, or more irregular lobes. In the centre there is a very short quadriradiate axial cross. Surface-spicules of this kind are figured in my monograph of *Cœloptychium* (Taf. vii. figs. 25–27, 29, 30). Carter has described similar forms from the Greensand of Haldon, under the name of *Dactylocalycites Vicaryi**. If the shaft be reduced to a minute stylet, and the rays of the axial canal become still shorter, the depressed arms of the furcate anchor broader, and their lobate branches more numerous, structures are produced such as the short-stalked many-lobed siliceous disks represented in my monograph of *Cœloptychium* (Taf. vii. figs. 36, 37), or those figured by O. Schmidt (*l. c.* Taf. iii. fig. 8) as *Corallistes polydiscus*, Schm. (not Bocage), by Bowerbank (Mon. Brit. Sp. figs. 104–106) as “foliato-peltate spicules,” and by Carter (*l. c.* pl. vii. figs. 3, 4) as *Dactylocalycites polydiscus* from the Greensand of Haldon. Similar minute disks occur in *Kaliapsis*.

Close to these come the sometimes circular, sometimes oval siliceous disks of *Discodermia polydiscus*, Bocage (see Bowerbank, Proc. Zool. Soc. 1869, pl. vi. figs. 10, 11), in which there are in the centre a minute conical stylet and a short quadriradiate axial cross. Carter (*l. c.* pl. vii. fig. 5) has also found the same disks fossil; and with these may probably be ranged the large irregular and angular siliceous plates of the fossil genus *Plinthosella*.

In the neighbourhood of *Discodermia* we must possibly also place those elegant siliceous disks with highly-developed and repeatedly divided radial canals, and perforated at the margin, of which I have already figured several specimens (*Cœloptychium*, Taf. vi. figs. 32–35). Similar disks are described by Carter from the Greensand of Haldon (*l. c.* pl. ix. figs. 40–42).

* Ann. & Mag. Nat. Hist. ser. 4, vol. vii. (1871) pl. vii. figs. 1, 2.

If we now return to the simpler, short-stalked, furcate anchors with curved arms of *Theonella*, we find that these are approached by other more complicated forms. Thus the shaft is reduced to a short conical style, and the curved arms emit lateral branchlets, which, in their turn, are beset with root-like excrescences. Elegant structures are thus produced (see Bowerbank, Proc. Zool. Soc. 1869, pl. v. figs. 2-4, and pl. xxv. fig. 4), which in their appearance considerably approach the true skeletal corpuscles. This resemblance becomes still greater when the short shaft itself runs out at its extremity into filigreed processes (*Azorica Pfeifferæ*, Cart.).

In these last-mentioned "surface-spicules," their relation to the skeletal elements is quite indubitable; but there are many, especially fossil, Lithistidæ in which the siliceous corpuscles of the surface, although differing in size and ramification from those of the rest of the skeleton, can only be regarded as modified skeletal corpuscles, but cannot be referred back to an anchorlike structure (*Leiodermatium*, *Leiodorella*, *Verruculina*, *Amphithelion*, *Seliscothion*, *Chonella*, &c.). I regard such "surface-spicules" merely as young still undeveloped skeletal elements.

The arrangement of the anchor-shaped surface-spicules is almost invariably such that the shaft is turned inwards and the prongs outwards. In *Corallistes*, *Turonia*, *Callopegma*, *Calymmatina*, *Theonella*, &c. the double prongs of the anchors, which diverge in the same plane, form a remarkably elegant stellate pavement, the interstices of which were occupied in the living state by sarcode and minute flesh-spicules. In *Doryderma* the anchors, which are furnished with short double prongs, are remarkable for the considerable length of their shafts. They are grouped together in dense tufts, and stick, with their notched ends outwards, in mesh-like depressions of the skeleton. The lobate and notched short-shafted anchors and the siliceous disks of *Discodermia* &c. also form a more or less dense surface-layer, which is the more perishable in proportion as the shafts, which are directed inwards, penetrate to a less distance into the mass of the skeleton.

As a rule, those surface-structures which, in their general habit, differ least from the true skeletal corpuscles, and are probably only young undeveloped skeletal elements, are placed very close together. Sometimes they form an apparently solid and smooth siliceous membrane, which either covers only certain portions of the sponge-body (*Turonia*, *Chenendopora*, *Thecosiphonia*), or else clothes the whole sponge as a regular fine siliceous envelope (*Calymmatina*, *Astrocladia*). D'Orbigny, Fromental, Courtillet, and Pomel have repeatedly

called attention to this peculiar covering-layer, but have frequently confounded it with the epithecal structures of corals or with the dense coat of the fossil calcareous sponges.

[To be continued.]

EXPLANATION OF PLATE VIII.

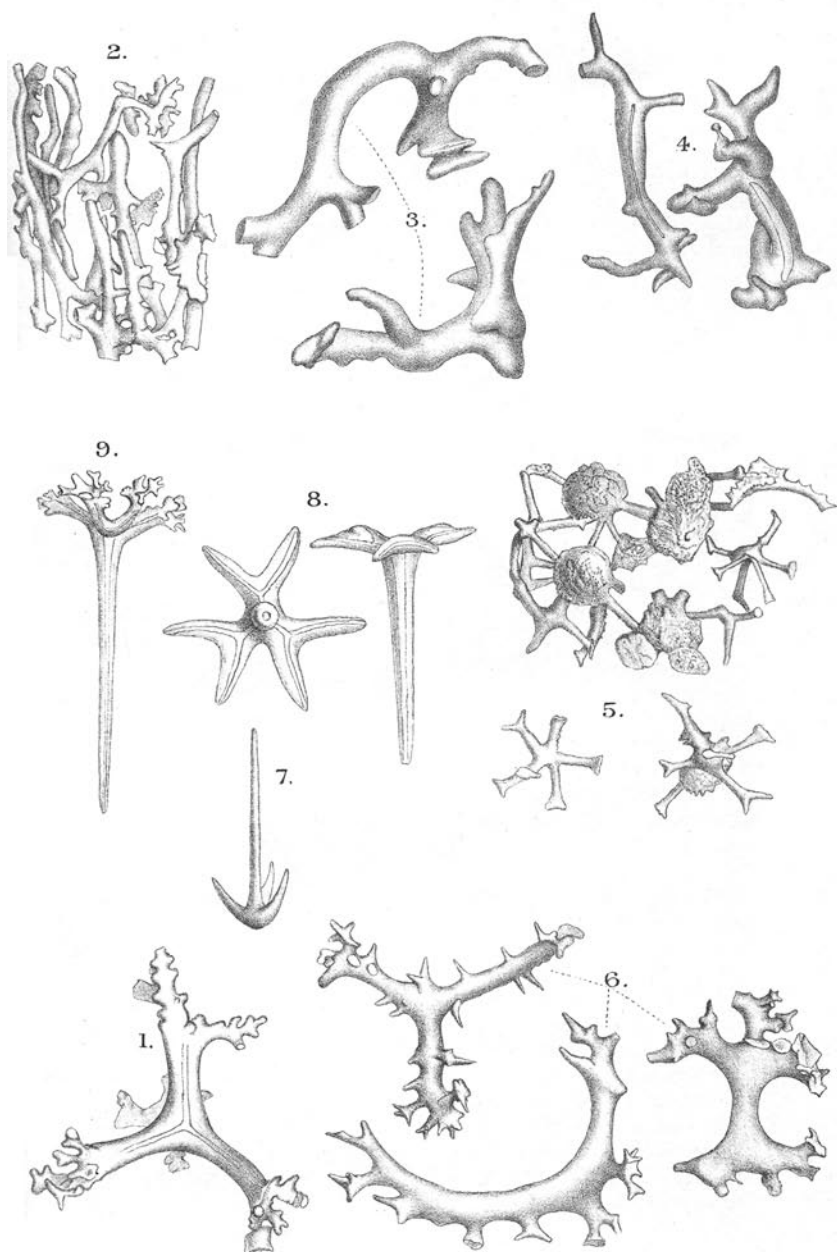
- Fig. 1.* Isolated skeletal element of the wall of *Callopegma Schloenbachi*, Zitt., from the *Mucronatus*-Chalk of Ahlten. $\times 64$.
Fig. 2. Skeletal elements of the stalk of *Aulaxinia sulcifera* (Röm.) from the *Mucronatus*-Chalk of Ahlten. $\times 32$.
Fig. 3. Skeletal elements of *Doryderma dichotoma* (Röm.) from the *Mucronatus*-Chalk of Ahlten. $\times 32$.
Fig. 4. Skeletal elements of *Megalithista foraminosa*, Zitt., from the Upper White Jura (ϵ) of Nattheim. $\times 32$.
Fig. 5. Skeletal corpuscles of *Mastosia Wetzleri*, Zitt., connected and isolated, from the Upper White Jura (ϵ & ζ) of Sozenhausen, near Günzburg. $\times 64$.
Fig. 6. Skeletal elements of *Hyalotragos patella* (Goldf.) from the White Jura of Streitberg. $\times 64$.
Fig. 7. Anchor-spicule of *Chonella tenuis* (Röm.) from the *Quadratus*-Chalk of Linden, Hanover. $\times 64$.
Fig. 8. Forked anchor of the surface of *Pachinion scriptum* (Röm.), from the side and from beneath. $\times 64$. From the *Mucronatus*-Chalk of Schwiechelt, in Brunswick.
Fig. 9. Forked anchor of *Corallistes nolitangere*, Schmidt, from the side. $\times 64$. Recent, Florida.

XIV.—On *Bellidia Huntii* of Gosse. By C. SPENCE BATE.

HAVING some time since communicated to Mr. Gosse my hesitation to accept his genus *Bellidia* (Ann. & Mag. Nat. Hist. Oct. 1877, vol. xx. p. 313, pl. 10) as that of a new or undescribed form, I took the earliest convenient opportunity to examine the specimen from which he drew up his description. This he sent to the British Museum, where it is carefully preserved.

I found it in the same condition and retained in the same bottle in which it was forwarded by the author, the peculiar chelate hand of the first pair of pereiopoda being detached and preserved with it.

It is needless to go into very minute details of the general characteristics of the animal, since careful, prolonged, and repeated examinations convinced me that the specimen was *Hippolyte Prideauxii* of Leach. Mr. Miers, the assistant in the Zoological Department under whose superintendence the Crustacea are, kindly assisted me to compare Gosse's animal with Leach's type of *H. Prideauxii*; and after comparing my



Mintern Bros lith.

SKELETAL ELEMENTS OF LITHISTIDÆ.