This article was downloaded by: [Virginia Tech Libraries]
On: 25 February 2015, At: 00:10
Publisher: Taylor & Francis
Informa Ltd Registered in England and Wales Registered Number:
1072954 Registered office: Mortimer House, 37-41 Mortimer
Street, London W1T 3JH, UK

Annals and Magazine of Natural History: Series 5

Publication details, including instructions for authors and subscription information:
<http://www.tandfonline.com/loi/tnah11>

XL.—Studies on fossil sponges.—V. Calcispongioe

Karl Alfred Zittel

Published online: 15 Oct 2009.

To cite this article: Karl Alfred Zittel (1879) XL.—Studies on fossil sponges.—V. Calcispongioe , Annals and Magazine of Natural History: Series 5, 3:17, 364-379, DOI: [10.1080/00222937908694103](https://doi.org/10.1080/00222937908694103)

To link to this article: <http://dx.doi.org/10.1080/00222937908694103>

PLEASE SCROLL DOWN FOR ARTICLE

Taylor & Francis makes every effort to ensure the accuracy of all the information (the "Content") contained in the publications on our platform. However, Taylor & Francis, our agents, and our licensors make no representations or warranties whatsoever as to the accuracy, completeness, or suitability for any purpose of the Content. Any opinions and views expressed in this publication are the opinions and views of the authors, and are not the views of or endorsed by Taylor & Francis. The accuracy of the Content should not be relied upon and should be independently verified with primary sources of information. Taylor and Francis shall not be liable for any losses, actions, claims, proceedings, demands, costs, expenses, damages, and other liabilities whatsoever or howsoever

caused arising directly or indirectly in connection with, in relation to or arising out of the use of the Content.

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form to anyone is expressly forbidden.

Terms & Conditions of access and use can be found at <http://www.tandfonline.com/page/terms-and-conditions>

XL.—*Studies on Fossil Sponges*.—V. *Calcispongiæ*.

By KARL ALFRED ZITTEL.

[Continued from p. 312.]

V. CALCISPONGIÆ.

Thanks to Ernst Hæckel's brilliant monograph*, the Calcispongiæ, of all the sections of existing sponges, are the most accurately known. As regards palæontology, however, the path-making work of the zoologist of Jena did not appear to possess the great importance which might *à priori* have been expected of it, considering the opinions previously prevalent upon fossil sponges. Hæckel very decidedly and quite justly opposed the notion that the majority of the fossil sponges must have had a calcareous fibrous or latticed skeleton. "Hitherto," he says (Bd. i. p. 341), "*no fossil Calcispongiæ are known*." It is true that in various collections of fossils there exist certain specimens with the tickets of 'fossil Calcispongiæ.' But whatever I have myself seen and had sent to me of such, most certainly do not belong to the Calcispongiæ. Moreover, *of all the descriptions and figures of fossil sponges, not a single one can be referred to a calcareous sponge*. Any one acquainted with the living Calcispongiæ will find this deficiency of petrified Calcispongiæ perfectly natural, considering their great delicacy and destructibility. We might, indeed, at least expect to find their microscopic calcareous spicules fossil in various rocks; and probably such will often be found by more accurate microgeological investigations. As yet, however, nothing of the kind has been described or figured."

When such an authority as Hæckel denies the existence of fossil Calcispongiæ so decidedly, it may seem a bold thing for me to say that I nevertheless refer to the Calcispongiæ a considerable portion of the fossil sponges with a vermiform fibrous skeleton, denominated *Vermiculata* by Oscar Schmidt.

After the separation of the Hexactinellidæ, Lithistidæ, Tetractinellidæ, and Monactinellæ, there still remains a considerable residue of fossil sponges, distinguished by the calcareous and at the same time fibrous nature of their skeleton. By their anastomosing fibrous texture and partly also by their external habit, they remind one most of the existing horny sponges. They have indeed frequently been taken for such; and it has been supposed that the horny fibres had, in course of time, been converted into carbonate of lime.

* Die Kalkschwämme, eine Monographie. Berlin, 1872.

In my first publications upon fossil sponges* I characterized these as "*Calcispongia fibrosa*," and regarded them, on account of the peculiar radiate microstructure of the calcareous fibres which frequently occurs in them, as a perfectly isolated extinct order. Continuing my investigations, and especially by the employment of higher powers, however, the fibres in well-preserved specimens proved sometimes to be composed of spiculiform bodies. This observation, which was soon afterwards confirmed by W. J. Sollas† in the case of a fibrous sponge consisting of carbonate of lime from the Greensand of Cambridge (*Pharetrospongia Strahani*), led to new points of view, and in the first place to a comparison with the existing *Calcispongiæ*.

In the latter the skeleton consists of calcareous spicules, of triradiate, quadriradiate, or uniaxial form, isolated, never amalgamated or cemented together, and usually regularly arranged. The triradiates are by far of the most general occurrence.

According to Hæckel, there are among existing *Calcispongiæ* eighteen species of which the skeleton consists exclusively of triradiates, forty-four species which possess tri- and quadriradiates, and sixty-one species which have triradiates, quadriradiates, and bacillar spicules; in eight species the skeleton is exclusively composed of quadriradiates; and only in six species are bacillar spicules alone met with.

Hence Hæckel concludes that in the *Calcispongiæ* the triradiates originally and primarily play the principal part, and that the quadriradiates are to be regarded only as internal adaptive structures of the gastral surface, and the bacillar spicules as external adaptive structures of the dermal surface.

A noteworthy peculiarity of the calcareous spicules is their small average size. Tri- or quadriradiates in which the longest limb attains a length of half a millimetre are among the larger ones; very often they remain considerably under this measurement. The bacillar spicules also are of correspondingly small dimensions. In opposition to most siliceous spicules, the axial canals of the calcareous ones are so extraordinarily fine that they only become visible under a very high power. For all further details relating to the form, structure, and arrangement of the skeletal elements in the living *Calcispongiæ* I may refer to the exhaustive descriptions of Hæckel (*l. c.* Bd. i. pp. 170-209).

* *Zeitschr. der deutsch. geol. Gesellsch.* Bd. xxviii. p. 651; and *Neues Jahrb. für Min. &c.* 1877, p. 338.

† *Quart. Journ. Geol. Soc.* vol. xxxiii. p. 242.

The next question is, whether the above-mentioned "*Calcispongia fibrosa*" can be placed with the existing *Calcispongiæ*, or whether they belong to another section of sponges.

The chemical constitution of the skeleton, which furnishes the most reliable character in the living sponges, can only be employed with great caution in the case of the fossil ones; for not only do originally siliceous sponges occur in a calcareous state, but calcareous petrifications often pass into the siliceous condition. It is therefore by no means unusual for one and the same species to occur with a siliceous and with a calcareous skeleton.

The microstructure of the skeleton alone is of decided importance for the determination of all sponges. In this respect the fibrous sponges present exceedingly remarkable phenomena, which, however, are not difficult to explain by subsequent chemical and physical alterations.

According to the genera and species, the fibres vary between 0.3 and 1 millim. in thickness; and upon this depends the more or less loose texture of the skeletal tissue. They are always irregularly curved, frequently of different strengths (primary and secondary fibres) in one and the same skeleton; and the interspaces produced by anastomosis are of unequal size and always of irregular form. The old denomination, sponges with "vermiform skeleton," best suits certain *Calcispongiæ* with coarse irregularly crooked fibres.

For microscopic examination thin sections alone can be employed, as in silicified specimens the finer structural conditions are destroyed. Higher powers (100–150 diameters) are necessary, however, than with the fossil *Hexactinellidæ* and *Lithistidæ*, in order to obtain distinct images, as the constituents of the fibres are of very small size.

If we examine a thin slice of a well-preserved *Corynella* from the Tourtia of Essen, or of a *Peronella* from the Greensand of Le Mans, under a moderate power (about 50 diameters), the fibres appear indistinctly striated parallel to the surface. By the employment of higher powers the longitudinal lines are resolved into small bacillar spicules closely applied to one another, which compose the whole fibre. Sometimes they are clearly separated from each other by a surface-layer which appears dark by transmitted light; but more commonly the fibre appears like a light mass of calc spar in which the spicules are not easily recognized. Usually the spicules are observed only in the longitudinal direction of the fibre, and, indeed, so arranged that their extremities overlies one another; so that their whole length is rarely visible. Quite exceptionally, thin transverse sections may be detected as packets of minute trans-

parent circles*. From this it appears that the spicules possess a cylindrical form. Their length varies between 0·08 and 0·1 millim., and therefore remains within very modest dimensions. In general the bacillar spicules of the fibres are of almost exactly the same size and form. In a specimen of *Peronella multidigitata* from the Greensand of Le Mans, the bacillar spicules lie separately in a homogeneous light-coloured mass, from which they are very clearly distinguished; in certain parts they become sparse, whilst in others the whole fibre, as in the first case, appears to be composed of spicules. The occurrence here of a few minute triradiates is worthy of notice. Such triradiates, scattered among bacillar spicules, occur more or less frequently in several genera. They differ considerably in their dimensions, and sometimes attain a considerable size. Their arms are either straight or somewhat curved, but never forked at the ends. It is a comparatively rare occurrence to find sponges in which the fibres consist exclusively of *triradiates*. A remarkable example of this kind is presented by *Peronella cylindrica* of the Upper Jura. In this the individual triradiates (with which quadriradiates also appear to be intermixed) may be clearly distinguished in well-preserved specimens, especially at the periphery where individual spicules have been somewhat separated and project with one or two of the arms from the fibre.

I have been unable to detect axial canals either in the bacillar spicules or in the triradiates.

It is not often that the spicules are to be seen so distinctly as in the preparations just described. Frequently an incipient crystallization has effaced their contours and form, and the skeletal fibres show an indistinctly lamellar structure, or appear as if composed of prismatic corpuscles of calc spar, which sometimes completely coalesce with one another. In the sponges of the North-German Hills and the Triassic marl of St. Cassian, this state of preservation is common.

Very frequently a total destruction of the spicules, evidently after the imbedding of the sponges in the strata, occurs. A *Peronella* from Le Mans has already been mentioned, in which the spicules lie here and there quite separate in a homogeneous mass. Fibres are also not unfrequently met with, of which one end still appears distinctly to be composed of spicules, whilst the other has acquired a perfectly dense constitution. In certain localities (*e.g.* near Maestricht) most of the sponges are characterized by structureless homogeneous fibres.

A further alteration is effected by recrystallization of the

* Sollas on *Pharetrospongia*, Quart. Journ. Geol. Soc. vol. xxxiii. (1877) p. 246, pl. xi.

skeletal fibres. Centres of crystallization are formed, from which fine rays issue in all directions ; and as these centres are situated, in great numbers, sometimes in the middle and sometimes near the margin of the fibres, the latter acquire an extremely fine spheroidally-fibrous microstructure. This state of preservation sometimes also occurs in specimens in which individual fibres still distinctly show that they are composed of spicules.

In certain localities, for example near Wattenheim, Muggendorf, and Ambey, in the Swabio-Franconian Jura, as also in the "Terrain à chailles" of Switzerland, the fibrous sponges occur entirely or partially in a siliceous condition, like most of the fossils occurring with them ; these, especially when they are imbedded in a calcareous rock, can be completely freed from the matrix by dilute muriatic acid, and then do not yield at all in beauty and freshness to the associated Hexactinellidæ and Lithistidæ. But if we examine their siliceous fibres under the microscope, no trace of spicular structure is to be discovered ; the siliceous mass appears turbid, and as if composed of minute, rough, granular, or vermiform corpuscles of no definite form. In contrast to the hyaline latticed meshes of the Hexactinellidæ, or the transparent Lithistid elements which occur in the same localities, the silicified skeletons of the fibrous sponges are at the utmost translucent, and always produce the impression of fissured and chemically altered structures. Sometimes only an outer rind of the sponge-body is silicified, the fibres of the interior remaining calcareous. In such cases I have always found the silicified fibres of the rough nature above described, the calcareous fibres, on the contrary, filled with distinct spicules. Now and then, indeed, the spicules appear to be able to preserve their form even after silicification ; at least Sollas (*l. c.* p. 253), in treating *Pharetrospongia Strahani* with dilute acid, obtained silicified parts, consisting of spicules, at the surface of calcareous fibres. I have never seen such examples ; but I certainly know several Jurassic fibrous sponges and one Triassic one (*Stellispongia variabilis*) both in the calcareous and in the siliceous state ; and in the latter every trace of minute structure is destroyed.

This circumstance seems to me to furnish a satisfactory proof that *the fibres were originally composed of calcareous spicules, and only subsequently became converted into silica. I therefore regard the fibrous sponges as true Calcispongiae.*

This opinion contradicts the above-mentioned dictum of Hæckel, that no fossil *Calcispongiae* are known ; it is also in opposition to the views of Sollas and Carter, according to which a decidedly fibrous sponge from the Greensand of

Cambridge (*Pharetrospongia*) belongs not to the calcareous but to the siliceous sponges. The form and position of the spicules and the observation that in fossil sponges originally siliceous skeletons often appear converted into calcite, decided Sollas to place *Pharetrospongia* in the group Holorhaphidota.

Carter* summarizes the arguments which render it improbable that *Pharetrospongia* belongs to the Calcispongiæ as follows:—1. All existing Calcispongiæ are not only very small, but for the most part absolutely minute. 2. With the exception of half a dozen species, the skeleton of the Calcispongiæ consists of triradiates or quadriradiates, and the bacillar spicules are always straight, never curved in the form of an arc. 3. The Calcispongiæ are so perishable, that immediately after death they become diffuent, and indeed, in consequence of the absence of horny fibres and siliceous constituents. 4. The spicules break up very rapidly even in Canada-balsam preparations, pass into watery spherules, and in a short time leave no trace of their existence.

All these objections, raised with respect to *Pharetrospongia*, apply also to the other fibrous sponges; if they hold good, the possibility of the occurrence of any fossil Calcispongiæ is most seriously shaken.

In the first place, with regard to comparative size, it must be admitted that the living Calcispongiæ rarely attain any considerable magnitude; but nevertheless Hæckel describes stocks from 50 to 100 millims. in height in all the three existing families; and among the Leucones there are even individuals 30–40 millims. long and 15–20 millims. broad. These latter, in size and external form, are almost undistinguishable from the most common forms of fossil fibrous sponges, such as *Peronella* and *Corynella*. Just as the recent Calcispongiæ yield considerably in size to the other sponges, so also the fossil fibrous sponges are generally distinguished, in comparison with the Hexactinellidæ and Lithistidæ, by their small dimensions. The genus *Pharetrospongia*, described by Sollas, chances, with *Pachytilodia*, to contain the largest known forms of fibrous sponges. The difference of size between the living and fossil Calcispongiæ is by no means so considerable as to exclude the possibility of their relationship.

The objection relating to the form of the skeletal elements is of more weight. That in living Calcispongiæ bacillar spicules only exceptionally (in eight species) form the skeleton, cannot be disputed; but among the Ascones, as well as the Sycones and Leucones, there are genera consisting

* Ann. & Mag. Nat. Hist. ser. 5, vol. i. (1878) p. 136.

entirely of bacillar spicules. It need not surprise us, therefore, if the skeletons of all fibrous sponges were composed entirely of bacillar spicules; for it is a matter of observation that extinct families, or such as are richly developed in the older formations, are much more frequently closely allied to rare and isolated existing forms than to those which at the present day stand at the height of their development. The uniformity in the size and form of the spicules in the fossil fibrous sponges, as also the absolute deficiency of bowed spicules and fibulæ (*Spangen*), may also be cited in favour of their originally calcareous nature.

The predominance of bacillar spicules in the fossil *Calcispongiæ* seems to me, however, to be of special significance from another point of view. According to the concurrent observations of Metschnikoff, F. E. Schulze, and Barrois, the bacillar spicules first make their appearance in the embryo of most *Calcispongiæ*, and only afterwards the tri- and quadriradiates. Hence, according to the biogenetic fundamental law, the bacillar spicules are the oldest and primary skeletal elements, and they must therefore, even on theoretical grounds alone, be assumed to have been especially present in the fossil ancestors of the *Calcispongiæ*.

Moreover, that the characteristic triradiates of the *Calcispongiæ* are not wanting in the fossil forms has already been mentioned. They sometimes lie singly among the bacillar spicules; sometimes, in association with quadriradiates, they form the whole skeleton. With a little caution any confounding of the tri- and quadriradiates of *Peronella* with similarly formed skeletal elements of siliceous sponges (*e. g. Stelletta, Pachastrella, &c.*) is impossible. The spicules of the *Calcispongiæ*, in comparison with the above-mentioned siliceous structures, are of diminutive size; their straight or curved arms are pointed or truncate, *always simple, never forked*; and their axial canals are excessively fine, in fossil forms generally invisible.

Carter's third objection relates to the small power of resistance of the calcareous skeletons to the force of the waves and chemical influences. According to the observations of that experienced spongologist, the recent *Calcispongiæ*, which live almost exclusively in shallow water, are completely destroyed in a very short time. In the fossil calcareous sponges the peculiar arrangement of the spicules in fibrous trains, as also the frequent presence of a delicate superficial layer, certainly seems to have furnished some protection against mechanical destruction; but that the spicules, exactly like those of the living forms, only made a feeble resistance to chemical action,

is a necessary consequence of the constitution of the calcareous fibres. Specimens with well-preserved, clearly-distinguishable spicules occur very rarely; much more frequently the minute skeletal elements are entirely or partially destroyed, and the fibres have acquired a structure which scarcely allows one to assume the former existence of spicules.

It seems to me, therefore, that neither the size and the external form, nor the constitution of the skeleton of the fossil fibrous sponges are opposed to their relationship to the *Calcispongiæ**.

In the consideration of the fossil fibrous sponges their occurrence in *decidedly littoral deposits* must also be of significance, as the existing *Calcispongiæ*, for the most part, live only at a very small depth. Most of them occur attached to stones in the littoral zone from high-water mark to a depth of 2 fathoms. Very few of them go down to 20 fathoms; but isolated forms have been brought up from 60–70 fathoms, and a single species (*Leucalis bathybia*) even from a depth of 342 fathoms according to Hæckel.

Although after the observations that have been made upon the metamorphosis of the fossil siliceous sponges into calcite, the chemical constitution of the skeleton can only be taken into consideration with great caution, it cannot be a matter of indifference that perhaps nine tenths of all the known fossil fibrous sponges, and these from the most diverse formations and localities, are in the calcareous state, and that silicified specimens usually occur only where nearly all the formerly calcareous shells and skeletons are converted into silica.

Now that I have endeavoured to prove that the fossil fibrous sponges belong to the *Calcispongiæ*, it remains to discuss the further question, whether they enter one of the existing families or constitute an independent group.

According to Hæckel the *Calcispongiæ* are divided into three families—*Ascones*, *Leucones*, and *Sycones*. In the *Ascones* the thin wall is permeated only by transient cutaneous pores or orificial canals; in the *Leucones* a rather complex system of branching canals is developed in the thick wall; and in the *Sycones* the whole sponge-body consists of simple radial tubes, which open into the stomachal cavity.

The *Sycones* are represented in the fossil state by a single genus occurring in the Upper Jura. The calcareous fibrous sponges agree in respect of their canal-system neither with the *Ascones* nor with the *Sycones*; but there are among the

* To my great satisfaction Mr. Carter, after I had sent him a number of fossil specimens, together with some microscopic preparations, has declared the existence of fossil *Calcispongiæ* to be indubitable.

living *Leucones* forms with an absolutely identical arrangement of the water-canals. In this respect, therefore, the fossil calcareous sponges most approach the *Leucones*; but their union with these is decisively opposed by the extremely peculiar arrangement of the spicules in fibre-trains.

In general there is a close agreement in the distribution and arrangement of the skeletal elements within the different families of the *Calcispongiae*. Thus, for example, in the *Ascones* the *triradiates* lie almost all in a single layer and are completely imbedded in the syncytium; of the *quadriradiates*, on the contrary, the three facial limbs are placed entirely in the plane of the dermal lamella, whilst the fourth or apical ray projects freely into the stomachal cavity. The bacillar spicules also are originally entirely enclosed in the syncytium; but subsequently they usually protrude more or less, and form tufts, circlelets, and bristles.

The spicules in the *Sycones* are exceedingly regularly distributed. The composition of the wall of radial tubes gives rise to peculiar conditions of differentiation in the skeleton and to a definite radial arrangement of the individual parts. We consequently always distinguish the true skeleton of the wall and radial tubes from the skeleton of the gastral and dermal faces. The former usually consists only of *triradiates*, very rarely of bacillar spicules or *quadriradiates*; in general the *triradiates* form several parallel layers, and are always so arranged that the sagittal ray turns outwards, while the two lateral (usually short) arms diverge obliquely inwards nearly in the same plane. In the dermal and gastral skeletons also the spicules are remarkable for their regular arrangement.

The skeletal elements of the *Leucones* are quite otherwise arranged. In them also the outer surface and that of the stomachal cavity exhibit a constitution different from that of the true wall; so that we can likewise distinguish a dermal, a parenchymal, and a gastral skeleton. In the interior of the thick wall the parenchymal skeleton is composed of a mass of calcareous spicules of different forms and sizes, as it were thrown together *without any definite arrangement*. The *triradiates* generally predominate; and with them a few *quadriradiates* and bacillar spicules are intermixed. The surface of the *Leucones* is either smooth or spiny. The *smooth dermal skeleton* is produced by the spicules being pressed close together, and rather more regularly arranged than in the interior of the wall. The *spiny dermal skeleton* is formed by large bacillar spicules which project beyond the surface with their distal part. The smooth or spinose skeleton of the gastral surface is produced in the same way as the dermal skeleton.

As may be seen from this rapid description of the skeletal characters of the recent *Calcispongiæ*, the fossil forms are essentially distinguished from the *Ascones*, *Sycones*, and *Leucones* by their generally uniaxial spicules being grouped in fibre-trains, in which they lie close together, parallel to the longitudinal axis of the fibres, like the arrows in a quiver. This peculiarity, in combination with certain characters of the canal-system and external form, justifies the establishment of a distinct family, for which I propose the name of *Pharetrones* (from *φάετρα*, a quiver).

PHARETRONES, Zitt.

External form.—As in all other orders, the external form of the calcareous sponges, from its instability and multifariousness, furnishes no characters of decisive systematic importance. We find among the *Pharetrones* nearly all the peculiarities of form which occur among the *Lithistidæ*; here also cylinders, clubs, basins, cups, leaves, nodules, and ramified bushes or twigs are the most common forms. In general, however, the *Lithistidæ* attain much more considerable dimensions; whilst among the *Pharetrones* basins of 70–80 millims. diameter, or cylinders of equal length, are to be regarded as unusually large forms. Nevertheless in average size the *Pharetrones* considerably exceed the existing *Calcispongiæ*.

The *walls* are of considerable thickness, and consist of solid anastomosing calcareous fibres.

The *stomachal cavities* may generally be very clearly distinguished from the canal-ostia or pores of the surface. They are sometimes tubularly prolonged and reach from the vertex to the base, sometimes funnel-shaped, sometimes shallow or even scarcely sunk into the skeletal mass.

All *Pharetrones* attach themselves firmly to a support.

Canal-system.—In many *Pharetrones*, especially in those with a well-developed, impressed stomachal cavity, the canal-system agrees with that of the *Leucones*. Crooked branching canals, commencing with their fine ramified ends near the surface, and uniting towards the interior to form a stem gradually increasing in thickness, open into the stomachal cavity. These canals generally have a radial course, but in the middle of the sponge-body, especially when the stomachal cavity is shallow, they sometimes take a perpendicular direction, and convey the water from below to the cavity. The canal-ostia upon the gastral surface are placed irregularly, and in size dependent upon the thickness of the canals.

In forms with undeveloped stomachal cavity fine crooked

canaliculi penetrate from one or both surfaces into the wall, without traversing it.

Not unfrequently definite canals are entirely absent; and this phenomenon is observed both in forms with a tubular stomachal cavity, and in those without any oscula and stomachal cavities. In all cases where the canals are wanting the skeletal tissue presents a looser constitution, which enables the circulation of water to go on without hindrance.

Exceedingly peculiar phenomena of water-circulation are met with in the genera *Verticillites* and *Celyphia*. In the first-named genus the cylindrical individuals with a tubular stomachal cavity consist of hollow rings placed one upon the other, and of which the cover of one always serves as the base of the next. Only the walls of these rings consist of spicular fibres; the interior is hollow. From the cavities of the rings fine orificial canals lead into the stomachal cavity; and they are placed in communication with each other by similar canals. In *Celyphia* the stocks are composed of hollow globular individuals which possess no common stomachal cavity, and communicate with the outer world only by small round apertures.

Skeleton and State of Preservation.—These have been already described in detail; so that nothing essential remains to be stated in regard to the fibres and their structure. A noteworthy peculiarity of the Pharetrones is that isolated surface-spicules of characteristic form or remarkable size never occur in them. The fibrous skeleton either comes naked and unprotected to the surface, or it is enveloped by an external smooth *dermal skeleton*, which, however, does not consist, as in the Lithistidæ, of differently formed surface-spicules, but of exactly the same small spicules as the whole of the rest of the skeleton. To the naked eye the dermal layer of the fossil calcareous sponges appears smooth or concentrically wrinkled, and exactly in agreement with the so-called *epithea* of the corals. It has therefore hitherto always been designated by the same name. It is rarely, however, that one can succeed in demonstrating its spicular structure, as it is precisely at the surface that the chemical influences have been particularly effective, and have generally led to the complete destruction of the skeletal elements.

Classification.—We must not for the present attempt a special classification of the rich and varied family Pharetrones, as the skeletal spicules can be observed with sufficient distinctness only in a few genera. In general we have to content ourselves with ascertaining the actual existence of spicules; and it is only exceptionally that we are able to distinguish

their form exactly. All other characters, derived from the external form, the structure, and the canal-system, prove insufficient for the establishment and especially for the sharp discrimination of natural groups. In the special part I have therefore enumerated the genera in the sequence in which they can best be arranged in accordance with the totality of their characters which are accessible to observation.

Occurrence, Distribution in Time, and Pedigree.—In opposition to the Hexactinellidæ and Lithistidæ, the Pharetrones occur associated together and in considerable numbers only in deposits of littoral origin, and most frequently in marly and sandy rocks, usually mingled with numerous Gastropoda, Pelecypoda, Brachiopoda, Bryozoa, and Echinodermata. The most ancient calcareous sponges which I have been able to examine are derived from the Devonian *Stringocephalus*-limestone of Vilmar in Nassau, a locality celebrated for its wealth of well-preserved Gastropods and Bivalves. These belong to the rich genus *Peronella*. According to an oral communication from Prof. de Koninck numerous undescribed forms are found in the Carboniferous Limestone of Tournay in Belgium. Among the sponges of the Dyas described by Geinitz and King, *Eudea tuberculata*, King, may belong to *Corynella*; but most of the others are very doubtful, and some of them certainly of inorganic origin.

The extra-Alpine Trias has furnished a genus of Pharetrones (*Corynella*) only in Silesia; but, on the other hand, there is in the Alps near St. Cassian, and in the Seeland Alp near Schludersbach, the first rich Calcispongian fauna, in which thirteen genera with numerous species have been discovered. These deposits bear the most decided stamp of littoral formations, and are filled with that characteristic pygmy fauna which, according to Fuchs, lived in the fields of Laminariæ of that epoch. The genera *Eudea*, *Peronella*, *Corynella*, *Verticillites*, *Colospongia*, *Stellispongia*, *Leiospongia*, *Pharetrospongia*, &c. already represent the most important modifications which occur in the structure and external appearance of the Pharetrones in general.

From the Rhætics of the Bavarian Alps I am acquainted with some badly preserved and in part silicified Calcispongiæ, which, however, cannot be accurately determined. The Lias appears to have been very unfavourable to the development of sponges; it has hitherto furnished only isolated siliceous spicules, but no coherent skeletons of either siliceous or calcareous sponges.

From the Inferior Oolite of Bayeux and Port-en-Bessin, in Calvados, Michelin and D'Orbigny mention numerous sponges,

for the most part belonging to the Pharetrones (*Peronella*, *Corynella*, *Pharetrospongia*, *Stellispongia*). The same genera occur still more abundantly in the Great Oolite of Ranville, St. Aubin, and Langrune, as also in strata of the same age in the Cracow district, especially near Balin.

The Upper Jura, which contains such astonishing quantities of Hexactinellidæ and Lithistidæ in the Sponge-limestones of the Jura chain, is poor in calcareous sponges. The most ancient representative of the Sycones (*Scyphia punctata*, Goldf.) occurs here as a rarity, accompanied by *Myrmecium rotula*, Münst., and *Peronella cylindrica*, Goldf. On the other hand, the Terrain à chailles, the Coral Rag of Nattheim, and the siliceous Jurassic limestone of Amberg may be indicated as horizons for Calcispongiæ. In these localities there are found various species of *Peronella*, *Corynella*, *Eusiphonella*, *Crispispongia*, *Eudea*, and *Blastinia*, and, indeed, generally in a silicified state. From the neighbourhood of Bruntrut and Chambéry also a number of Upper-Jurassic Calcispongiæ of the above-named genera have been described by Etallon* and Fromentel†.

In the Cretaceous formation the Pharetrones appear to have attained the zenith of their development. They occur in great quantities in various horizons of the lower division of that formation (Valenginian, Neocomian, and Aptian); and the North-German Hils, the Neocomian of St. Dizier, Germinéy, Vassy, Morteau, Fontenoy, &c., in France, the Valenginian of Arzier, the Neocomian of Mont Salève, the Urgonian of La Rusille and Landéron, the Aptian of La Presta in Switzerland, and the inferior sand of Farringdon in England, especially, have attained a certain celebrity through the writings of Fromentel‡, F. A. Römer§, Loriol||, and Sharpe¶.

In the Cenomanian, the Tourtia of Essen, and the Green-

* Thurmann und Etallon, "Lethæa Bruntrutana," Neue Denkschr. der schw. naturf. Gesellsch. vols. xix. & xx.

† Pillet et Fromentel, 'Description géologique et paléontologique de la colline de Lemenc.' Chambéry, 1875.

‡ E. de Fromentel, "Introduction à l'étude des éponges fossiles," Mém. Soc. Linn. Norm. vol. xi. 1859; and "Catalogue raisonné des Spongitaires de l'étage Néocomien," Bull. Soc. Sci. de l'Yonne, 1861.

§ F. A. Römer, "Die Spongitarier des norddeutschen Kreidegebirges," Palæontographica, vol. xiii. 1864.

|| P. de Loriol, 'Description des animaux invertébrés fossiles du Néocomien moyen du Mont Salève,' 1863; and "Monographie des couches de l'étage Valenginien d'Arzier," in Pictet's 'Matériaux pour la Paléontologie Suisse,' 4^e sér. 1868. P. de Loriol et Gilliéron, "Monographie de l'étage Urgonien inférieur de Landéron," Mém. Soc. Helv. Sci. Nat. vol. xxiii. 1869.

¶ Sharpe, Quart. Journ. Geol. Soc. vol. x. 1854.

sand of Le Mans and Cambridge are remarkable for the abundance of beautifully preserved *Calcispongiæ*; and, finally, the Cretaceous tuff of Maestricht is the locality which harbours the last representatives of the *Pharetrones* in considerable numbers.

As will be seen from the following Table (p. 378), most of the Cretaceous genera agree with those already occurring in the Jura.

It is remarkable that, with the exception of isolated spicules in the Red Crag, which are referred by Johnson to *Grantia compressa*, no *Calcispongiæ* have been detected in the Tertiary formation; consequently the *Pharetrones*, which are evidently the most resistant forms, seem to have become extinct at the close of the Mesolithic epoch.

Contrary to what occurs in the siliceous sponges, we find in the *Pharetrones* a tolerably continuous development. Many genera overstep the bounds of one or two formations, and are remarkable for their unusual longevity. The change of form within the genera is also confined within moderate limits, so that, under certain circumstances, the species from the uppermost Cretaceous present a delusive resemblance to those from the Jura and Trias.

The former mode of life of the *Calcispongiæ* probably furnishes the simplest explanation of their closed sequence. They were inhabitants of the coasts; and as, in general, more littoral than deep-sea formations are accessible to examination, it cannot surprise us if the *Calcispongiæ* occur in more numerous localities and on more horizons than the *Hexactinellidæ* and *Lithistidæ*, which belong to deep-sea deposits.

From a phylogenetic point of view the *Pharetrones* may be regarded as the forms from which the existing *Leucones* and *Ascones* have been developed. If we assume, with Hæckel, as the stem-form of the *Calcispongiæ* (leaving out of consideration the problematic preceding and unpreservable embryonic types) an adherent *Olynthus* furnished with osculum and stomachal cavity, we must imagine this provided with bacillar spicules; for not only are the uniaxial skeletal structures the first to make their appearance in the larvæ of the existing *Calcispongiæ*, and consequently to be regarded as genetically the oldest, but in the most ancient *Pharetrones* they exclusively compose the skeleton.

Any detailed discussion of the genetic connexion of the genera of *Pharetrones*, such as Hæckel has given to the genera of the three living families, must be abandoned in the face of our still imperfect knowledge of the details of the skeletal constitution; it could only lead to unreliable results. For

Distribution of the Calcispongiæ in Time.

RECENT.		<i>Ascones.</i>	<i>Leucones.</i>	<i>Sycones.</i>
		Ascetta.	Leucetta.	Sycetta.
		Ascylla.	Leucylla.	Sycylla.
		Ascyssa.	Leucyssa.	Sycyssa.
		Ascaltis.	Leucaltis.	Sycaltis.
		Ascortis.	Leucortis.	Sycortis.
		Asculmis.	Leuculmis.	Syculmis.
	Ascandra.	Leucandra.	Sycandra.	
TERTIARY.	Isolated Spicules.			
UPPER AND MIDDLE CRETACEOUS.	<i>Pharetrones.</i>			
	Verticillites.	Oculospongia.		
	Peronella.	Elasmostoma.		
	Corynella.	Diplostoma.		
	?Hippalimus.	Pharetrospongia.		
	Synopella.	Pachytilodia.		
LOWER CRETACEOUS.	Verticillites.	Sestrostomella.		
	Peronella.	Synopella.		
	Elasmocœlia.	Oculospongia.		
	Conocœlia.	Elasmostoma.		
	Corynella.	Diplostoma.		
	Stellispongia.	Pharetrospongia.		
UPPER JURASSIC.	Eudea.			Protosycon.
	Peronella.			
	Eusiphonella.			
	Corynella.			
	Myrmecium.			
	Stellispongia.			
	Sestrostomella.			
	Blastinia.			
	Crispispongia.			
MIDDLE JURASSIC.	Eudea.			
	Peronella.			
	Corynella.			
	Lymnorea.			
	Stellispongia.			
	Sestrostomella.			
	Pharetrospongia.			
LIAS.				
TRIAS.	Eudea.	Corynella.		
	Colospongia.	Stellispongia.		
	Verticillites.	Sestrostomella.		
	Celyphia.	Crispispongia.		
	Himatella.	Pharetrospongia.		
	Peronella.	Leiospongia.		
PERMIAN.	? Peronella.			
	? Corynella.			
CARBONIFEROUS.	?			
DEVONIAN.	Peronella.			

the present also we have no sound data for deciding whether, how, and when the Ascones and Leucones were developed from the Pharetrones. It is, however, certain that the family Sycones branched off very early (at least in the Jurassic period).

[To be continued.]

XLI.—*Descriptions of new Coleoptera belonging to the Genera Monomma, Silis, and Lithinus.* By CHARLES O. WATERHOUSE.

Monommidae.

Monomma quadrimaculatum, sp. n.

Elliptico-ovale, convexum, piceum, nitidum; elytris nigro-piceis, maculis rotundatis rufis notatis.
Long. $2\frac{3}{4}$ lin.

General form of *M. philippinarum*. Head very closely, finely, but distinctly punctured. Thorax densely and rather strongly punctured; the sides not reflexed, but narrowly impressed within the margin. Elytra rather strongly and closely striate-punctate; the punctures in the scutellar region much larger, the first stria very short; the interstices rather closely, very delicately, but distinctly punctured; each elytron with two rather large round spots, one near the shoulder, the other subapical.

Hab. Philippine Islands (*Cuming*).

Monomma pilosum, sp. n.

Elliptico-ovale, leviter convexum, nitidum, nigro-fuscum, fulvo-pilosum; thorace subtiliter irregulariter punctulato, angulis anticis productis obtusis, marginibus piceis; elytris sat fortiter striato-punctatis, striis apicem versus evanescentibus; prosterni projectura valle marginata, medio fortiter parce punctato; tarsis longis.

Long. $6\frac{1}{2}$ lin.

Rather an elongate species, not very convex, blackish brown, with very short fulvous pubescence above. Thorax not quite twice as broad as long, very finely and not very thickly punctured, the lateral margins flattened but not reflexed. Elytra scarcely broader than the thorax, three times as long, rather attenuated towards the apex; the lines of punctures are well marked, but disappear towards the apex;