CHAPTER XV.

THE SPONGES OF LAKE TANGANYIKA.

The sponges which were obtained during the Tanganyika expeditions from that lake itself appear to consist of three distinct forms. Two of these new species were examined and described by Mr. Richard Evans under the names of *Spongilla moorei* and *Spongilla tanganyikæ*; but besides these among the material obtained during the first expedition there were encountered the spicules of a third form embedded in the mud of the lake. The character of these spicules, it seems, might, with equal propriety, suggest that the sponge to which they belong is allied either to the New World genus, *Uruguaya* or to the Congo genus *Potamolepis*. As, however, nothing but the spicules had been obtained, Mr. Evans left the form unnamed. During the second Tanganyika expedition a small specimen of this third species was dredged alive from great depths adhering to a *Paramelania* shell, and this material was sent eventually to Herr Weltner in Berlin, who replies that the sponge is undoubtedly a new form, the framework being very similar to *Spongilla böhmii*. The sponge, however, still remains nameless, and as this is most inconvenient, I propose the specific term *weltneri*, leaving the form for the present as a member of the genus *Potamolepis*.

SPONGILLA MOOREI (R. Evans).

This sponge grows on the shells of various mollusca, and partially covers them as a crust. The upper surface is raised into lobes or mound-like elevations, which in no case are more than half an inch above the general surface, and which are usually no more than an eighth of an inch above the shallow depressions which separate them. The surface texture of the preserved sponge is somewhat woolly in appearance, though this is probably the result of the broken condition of the dermal membrane, for it has been observed that some of the fragments preserved in Flemming's fluid are smooth, and the spicules of the skeleton, though supporting the dermal membrane, do not in the natural condition penetrate it.

An osculum is situated at the tip of each of the lobes or mound-like elevations of the surface of the sponge. This opening measures about an eighth of an inch in diameter, and underlying it there is a fairly large gastral cavity. The dermal pores are small, as usual, and are situated on the flanks of the lobes as well as in the intermediate depressions.

(2) THE SKELETON.—In treating of the skeleton or the supporting part of the sponge, first, the spicules will be described ; secondly, the arrangement of the spicules to form fibres, and of the fibres at large to form the skeleton, and thirdly, the spongin which binds the fibres together.

(A) THE SPICULES.—In order to facilitate description, the spicules will be divided into three classes, the ordinary division into "megascleres," and "microscleres" being intentionally avoided, because it is, to say the least, doubtful whether the small, smooth spicules are microscleres or young megascleres.

The three classes of spicules are :—

(α) Diactinal monaxons, which taper to a sharp point, either gradually (amphioxea) or more rapidly (amphitornota), and are without swellings on their shaft. The former are always straight, the latter curved (Fig. 1—*a.*).

(β) Similar straight amphioxea or curved amphitornota, with distinct swellings on the shaft (Fig. 1—*d.*).

(γ) Irregular systems formed by the fusion of spicules belonging to class *a.* (Fig. 1).

(α) The straight amphioxea taper gradually into a sharp-pointed end (Fig. 1—*b.*), while the curved amphitornota, which are far more numerous, taper much more abruptly into a similar point (Fig. 1—*c.*). Both the straight amphioxea and the curved amphitornota are highly variable in thickness, and exhibit all stages of development. The axial thread is of even thickness throughout its whole length in all these spicules.

(β) In addition to being slightly more slender than the spicules already described, the main feature of these spicules is the presence of a number of swellings which varies from one to five. As a rule they are situated symmetrically with regard to the middle point of the spicule ; that is, if there is only one swelling it is situated at that point, but if there are two they are placed one on each side of that point, and at equal distance from it ; and similarly the symmetry is maintained when there are three, four or five swellings. The absence of the symmetrical arrangement, as seen

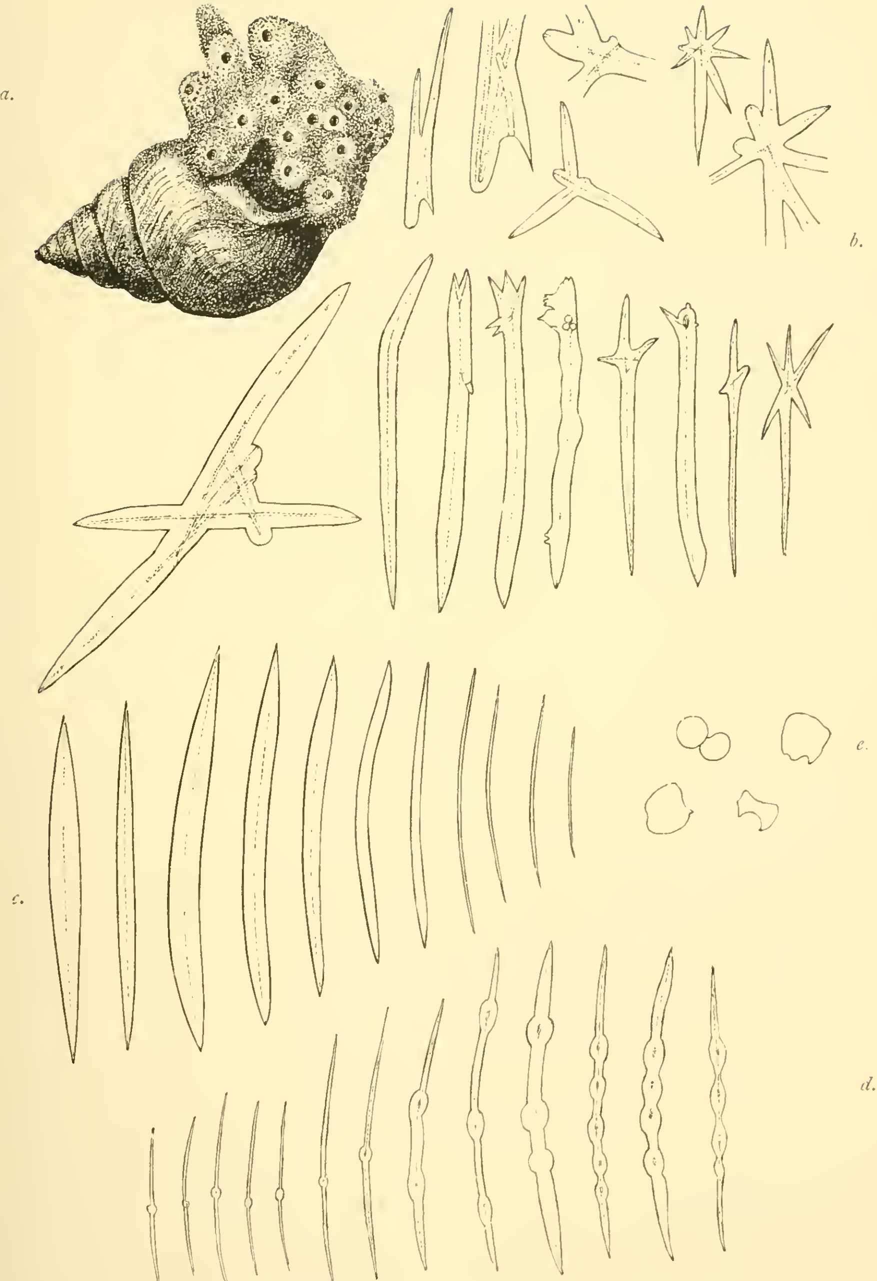

Fig. 1.—*a.*, *Spongilla moorei* growing upon a shell. *b.*, A number of irregularly shaped spicules. *c.*, Amphioxea and amphitornota, without swellings. *d.*, Amphioxea and amphitornota, with swellings. *e.*, Masses of silica.

in Fig. 1—*d.*, is very exceptional. The axial thread, in contrast to spicules of class (*a.*), present a dilation corresponding to each swelling on the spicule.

(γ) The spicules of this class are of variable and irregular form, since the individual amphioxea or amphitornota which form them may fuse at any point and at any angle (Fig. 1—*b.*). As a rule these compound systems are formed from spicules from class (*a.*), though occasionally a spicule of class (β) is found to take part in their formation.

With regard to their origin, two suppositions are possible; first, that they are the result of irregular growth, and branching of a single spicule derived entirely from a single scleroblast; secondly, that they arise by fusion of spicules primitively distinct, and formed each by its own scleroblast. Fig. 1—*b.* might be taken as evidence of the former view, but such forms as that represented in Fig. 1—*b.* render such a supposition highly improbable, to say the least. The view that these spicular systems are of compound origin receives strong support from the way in which their axial threads cross one another instead of branching. If these irregularities arose as outgrowths from one spicule formed in one mother cell, it might well be expected that their axial threads should be also formed as outgrowths from that of the main spicule; but this is certainly not the case in many spicules of our Spongilla, as can be seen trom the figures. In another sponge, which is probably a monaxonid of the family Axinellidœ, viz., *Tricentrium muricatum* (Pallas 1756), Ehlers, 1870 (=*Plectronella papillosa*, Sollas, 1879), there are branched spicules iu which the axial threads are continuous throughout, a fact which may indicate that the spicules themselves owe their form to branching. It seems clear, therefore, that the irregular spicules of Spongilla moorei have, in many cases, been produced by fusion. Judgment must be suspended for the present with regard to those systems in which no discontinuity can be detected in the axial threads of the component spicule rays; such spicules may be simply branched. The question cannot be decided until the actual origin of the spicules has been studied; and the same may be said for *Tricentrium.* Since now it has been shown that the triradiates and quadradiates of the Ascons are formed by fusion, there is no inherent improbability in a similar process occurring in other cases.

Spicules of a similar character to the compound systems here described have been figured by many authors in various Spongillidæ (*Spongilla aspinosa*, Potts) *Lubomirskia intermedia*, Dybowski). All these authors regard them as abnormalities, but in moorei they are so frequent that they must be considered as a normal feature of the species. It is possible that in other Spongillidæ these systems have not received the attention they deserve.

In addition to the spicules described above there are small masses of silica in *Spongilla moorei*, comparable with those found in *Spongilla aspinosa* (Fig. 1—*e.*).

(B) The Arrangement of the Spicules to form Fibres, etc.—The spicules which form the polyspiculous fibres belong mainly to the first and third classes above described. Spicules of the first class form the greater part of the fibies, while others lie about in the sponge tissue, presenting for the most part an iiregular method of arrangement, though many such spicules are placed so as to bridge over the spaces between the fibres in a perfectly definite way. Spicules of the second class, which are far less numerous than those of the first, seldom participate in the formation of the fibres, but, as a rule, lie scattered irregularly between the fibres.

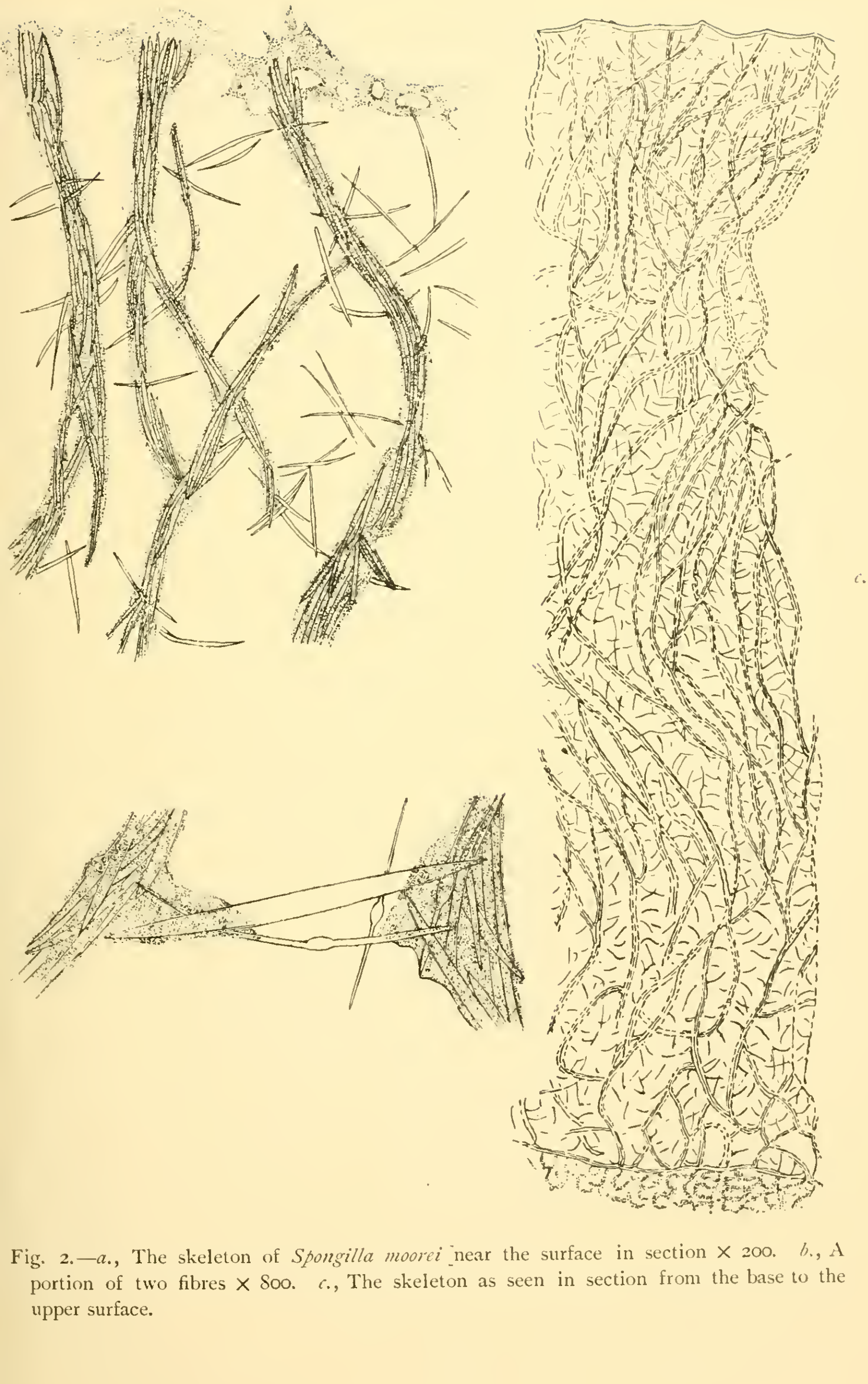

Fig. 2.—*a.*, The skeleton of *Spongilla moorei* near the surface in section × 200. *b.*, A portion of two fibres × 800. *c.*, The skeleton as seen in section from the base to the upper surface.

The spicular systems of the third class are seldom found in any other position than in the fibres.

As a rule, the spicules are arranged in the fibres with their axes parallel to one another, and in the deeper parts of the sponge the connecting spicules are rather numerous, and more strongly developed than in the more superficial parts. The connecting spicules are usually the most strongly developed spicules in the whole sponge as regards size, differing, however, only in thickness from the smooth, curved amphitornota which constitute the fibres (Fig. 2—*a.*). Speaking generally, the largest spicules of the first class, together with a few of the second and all the third, form the fibres and the connecting links between them, while the smaller spicules belonging to the first, and nearly all those belonging to the second class, are scattered about irregularly in the meshes between the fibres. The smallest spicules of all seem to be absolutely independent of the skeletal meshwork, and this is the strongest argument that can be adduced in favour of the view that they are microscleres and not young megascleres.

The arrangement of the skeleton at large is reticulate. The most general feature of the general conformation of the fibres is the way they pass from the surface of fixation of the sponge to the dermal membrane which they support. Along their course from one surface to the other they present a wavy appearance, often dividing and again reuniting, approaching the dermal membrane nearly always at right angles, and in many cases expanding into a brush-like structure which supports that membrane (Fig. 2—*c.*). In some of the largest lobes of the sponge the fibres nearest the centre pursue a straight course, while those furthest from that position curve outward, so as to form supports to the dermal membrane which covers the flanks of these mound-like elevations. Owing to this arrangement a longitudinal radial section of one of these lobes presents an almost fan-like appearance, as regards the skeletal fibres.

(C) The Spongin.—All the skeletal fibres of this sponge are enclosed in a distinct sheath of spongin, which is greatly thickened at the points where the connecting spicules occur, these being either partially or completely surrounded by it (Fig. 2—*b.*). Not only are the fibres and the connecting spicules enclosed in a sheath of spongin, but the surface of the sponge is covered by a thin layer or cuticle of the same substance, which dips down between the cells of the dermal membrane and communicates with that which envelopes the fibres (Fig. 2—*a.*).

(3) The Canal System.—Owing to the fact that the material which had been preserved for histological study of the sponge had been shaken considerably in moving from place to place, a great number of cells had, apparently, become loose, and were found lying in the spaces of the canal system. In consequence it was impossible to make a complete and thorough study of that system, though individual cells were in many places nicely preserved; nor is *Spongilla*, for other reasons, a favourable object for the study of the canals in the Monaxonida.

The canal system in *Spongilla moorei* belongs to the type usually described as the third. The dermal pores, which are situated on the flanks of the mound-like elevations of the surface and in the intermediate depressions, are small, and open into the subdermal cavity, which is lined by flattened epithelium, and considerably reduced by the passing through of the skeletal fibres, which are enclosed in a sheath of spongin, which is covered by cells of the epithelial layer.

The inhalant canals which pass from the subdermal cavity into the chambers are narrow and difficult to make out. In some cases these canals are short, owing to the flagellated chambers being situated close to the floor of the subdermal cavity. Those canals which pass into the chambers which are situated more deeply in the sponge are long and narrow, following a winding course, and keeping nearly always between the chambers and the fibres of the skeleton. On their way down into the deeper parts of the sponge they give off branches which open into the chambers by way of prosopyles, which are so small that it is almost impossible to make them out. The apopyle was easily distinguishable as a wide opening, communicating directly with the wide exhalant canals, and occupying nearly a fourth of the surface of the otherwise almost spherical flagellated chamber, which is lined by collar-cells with nuclei situated at their bases. The canals of the exhalant system are much wider than those of the inhalant, and, as a rule, occupy a central position between the fibres. As they pass down into the deeper parts of the sponge they converge and unite together, forming wider canals, which are few in number, and which open into the somewhat spacious gastric cavity, which communicates with the exterior by way of an osculum situated at the summit of each of the mound-like elevations of the surface.

(4) The Gemmule.—The gemmules, which are few in number and scattered about singly, are spherical in shape and small in size, measuring only ·35 mm. in diameter. They have a thin coat, which is not surrounded by spicules specially characteristic of the gemmule, but by the ordinary skeleton spicules. Their cellular contents present the same characters as do those of the common species of *Spongilla*, and each individual cell is full of the two kinds of granules which are quite characteristic of the cells of Spongillid granules. It is just possible that, had the material been preserved later in the year, the gemmules would have been more numerous, though there would appear to be no absolute necessity for the production of gemmules, since the sponges live at a depth of three hundred fathoms and cannot possibly be either dried or frozen.

THE AFFINITIES OF "SPONGILLA MOOREI."

The presence of the gemmule is the most important character tending to fix the position of *Spongilla moorei* among the Spongillidæ. Gemmules have been described in marine sponges, and this fact diminishes the importance of the existence of gemmules in a newly-discovered sponge as a character supposed to be distinctive of the Spongillidæ (Topsent). It appears that there is no special feature in the structure of the skeleton of *Spongilla moorei* that would cause it to be separated from the Chalinidæ had it been a marine sponge. It most decidedly possesses more spongin than the Spongillidæ are usually supposed to have. As a matter of fact, it is difficult to make out what structural reasons there are for retaining the family Spongillidæ. It is not at all improbable that, when they are more carefully studied, they will be distributed among the several genera of the Homorrhaphidæ. But as our knowledge has not yet attained a stage which will enable us to do this, it is deemed advisable for the present to place this new species among the Spongillidæ, and to retain that assemblage of sponges as a family, however artificial it may be.

Spongilla moorei appears to be more closely related to *Spongilla aspinosa* (Potts) than to any other species of the Spongillinæ. Both species agree in possessing spicules which are smooth, straight or curved, and for the most part rather abruptly pointed. Malformed spicules, as they are described by Potts, are found in both, but they appear to be more numerous and more complicated in *Spongilla moorei* than in *Spongilla aspinosa.* Further, both species produce gemmules which are small in size, spherical in shape, and supplied with a thin crust which is not protected by spicules characteristic of the gemmule, but by the ordinary skeleton spicules. Though the gemmules are few in *Spongilla aspinosa*, they are more numerous than in *Spongilla moorei*, a feature which may be explained either by the lesser importance and consequent scarcity of the gemmule in the latter species, or simply by the season at which the material was collected.

Spongilla aspinosa differs from *Spongilla moorei* in that it possesses small flesh spicules, which lie on the dermal membrane and among the smooth, slender skeleton spicules. These small spicules are not found in *Spongilla moorei*, unless they are represented by those which are drawn in Fig. 2—*b.*, which is probably the case. However, it must be admitted, as has been done by Potts, that in both cases these small spicules may be young megascleres, and not microscleres. The only distinction obtaining between megascleres and microscleres, viz., that the former are bound up in the general skeleton of the sponge while the latter lie scattered about freely, is a functional rather than a morphological character, and seems to break down in the Spongillidæ, whose Homorrhaphid ancestors were probably without microscleres. The consequence of this is the impossibility of deciding definitely the true character of certain spicules. It seems, however, a safe conclusion that these small spicules are the same in *Spongilla moorei* as in *Spongilla aspinosa*, though in the former they are not found in the dermal membrane, their place being taken by the cuticular layer of spongin which covers the surface.

The form of growth of these two species appears to differ. *Spongilla aspinosa* is provided with long, slender, cylindrical branches which occasionally subdivide. These branches grow from a thick basal membrane. *Spongilla aspinosa*, however, at times forms merely a sheet which envelopes the support on which it grows, while *Spongilla moorei* in all the specimens examined presented this appearance.

The spongin has not been described in *Spongilla aspinosa*, and therefore neither comparison nor contrast is possible.

The colour of *Spongilla aspinosa* is said to be green, a fact which is the result of the position in which it grows, for *Spongilla lacustris* and *Ephydatia mülleri* and *fluviatilis* may be either green or brown, according as they grow in direct sunlight or in the shade. Owing to the depth at which *Spongilla moorei* lives, the green colour of *Spongilla aspinosa* is wanting.

SPONGILLA TANGANYIKÆ (Evans).

Owing to the fact that there was but a small piece of this sponge among the material collected, it is impossible to make any statements with regard to its external form, but it must have been closely similar to that of *Spongilla moorei*, otherwise the difference would have been detected. But although thus, the two sponges are similar to one another in their habits of growth ; they are strikingly dissimilar in the characters of their individual spicules, though the general arrangement of the spicules in the fibres and of the fibres at large is strikingly alike.

The description of this species must, of necessity, be brief. The same plan will be followed, as far as possible, as in the case of the description of *Spongilla moorei.*

(1) The skeleton will be described under the following headings :—

(A) Spicules.
(B) Arrangement of Spicules, etc.
(C) Spongin.

(A) SPICULES.—It may be safely stated that there are megascleres and microscleres in this sponge. The megascleres consist of amphistrongyla and amphitornota, which are, for the most part, thickly covered with small spines. In addition to these there are a few smooth or sparsely-spined amphioxea (Fig. 3—*b.*). The microscleres are much slenderer than the megascleres, though they almost equal them in length. They are always smooth and slightly curved (Fig. 3—*a.*).

(B) THE GENERAL ARRANGEMENT.—The arrangement of the spicules does not differ materially from that already described in *Spongilla moorei.* The spiny amphistrongyla and amphitornota, together with a few smooth or sparsely-spined amphioxea, are arranged with their axes parallel to one another to form the skeletal fibres. These divide and again reunite, producing an arrangement which is usually described as being reticulate. The fibres are connected together in many places by spicules which bridge over the intermediate spaces. These spicules are the largest in the whole sponge, as a rule, as was found to be the case in *Spongilla moorei.* In addition to these there are many spicules, both spiny and smooth, which appear to lie about more or less freely in the tissues. The slender microscleres are nowhere connected with the fibres, but lie absolutely free in the tissues.

(C) THE SPONGIN.—The spongin is not so highly developed in *Spongilla tanganyikæ* as in *Spongilla moorei.* The former, therefore, in this respect resembles more closely the ordinary species of Spongillidæ than the latter appears to do. The spongin does not appear to extend to the surface, and the layer which covers the fibres is correspondingly thin. The greater development of spongin occurs at points where the fibres branch or reunite, and at the places where the connecting spicules penetrate the fibres.

(2) THE GEMMULE.—Though there was but a small piece of this sponge, it happened to contain several gemmules. These are devoid of spicules, but are surrounded by the ordinary skeletal spicules and the microscleres ; they possess a thin coat, as in *Spongilla moorei*, and are spherical and of small size. As regards their cellular contents, they present the ordinary characters of the Spongillid gemmule.

a.

b.

Fig. 3.—*a.*, A portion of the skeleton of *Spongilla Tanganyikæ.*
b., Spicules of *Spongilla Tanganyikæ.*

AFFINITIES.

This subject must be considered from two aspects. In the first place, the character of the gemmulæ must be taken into consideration, since the grouping of the Spongillidæ into the three sub-families, Spongillinæ, Meyeninæ and Lubomirskinæ, and the division of the sub-families into genera, usually adopted, depends on these characters. In the second place, the spicules are of great importance, as presenting a close resemblance to the spicules of *Lubomirskia intermedia* var. a (Dybowski, cf. pl. iv., fig. 3, *b*), which belongs to the sub-family Lubomirskinæ.

(A) The Gemmule.—The gemmule of *Spongilla tanganyikæ* lacks the amphidiscs which surround the gemmule of the Meyeninæ. It therefore appears that the species cannot belong to that sub-family. But it equally lacks the small spicules which are usually found in close relation with the gemmule of the Spongillinæ. Potts, however, places *Spongilla aspinosa* among the Spongillinæ, in spite of the fact that its gemmules lack characteristic spicules. If this arrangement be followed, the absence of such spicules from *Spongilla moorei* and *Spongilla tanganyikæ* should not be considered as a barrier against including these species among the Spongillinæ. But the inclusion does away with the importance of the presence of special gemmule spicules as a sub-family character.

The thin coat of the gemmule resembles that found in *Spongilla moorei*, *Spongilla aspinosa* and others of the spongillinæ, and has no similarity to the thick coat of the gemmule of the Meyeninæ. The characters of the gemmule, therefore, as far as they go, point to this new African species as being one of the Spongillinæ.

(B) The Spicules.—It is generally stated that the skeletal spicules of the several species of the Spongillidæ have no characters of higher than specific value. It is difficult to make out from the literature of the family how far such a statement is justified. However, the spicules of *Spongilla tanganyika* possess such characters that it is almost impossible to believe that they have not a wider application. This sponge, considered from the point of view of the skeleton, seems to present a certain amount of affinity with a few species of the Spongillinæ on the one hand and of the Lubomirskinæ on the other.

The megascleres of the greater number of species arrayed under the sub-family Spongillinæ are sharp-pointed, that is, they are either amphioxea or amphitornota. There are, however, a few species which possess spicules with rounded ends, that is, amphistrongyla. The species in question are *Spongilla nitens* (Carter), *Spongilla böhmii* (Hilgendorf) and *Spongilla loricata* (Weltner), to which may be added *Spongilla tanganyikæ*, now described for the first time. *Spongilla tanganyikæ*, therefore, seems to be more closely related to these species, so far as the characters of the skeleton are concerned, than to any other species of the Spongillinæ. Of the three specie named above it appears to present closer affinity with *Spongilla böhmii* than with either of the other two, for in *Spongilla nitens* and in *Spongilla loricata* the amphistrongyla are smooth, while in both *Spongilla böhmii* and *Spongilla tanganyikæ* they are spiny. In the former the spines are more thickly set at the end, which is a special feature of the megascleres of some species of the Lubomirskinæ, and which may point to a certain amount of affinity in that direction, while in the latter they are evenly distributed over the whole spicule. In *Spongilla böhmii* the megascleres are curved as in *Spongilla nitens*, *Spongilla loricata* and most of the Lubomirskia, while in *Spongilla tanganyikæ* they are straight. However, there is among the Lubomirskinæ a variety of *Lubomirskinæ intermedia*, described by Dybowski as var. a, in which the spicules are spiny and almost straight. The spines are evenly distributed, and in many cases the ends of the spicules present the amphistrongylote character. Another feature of *Lubomirskia intermedia* agreeing with *Spongilla tanganyikæ* is that the microscleres are smooth and almost equal to the megascleres in length. In *Lubomirskia bracilifera* and *Lubomirska papyracea* the spicules are Amphistrongylote, though in the former the spines are arrayed at the ends of the spicules, in contrast with those of *Spongilla tanganyikæ*, but to a certain extent agreeing with those of *Spongilla böhmii*, while in the latter the spines are evenly distributed over the shaft of the spicule, in contrast with those of *Spongilla böhmii*, but similar to those of *Spongilla tanganyikæ*.

From these points of comparison it seems that *Spongilla tanganyikæ*, as well as *Spongilla böhmii*, must be closely related to the Lubomirskinæ. Had it not been for the presence of the gemmule in the small piece of *Spongilla tanganyikæ*, I should certainly have placed it among the Lubomirskinæ. On the other hand, were the gemmules to be found in any species of the Lubomirskinæ, the Tanganyika form would have to be removed from that sub-family as at present defined. Consequently, I venture to suggest that the sub-family Lubomirskinæ should be abolished and the species contained in it placed under the Spongillinæ, which then could be arranged into a number of genera according to the character of their megascleres.

POTAMOLEPIS WELTNERI, MOORE.

With respect to this curious form nothing more can at present be said than that it is a sponge growing in the deep water of lake Tanganyika ; that in the single specimen obtained it appears as a thin brown encrustation on a Paramelania shell ; that it has thick, slightly curved spicules which, unlike those of *Potamolepis leubnitziæ*, are slightly swollen at the ends, and that in general the enlarged ends of these spicules are micropunctate. It should, however, be noted that the characteristic spicules of this new form are closely similar to those of the old fossil genus *Renieria*.

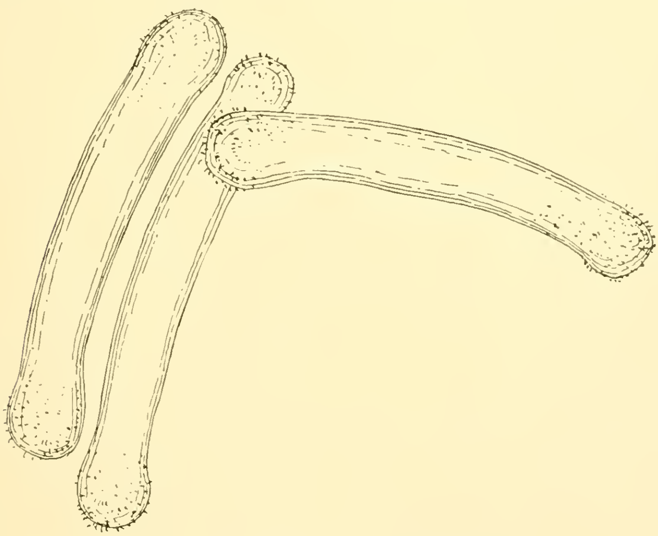

Fig. 4.—Spicules of *Potamolepis Weltneri*.

PROTOZOA.

With respect to the unicellular organisms which are found in Lake Tanganyika, I have encountered only two forms which seem to call for any special mention. It may be remembered that, in Livingstone's diary of his last journey, the explorer noticed that at times the surface of Tanyganyika was at times covered with what he called a "yellow scum," and which, he says, he thought to be of "vegetable origin."

I have encountered this scum repeatedly on the lake, the clear green for miles appearing as if tinged with a fine golden dust, the minute particles of which this is composed reflecting the bright sunlight, like the crystals of some yellow precipitate.

Upon examination these yellow clouds were found to consist of a large infusorian which at first sight looked exactly like a *peridinium*, having the characteristic equatorial groove, but on closer scrutiny the whole organism was found to be covered with long cilia which projected in lines from the pore-like apertures in the plates of the skeleton. But for the groove the animal would thus compare with a large *colpodium*.

Whatever it really is, this organism is a most conspicuous object. I have never seen it in any of the other lakes, and it appears to be as characteristic of Tanganyika as the rest of the members of the Halolimnic group.

Associated with the above form, and also present in the surface scum, there is a large *condylostoma*, the affinities of which are not doubtful ; and besides these two conspicuous and characteristic protozoa, there were found about twenty recognisable. types belonging to those groups which have habitually been encountered in the fresh-waters of the tropics.